INDIAN OCEAN TURTLE NEWSLETTER

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The Indian Ocean Turtle Newsletter was initiated to provide a forum for exchange of information on sea turtle biology and conservation, management and education and awareness activities in the Indian subcontinent, Indian Ocean region, and south/southeast Asia. The newsletter also intends to cover related aspects such as coastal zone management, fisheries and marine biology.

The newsletter is distributed free of cost to a network of government and non-government organisations and individuals in the region. All articles are also freely available in PDF and HTML formats on the website. Readers can submit names and addresses of individuals, NGOs, research institutions, schools and colleges, etc. for inclusion in the mailing list.

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Cover photograph: Flatback turtle in Western Australia

Photo Courtesy: Julian Kalau

IOTN is available online at www.iotn.org

EDITORIAL

EDITOR'S NOTE

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In response to questions about how to prolong satellite tag life or analyse telemetry data, I invited researchers from across the region to contribute their "tips and tricks" for satellite telemetry. Their responses to a series of questions are summarised in the first article of IOTN40. Some of the suggestions are similar across most or all of the researchers, while other responses are unique to the species or context in which they conduct telemetry studies. I hope that readers interested in or conducting satellite tracking find the article enlightening and useful. Other articles in this issue report on a stranded and entangled juvenile green and hawksbill turtle. These records, while seemingly brief, give us more data points on the habitat of different species and age-classes.

IOTN40 also includes two announcements. The first is for the 2025 sea turtle symposium, which is the 43rd in the series that has been organised by the International Sea Turtle Society and the first to be held in Africa. It promises to be an exciting event, and I look forward to seeing those from the region who are able to travel to Ghana next year. The second announcement introduces the new Olive Ridley Podcast, which explores a diverse array of topics and includes speakers from countries across the Indian Ocean. The last article in this issue summarises recent research on the ecological role of sea turtles in terrestrial food webs.

The coordinated special issue with MedTurtle Bulletin, highlighting work on the rescue and rehabilitation of sea turtles, was rescheduled to January 2025 so that more organisations and individuals had the opportunity to submit articles. Submissions for the special issue should be sent to iotn.editors@gmail.com by early October 2024.

CALL FOR SUBMISSIONS

The Indian Ocean Turtle Newsletter was initiated to provide a forum for the exchange of information on sea turtle biology and conservation, management and education and awareness activities in the Indian subcontinent, Indian Ocean region, and south/southeast Asia. If you would like to submit a research article, project profile, note or announcement for Issue 41 of IOTN, please email material to iotn.editors@gmail.com before 1st October 2024. Guidelines for submission can be found on the last page of this newsletter or at http://www.iotn.org/submission/.

ARTICLES

TIPS AND TRICKS FOR SEA TURTLE SATELLITE TELEMETRY

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DESCRIBE YOUR EXPERIENCE WITH TRACKING IN THE INDIAN OCEAN AND SOUTH-EAST ASIA REGION

Adhith Swaminathan: In 2010 I had the opportunity to work on leatherback sea turtles in the Andaman and Nicobar Islands, India. Little did I know that a year into the project, we would be attaching satellite transmitters on nesting leatherbacks for the first time in India. Between 2011-2014, Dakshin Foundation in collaboration with the Centre for Ecological Sciences, Indian Institute of Science, Bangalore and the Andaman Nicobar Environment Team deployed 10 transmitters in the West Bay of Little Andaman Island to study migratory routes and identify foraging sites. We used Platform Terminal Transmitters manufactured by Sirtrack (which was officially renamed Lotek NZ Ltd after the acquisition) model Kiwisat 202 that were specifically designed for leatherbacks to be surgically attached using the direct attachment method. Two transmitters deployed in 2014, gave us 266 and 395 days of data and these individuals even returned to nest after several years with no evidence of a transmitter attachment. More recently in 2023, I also assisted in the deployment of two transmitters (SPOT-317C) by Wildlife Computers on leatherbacks nesting in Sumatra, Indonesia.

ALan Rees: I have been involved in tracking sea turtles, with Argos satellite tags in the Indian Ocean since 2006, having tracked over 30 turtles from Oman, Kenya, Kuwait and Saudi Arabia. These tags were deployed on loggerhead, green, olive ridley and hawksbill turtles. Most tags were deployed on nesting turtles, but several were deployed on rehabilitated juvenile and subadult green turtles in Kuwait. I have also led projects tracking over 50 loggerhead turtles in the Mediterranean, since 2002, which have involved tracking adult male and female turtles as well as juveniles and subadults.

Nick Pilcher: I have had the great pleasure of being involved in numerous projects across the IO and SEA, and this has given me the opportunity to deploy transmitters on sea turtles in some interesting locations. I tracked seven post-nesting green turtles from Con Dao, in Viet Nam in partnership with WWF-Vietnam. I then tracked five juvenile green turtles from Mantanani island in Malaysia, hoping to see where their secondary foraging grounds were – but none went anywhere! I also tracked 25 post-nesting green turtles from the Turtle Islands Park in Sabah, Malaysia, and watched them move throughout the Sulu Sea and beyond into the Sulawesi Sea and the South China Sea. Between 2010 and 2014 in partnership with Emirates Wildlife and numerous national partners we deployed a total of 102 transmitters on post-nesting hawksbill turtles from multiple locations in Iran, Oman, Qatar and the United Arab Emirates and found that there was little movement in and out of the Straits of Hormuz. Gulf hawksbills mostly stayed inside the Gulf. Alongside Emirates Nature and partners in the United Arab Emirates in 2016-2019, we then deployed 75 transmitters on foraging green turtles at Ras Al Khaimah and out on Bu Tinah Island, some 80km off the coast of the UAE.

This last one was a fun project because we had to reverse engineer our plans to track reproductive turtles. From a nesting beach it is a relatively straightforward process to select a turtle and deploy a transmitter. But at these foraging grounds things were far more complicated. We needed to catch and tag turtles in breeding condition, so that they could be tracked when they migrated to nest. And this required being able to identify which turtles were adults and, among these, which were reproductively active. As you know, sea turtles do not breed every year, nor do they do so year-round. But the satellite transmitters used on this project were programmed to last between nine and 12 months. If our team caught a turtle at random and put a transmitter on it, there would be no guarantee that it would be an adult, or more precisely, that it would migrate to nest that year, and therefore the project might not get any

migration data or be able to link feeding and nesting sites. To solve this, I used a small surgical procedure called laparoscopy. This allowed me to determine the sex and the age class of the turtles, and importantly if they were in breeding condition. Laparoscopy is a delicate procedure that involves making a small incision close to the rear flippers and inserting a scope with a fibre optic light supply to look at the reproductive organs. Once the sex and reproductive condition were determined, and the turtles selected for tracking, the incision was sewn up with two stitches and the turtles were ready for the attachment of satellite transmitters.

Paul Whittock: I have attached tracking units to 40 flatback turtles and four green turtles in Western Australia, as well as five olive ridley turtles in the Philippines. All units were placed on adult female turtles during their nesting activities on the beach. For flatbacks, we use a harness approach for attaching the units due to the poor adherence of epoxy to their carapace. The purpose of these attachments was to provide a better understanding of their movements and behaviour around client infrastructure and offshore activities during their inter-nesting phase. They also provided valuable insights into their post-nesting migration and foraging phases.

TIPS AND TRICKS FOR SATELLITE TELEMETRY

Choosing a satellite tag to meet your research objectives

Adhith Swaminathan: Argos-only tags are cheaper and the batteries also tend to last longer in comparison to FastGPS tags. These tags are great for tracking migratory routes and identifying foraging sites. FastGPS tags are more expensive but provide better spatial resolution, which might be crucial to study inter-nesting movements and foraging behaviour. Both tags have an option of adding dive sensors to collect dive data, which increases the cost and affects the battery life of the tags.

ALan Rees: Choice of tag involves a trade-off between two competing components that are driven by the normal limitation of constrained funding. These are sample size (the number of tags you can deploy) and data requirements (the need for accurate location data or other data such as dive behaviour). In general, if the research question only requires broad-strokes location data – typical for determining post-nesting migration routes and overwintering grounds – then the cheaper Argos location only tags are sufficient. However, if the objective is to study fine-scale movement in a foraging or internesting area then more expensive tags with accurate GPS derived locations (which may cost approximately double the Argos location only tags) are required. Similarly, if understanding use of the water column is required then more expensive tags with pressure sensors are what you need. It should be noted that projects can use more than one style of tag to generate location or other data, for example most tags in a study can be simple Argos location only tags, but a subset have pressure or GPS sensors to enhance the overall results. Where more than one style of tag is used it is important to ensure they are all programmed in such a way as to generate comparable datasets. Ensuring data compatibility is most important for pressure sensing tags where, for example, time and depth thresholds can be set by the user to qualify the onset and end of dives or separate depth bins.

Nick Pilcher: Choosing the right model is all about knowing what the research question is to start with. Transmitters are just the tools with which we acquire information. They are not the information themselves. So, prior to choosing a transmitter the real question is 'What do I want to know?" Once you clearly articulate the objective of the study, choosing the right transmitter is likely to be the easy part. Transmitters that rely on Argos services provide location data that are typically far coarser than those that rely on Fastloc GPS data, but while 'Argos' data is often perceived as being of lower quality than Fastloc GPS data, a lot depends on what the researcher is after. The degree of precision between the two data services, in some cases, can be quite comparable, it just depends on what the question is, and the precision required. A rule of thumb I use is as follows: If you want to get a large-scale idea of where turtles travel after nesting, with a goal of identifying the general areas where they feed, then Argos data is probably more than sufficient for your needs. If knowing which headland they round on the way to a feeding area, you probably need something with greater spatial resolution. One last thing about these transmitters is that they are not the only choices out there. There are Iridium tags that transmit data through the Iridium satellite communications constellation, and there are GSM tags that rely on the signal being picked up by a phone communications tower. While these are not located all over the oceans, the system would work if you wanted to track internesting movements of sea turtles when they are close to shore. Another thing is that they can store the location data and upload it all when they are next in contact with a receiving station. For me another important consideration is also the design. I find that the transmitters with 'rhino' horns at the front end provide better protection for the antenna – and trust me, turtles go to no small measures to knock the units off! And then there is cost: Fastloc transmitters are double or more than the price of Argos location transmitters, so this is likely another key consideration in your selection process.

Paul Whittock: The weight of the tag, as a proportion of the animal's weight, should be a primary consideration. If the tag is too heavy or too large, it may affect the animal's movement and behaviour, potentially biasing your research findings.

Consider the spatial scale and location accuracy necessary to meet your research objectives. This will help determine whether cheaper tags that generate low accuracy Argos locations are sufficient or if more expensive highly accurate Fastloc GPS tags are required. For example, if you aim to understand movement across an ocean, high accuracy may not be essential, whereas tracking movement around infrastructure or within a small harbour may require high accuracy.

Transmitter programming

Adhith Swaminathan: Transmitters can also be programmed to collect data at different intervals depending on the objectives. This can significantly reduce or increase the battery life of the transmitter. Since our project objectives were to identify the migratory routes and their foraging sites, we programmed the transmitters to transmit data continuously for the first 3 months and every alternate day after that as we prioritized longer battery life through low usage. The transmitters were also fitted with a salt-water switch that automatically turned on the transmitter to send the data when the turtle surfaced to breath.

ALan Rees: Sat tags have two kinds of transmission scheduling. The first is repetition rate which is how frequently the tag sends transmissions when at the ocean surface. This is programmed at the time of manufacture. The interval between transmissions used to be around 40 seconds but more recently 15 second intervals are more common. Given the accuracy of an Argos location depends in part on the number of transmissions received by the passing satellites, the reduced interval has led to an increase in the number of higher quality Argos locations generated per tag per day. The second scheduling is called duty cycling and is a user defined schedule on when the tag sends transmissions and when it is dormant. My advice is to not schedule dormant periods to save battery as battery running out is rarely the cause for the tags to stop working and hence you lose data that could be acquired during the dormant periods. However, there are certain 'dead times' in different parts of the globe where there can be reliably predicted to have little to no satellite coverage per day, and scheduling your tags to be quiet during those periods can extend battery life with no detriment to data collection. Note though that CLS will have a new fleet of satellites coming online in the not-too-distant future and these will hopefully dramatically reduce the coverage 'dead times.' Check with your tag manufacturer about appropriate duty cycling for your tags at your deployment location.

The other programming your tags may require varies according to your need for additional data (e.g. GPS derived locations and depth utilisation). Again, talk with your tag's manufacturer to discuss their tags capabilities and optimum settings.

Nick Pilcher: One thing I have repeatedly heard is about how researchers want to get the longest tracking plots they can, and sometimes they programme their tags to be off for a certain number of hours or even days to extend battery life. But turtle biology is rather predictable, and in my opinion, it is best to keep the transmitters sending signals frequently. This is because today's units (certainly those typically used to track post-nesting female or larger male turtles) have battery systems that can last for a good 9 to 12 months. This means that if a nesting season lasts two to three months, and a migration lasts another month or two, the battery would have sufficient power in most cases to track the turtle to its feeding area. And once there, how much data is needed to identify it as a feeding area? A month or two? If the turtle stayed six months, would it be any different of a feeding area? If the question (as noted above, it is always about the question) is about identifying where the feeding areas are, how long is 'long enough' to identify these clearly? In my opinion a month or two of data is more than sufficient. If the question is about extent of feeding areas and feeding area use, there may be reasons to programme a tag differently, but in my opinion the more data we get during internesting and migrations and arrival at the feeding areas, the better we expand our knowledge of sea turtle biology.

Paul Whittock: Discuss your research objectives and data collection priorities with the tag manufacturer. They have the expertise to program the tag to ensure your needs are met. They generally have the best understanding of how the tag may perform in your case. For instance, if you are particularly interested in capturing data during a specific period, such as inter-nesting, the tag can be programmed to maximise location and dive data collection during that time.

For peace of mind, verify that the option for the tag to turn on automatically when the turtle dives below a particular depth is turned on. This way, if you forget to turn the tag on, it will turn on (and stay on) once the turtle returns to the ocean.

Transmitter attachment

Adhith Swaminathan: I have only used transmitters with the direct attachment method. This requires additional equipment and materials that do not come with the transmitter. I would advise procuring all these before heading to the field site as some of these materials (like Equinox 40 (slow-set silicone putty that is placed between the tag and the leatherback's dorsal ridge to ensure a conformed fit), battery-operated drill, orthopaedic drill bit) might not be readily available. During the deployment in Indonesia, we had to use dental putty as we could not source Equinox 40. Though the Dental putty works great as a substitute, it has very little curing time, so we had to ensure that the tag was snug and secured in place within two minutes.

ALan Rees: I have used several methods of attaching tags to turtles such as seating the tags on silicone elastomer before covering them in fibreglass and polyester resin or encasing the tags in viscous marine two-part epoxy. For the last six years I have been using the method recommended by Wildlife Computers, generally using the kits that they supply to go with their tags. This involves sticking a base plate of fibreglass on the turtle's carapace with epoxy, attaching the tag to the baseplate using 'putty epoxy' with a final wrapping of the tag using strips of epoxy-soaked fibreglass. It is possible to make equivalent kits purchasing the components separately, though take care to purchase the correct epoxies otherwise you may find yourself waiting for several hours with your turtle while the epoxy cures instead of a matter of minutes (learned from bitter experience!).

However, before you get to the attachment stage you need to prepare the carapace. This involves removing all epibionts and sanding away flaking parts of scutes. I choose the second vertebral scute to position the tag. When doing this on the beach at night, do not be afraid to use white light to inspect the carapace. It is not possible to correctly identify that all epibionts (algae etc) have been removed under red light, so white light is imperative. If you leave any live stuff under the tag, it can only cause problems for tag retention. Do not sand through the dead keratin scute towards the live tissue below. Live tissues ooze and this ooze, like algae, will only cause problems for tag retention. As a last stage before attaching the transmitter, give the sanded area of carapace a good rub over with a clean rag soaked with acetone. This will clear away any powder from the sanding process and remove grease, which will improve tag adhesion. Do not touch the cleaned surface. Always clear an area larger than the zone that will be covered by your tag and epoxy to give yourself and the tag a buffer from epibiont growth. You can use a marker pen to outline the area covered by the fibreglass baseplate to ensure you have cleared enough area of the carapace and to guide you when you place the first layer of epoxy. To ensure repeatability in your attachment process – if following the Wildlife Computers method – count the number squeezes on the epoxy 'gun' that you use per stage. For example, I find five squeezes extrudes sufficient epoxy for attaching the baseplate fibreglass layer. Talking about fibreglass, precut the fibreglass to required sized pieces prior to going into the field and minimise the number of fraying threads on the pieces as they are a pain to deal with while spreading epoxy. I found that placing the cut fibreglass pieces between folded sheets of ~A4 sized paper keeps them in pristine condition ready for the attachment process.

Nick Pilcher: In Malaysia I have had a hard time sourcing the right Sika epoxies and have had to import them sometimes from Australia. But I find that the fiberglass and resin method is extremely reliable, and pretty much anywhere that manufactures anything in fiberglass will have the materials (resin, catalyst and mat) available. It takes longer and can be a bit messier, but I personally feel it holds better, and the fact that the materials can be readily found pretty much anywhere means it is an attachment protocol of choice for me.

Another thing I like to use, particularly with hawksbill and juvenile turtles whose carapace is not gently rounded but rather 'peaks' in middle, is Elastomer. This is a two-part silicone product that can be moulded to form a baseplate so that the transmitter sits flat on the turtle when the dorsal ridge is prominent. The product I use is called Sammons Preston Rolyan® 50/50 Mix™ Elastomer Putty.

Paul Whittock: Many of the epoxy/resin glues, epoxy putties, cleaning fluids, and anti-foul paints used in the attachment process are hazardous and must be handled according to the manufacturer's Material Safety Data Sheet (MSDS). Make sure that people using these chemicals wear the specific personal protective equipment, including gloves, safety glasses, and full-length clothing. Also, due to their hazardous nature, many of these chemicals are also prohibited from air travel. Therefore, you should either source them locally or allow plenty of time to transport them using a dangerous goods freight forwarder.

Ensuring animal welfare is the top priority when attaching tags. Securing the animal in a pen to prevent movement minimises both disturbance and improves the attachment process. Additionally, placing a cloth over its eyes, while keeping the nostrils uncovered, further

reduces disturbance to the animal.

"Fail to plan, plan to fail!" Make sure all equipment needed for the attachment process is available and stored in a designated location. Using labelled containers within a waterproof duffel bag for transport can greatly improve organisation when on the move.

If applying an extra coat of anti-foul after attachment, ensure there is sufficient time for it to dry before releasing the animal. Biofouling is a major cause of tag failure, so taking the time to apply it correctly could significantly improve the longevity of your transmission time.

Data analysis

Adhith Swaminathan: I found STAT (Satellite Tracking and Analysis Tool) on seaturtle.org very easy to use, especially to produce basic maps with some environmental layers. It's best to seek help from friends and colleagues to analyse the data, especially if you do not possess the knowledge and skills.

ALan Rees: You should have already thought about what data analyses you want to carry out before you selected your tag type, and had it programmed so the data you collect will be sufficient for your needs, which all ties in with the research question you are asking. If you do not have the technical skills yourself or within your group to complete the analysis, then it is worth reaching out to colleagues who can do so. Again, it is probably a good idea to make such arrangements prior to purchasing and programming your tags to ensure maximum utility of the data they generate.

Nick Pilcher: There are some powerful modelling tools available if you have access and the right skills, but for me the simplest way to interpret the data is visually. We know that sea turtles deposit multiple clutches of eggs in a season, and so we can account for movements in an internesting area between these events. We also know that turtles migrate back to home feeding areas after nesting is concluded, and that they reside in these areas for substantial periods before nesting again. Multiple tracking records across the planet tell us that the migrations are usually direct, and do not involve stopping to feed or other detours. Armed with this information, we can then infer what turtles might be doing from the data derived from satellite transmitters. I normally import the location points into a GIS package like QGIS, and manually edit the data set, deleting all erroneous points. I then look at the data and classify all points that are received after tag deployment and before a purposeful departure point from the nesting site as internesting (the period when turtles may be laying additional clutches of eggs). Within these data sets, subsequent nesting events could be presumed based on known internesting interval for sea turtles at that site. Next, location fixes after the purposeful departure can be categorised as migration fixes (direct purposeful travel from the nesting site with minimal deviation from a straight path). Finally, foraging activity at the home feeding areas can be inferred by a reduction in travel rates and a shift from purposeful migration direction and unidirectional orientation to short distance movements with random heading changes. Of course, Fastloc data allow even greater interpretation, as the data points might tell you exactly what beach they emerged on to lay eggs, and have far less ambiguity and variation than Argos data.

Another thing about data analysis relates to sample size and what we infer from the data set(s). One track from A to B does not tell us much about a population. It tells us a lot about that turtle, but it is not until we have a robust sample size that we can start to make inferences on where a population of turtles goes after laying eggs, or where they come from. Another thing to consider is what a turtle might have been doing when the signals ended. If a track was headed in a certain direction and then simply ended, would it be reasonable to assume the turtle had reached its home feeding areas? Or could the signals have ended in the middle of a migration? If we knew the turtle had reached an area where she subsequently spent several months moving around in short random movements she likely reached home. But an abrupt end to a track is likely not as informative.

Paul Whittock: Recording a large number of locations in a particular area does not necessarily indicate more time or usage by a turtle compared to another area with fewer locations. The turtle may have spent more time in the area with fewer locations, but data transmission issues could have occurred. Data analysis must therefore account for this imperfect dataset by temporally separating the dataset. This can involve selecting one location within a particular timeframe or using more complex state-space models to standardise the dataset across the time period.

Received location data should be filtered to remove biologically implausible locations based on inferred swim speeds between locations and excessive turning angles. This can be done through simple filtering in a spreadsheet or automatically using specialised R packages.

Track reporting

Adhith Swaminathan: Sharing the tracks with the local

communities and administration has always been a rewarding experience for us during our sensitisation or capacity-building workshops. Having the tracks accessible through platforms like STAT will be very valuable as people can track these animals in real-time.

ALan Rees: When presenting your tracking data, always indicate the species, life stage and – if possible – sex of the turtle(s) you are tracking. The start and end dates also should be reported. It used to be commonplace to report on the number of locations of different accuracy that were obtained from the tag over its lifespan, but with vastly improved capabilities of tags in recent years this type of information is now rarely required or useful. Try to publish your tracking studies as soon as possible after data acquisition is completed. Tracking turtles takes a lot of effort and relatively large sums of money so the results of your study should be shared with the community to increase the value of your work. Also consider sharing your tracking data with other researchers so that they may be used in meta-analyses thus adding further value to the work you have carried out.

Nick Pilcher: This is the hardest part of tracking for many people, but I actually find that once I have done all the graphics and made sure I have tidied up the tracks, it is actually not that hard to describe the movement pattern for turtles. I find that sometimes it is useful to put the movement patterns into 'bins'. For instance, several turtles went off in this direction, and a number of others followed the coast and went off in a different direction. That way you can simplify the graphics and guide the reader through what you found. The recent project tracking foraging animals was fun because we tracked them to their nesting beach, waited while they deposited all their clutches of eggs, and then watched them come back to their original feeding areas. That was an amazing tracking feat!

But I think it is super important to get the data published in one form or another, and also added to large global data sets like SWOT, OBIS Seamap or the like, so that it can be of use long after you get what you need and help inform on larger ocean migration patterns.

Paul Whittock: Data from satellite-tracked turtles is incredibly engaging and provides a unique opportunity to showcase their vast ocean-wide migrations, impressive diving ability, and the threats they face during their journey. Many tag manufacturers offer tools to share live data through maps that can be easily embedded on a website or shared on social media. If sharing data this way, be prepared to explain the turtle's fate if the tag stops transmitting, which is more likely due to tag failure rather than an issue with the turtle itself.

"Publish or be damned" was the motto I repeatedly heard with regards to reporting tracking data collected with expensive satellite tags. While track data can be presented in grey literature, client reports, or at conferences, it is best shared in the public domain through a peer-reviewed publication. This not only adds credibility to the recommendations made but also fosters collaboration and leads to better conservation outcomes.

Editor's note: Fastloc and FastGPS are trademarked methods for acquiring GPS locations with only small snapshots of GPS data.

Notes

RELEASE OF A HAWKSBILL TURTLE CAUGHT LIVE IN A GHOST NET- AN OUTCOME OF CITIZEN SCIENCE INITIATIVES AT CAR NICOBAR, ANDAMAN AND NICOBAR ARCHIPELAGO

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The issue of sea turtles becoming entangled in abandoned ghost nets has been reported across the world and is now a threat to sea turtles in some regions, including the Indian Ocean (Wilcox *et al.,* 2013; Stelfox & Hudgins, 2015; Tyabji & Patankar, 2017; Stelfox *et al.,* 2020). The issue of ghost nets and their potential impact on sea turtles has previously been reported in the Andaman Islands but not elsewhere in the Andaman and Nicobar archipelago (Tyabji & Patankar, 2017).

In the Nicobar Islands, Car Nicobar is a small island inhabited by tribal groups who depend on marine fishing activities for their livelihood and subsistence needs (Kiruba-Sankar *et al.,* 2020, 2023a). During fishing operations on the forenoon of 1st April 2024, in the coastal waters off Teetop village of Car Nicobar, some tribal Nicobarese fishers spotted a live sea turtle trapped in a floating ghost net (Figures 1 and 2). As part of the citizen science initiatives implemented in Car Nicobar, the tribal fishers were aware of the ecological significance of sea turtles and the need for their conservation (Nicobar Times, 2023, 2024). They approached the ghost net and removed the entangled turtle by cutting the net, then released the sea turtle after it was freed. Examination of videos and photos identified the turtle as a juvenile hawksbill turtle (*Eretmochelys imbricata*) (Figure 3). In a video shared by the fishers, the authors of this observation could see a decomposing dead turtle also entangled in the net, however, we could not identify the species.

Hawksbill turtles are recognized as keystone species in coral reef and seagrass ecosystems (Patel *et al.,* 2022). The Andaman and Nicobar Islands are home to nesting and foraging populations of hawksbill turtles (Bhaskar, 1979, Swaminathan *et al.,* 2017). Sea turtles in the area may be legally caught for local consumption by tribal

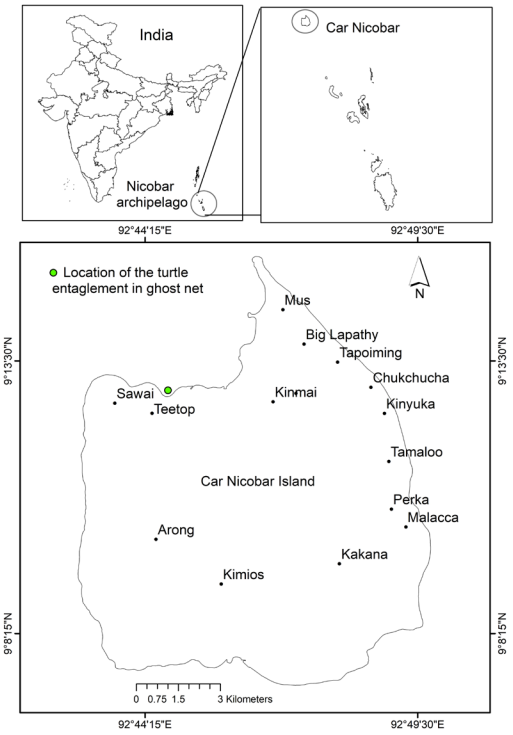

Figure 1. Location of ghost gear at Car Nicobar.

communities (Kiruba-Sankar *et al.,* 2023b).

Understanding the dynamics of sea turtle abundance in the Car Nicobar coastal waters has been the primary focus of the collaborative program launched by ICAR-Central Island Agricultural Research Institute, Port Blair, and the Department of Science and Technology, New Delhi. A series of awareness programs supported the citizen science initiatives on sea turtle monitoring (Nicobar Times, 2023, 2024) which led to the report of

Figure 2. Juvenile hawksbill turtle entangled in ghost gear at Car Nicobar. (Photo credit: Junaid Khan)

Figure 3. Juvenile hawksbill turtle freed from ghost gear at Car Nicobar. (Photo credit: Junaid Khan)

this turtle entangled in a ghost net.

Abandoned fishing gear remains a hazard to marine wildlife in the coastal waters of Car Nicobar Island (Kiruba-Sankar *et al.,* 2023c). In the future, more knowledge about the detrimental impacts of abandoned fishing gear on vulnerable marine animals, like sea turtles, should be facilitated through interactions with the local communities. To stop future occurrences of entanglement, the local tribes could also be involved in recovering abandoned fishing gear from Car Nicobar's waters.

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JUVENILE GREEN TURTLE STRANDED AT THIKKODI BEACH, KERALA, INDIA

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In the coastal regions of Kerala, India, olive ridley turtles (*Lepidochelys olivacea*) nest at low densities along the sandy shores while olive ridley, green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles forage in the state's waters. Sea turtles in Kerala face significant threats, including habitat loss, pollution, climate change and accidental capture in fishing gear (Bhupathy, 2007).

A dead juvenile green turtle (Figure 1 and 2) was found stranded on Thikkodi beach, Kolavipalam, Calicut, Kerala, on 11th December 2023. The stranding location was ~10km from the known nesting beach of olive ridley turtles at Kolavipalam Beach, Kerala. The stranded turtle was in a relatively fresh condition when found, and weighed 32kg (Delta Digital Scales, max 200kg capacity).

The northern Indian Ocean subpopulation of green turtles was recently assessed as Vulnerable on the IUCN Red List (Mancini *et al*., 2019). In India, all species of sea turtle are included in Schedule-I part (2) of the Indian Wildlife (Protection) Act, 1972. There is one other

Figure 1. Dorsal View of the Stranded Juvenile Green Turtle. (Photo credit: Ramya Abhijith)

Figure 2. Ventral View of the Stranded Juvenile Green Turtle. (Photo credit: Ramya Abhijith)

stranding of a green turtle from the same beach (Abhijith *et al.,* 2020) but no regular survey for stranded turtles or in-water surveys to understand threats and abundance of sea turtles in the area.

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ANNOUNCEMENTS

ANNOUNCEMENT FOR 43RD INTERNATIONAL SEA TURTLE SOCIETY SYMPOSIUM ON SEA TURTLE BIOLOGY AND CONSERVATION, 22ND – 27TH MARCH 2025 IN ACCRA, GHANA

ANDREWS AGYEKUMHENE

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In March 2025, the 43rd International Sea Turtle Society Symposium on Sea Turtle Biology and Conservation, hosted each year by the International Sea Turtle Society (ISTS), will be held in the beautiful country of Ghana in the city of Accra. This is the first time that the Symposium will take place on the African continent. The theme of the Symposium is "*Unity and Collaboration*" which underscores the need for the global community of turtlers to unite and foster strong and lasting collaborations to achieve our overarching goal of ensuring that sea turtles continue to thrive around the globe and play significant roles of sustaining ecosystems and species. The Symposium will be held from 22nd-27th March 2025 at the Mensvic Grande Hotel. The Mensvic Hotel offers world-class accommodations, cuisine, and hospitality, while the city of Accra boasts a rich and diverse cultural heritage of Ghana and Africa and provides opportunities to explore important nearby sites of cultural significance, National Parks, extensive shopping, and visits to the University of Ghana (formerly University College of Gold Coast) which is the premier University of the country. We expect more than 500 participants from around the world to attend the 43rd International Sea Turtle Society Symposium. The two pre-conference days will focus on regional meetings and a variety of practical workshops tailored to help build the capacity of participants in emerging topics in sea turtle conservation. During the Symposium, there will be carefully selected special sessions on fisheries, biology, and conservation, to list but a few, which will provide opportunities for students, researchers, government officials, and community members to present their conservation efforts and research findings among an engaging community of peers. The student mixer and opening social will feature local and international food stalls with local entertainment, while the closing banquet will be an elegant formal event you will not want to miss.

The Symposium website (https://www.ists43ghana.org) will go live later this year, with all the needed information regarding registration, deadlines, and helpful links for planning your trip and time at the Symposium and in Ghana. Be sure to register early. I and my entire organising team encourage you to begin planning now to attend the 43rd International Sea Turtle Society Symposium. We look forward to warmly welcoming you to Ghana, the gateway to West Africa.

‘SEA TURTLE STORIES’: A PODCAST ON ALL THINGS SEA TURTLES BY OLIVE RIDLEY PROJECT

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From their ancient origins to their present-day status as conservation icons, sea turtles have traversed oceans, forged connections with diverse ecosystems, and captured human imagination across cultures and generations. Yet, despite being the focus of research for many decades, how much do we truly understand about sea turtles and the conservation culture they inspire?

‘Sea Turtle Stories’, a podcast launched on 16th June 2024, by the Olive Ridley Project (ORP), attempts to answer this question. This engaging series delves into the world of sea turtles, featuring lively conversations with researchers and scientists who offer insights into various aspects of the sea turtle life cycle and conservation practices.

The eight episode podcast series explores a wide array of topics, from the lost years of sea turtle hatchlings, the often overlooked ecology of male sea turtles to best practices in hatchery management and bycatch prevention.

Dr Martin Stelfox, founder and CEO of ORP says “We are incredibly proud of our ‘Sea Turtle Stories’ podcast series, which has been over a year in the making. This platform enables us to connect with the sea turtle community and anyone interested in these prehistoric creatures, enhancing our understanding of how to protect them and identifying the challenges we face along the way”.

‘Sea Turtle Stories’ is available on popular platforms such as Apple Podcasts and Spotify, with new episodes releasing twice a month. Whether you are a seasoned conservationist, a curious listener, or simply passionate about sea turtles, this podcast promises something for everyone.

RESEARCH SUMMARY

ROLE OF SEA TURTLES IN TERRESTRIAL FOOD WEBS

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Nutrient and energy transfers between ecosystems are essential for maintaining food web structures and community dynamics (Polis *et al*., 1997). Mobile organisms transfer nutrients and energy between habitats, functioning as subsidies that enhance ecosystem productivity (Likens & Bormann, 1977; Vander Zanden *et al*., 2012). For example, seabird guano is a significant source of nitrogen and phosphorus compounds that enriches mangrove vegetation and supports invertebrate food webs (Appoo *et al*., 2024). Similarly, carrion and macrophytes provide energy to consumers, reducing predation and grazing pressures respectively on resident species (Bouchard & Bjorndal, 2000; Spiller *et al*., 2010) and influencing population dynamics across ecosystems. Therefore, it is important to identify ecosystem subsidies and their role in sustaining complex food webs.

Sea turtles play multiple ecological roles, such as ecosystem modifiers, e.g., green turtles regulate seagrass productivity (Lal *et al*., 2011; Christianen *et al*., 2014), and prey for marine apex predators, e.g., for tiger sharks (Hammerschlag *et al*., 2015). Despite spending limited time on land, they also transport nutrients between marine and terrestrial ecosystems. For example, live hatchlings carry nutrients and energy back to the sea while dead turtles wash ashore supplying energy as carrion. Nest contents such as hatched eggshells, chorioallantoic fluid from hatched eggs, undeveloped eggs, and dead hatchlings can provide an average of 688 g of organic matter, 18,724 kJ of energy, 151 g of lipids, 72 g of nitrogen and 6.5 g of phosphorus (Bouchard & Bjorndal, 2000) to the beach environment, nourishing nutrient-poor coastal habitats. These deposited nutrients are then utilised by dune vegetation and meiofaunal communities, improving beach productivity and underscoring the importance of sea turtles in non-marine habitats (Madden *et al*., 2008; Vander Zanden *et al*., 2012; Le Gouvello *et al*., 2017).

During the nesting season, sea turtles create a nutrient pulse, serving as a critical food source for terrestrial species. Nutrients remaining in the nest are consumed by detritivores and decomposers such as nematodes, flies etc. (Bouchard & Bjorndal, 2000; Tsiafouli *et al*., 2020), while eggs and hatchlings are predated upon or scavenged by mammals or birds, including jaguars, rats and seabirds (Caut *et al*., 2008; Fonseca *et al*., 2020; Stokes *et al*., 2024). Through the nutrient influx, sea turtles link food webs across marine and terrestrial habitats. The recent studies summarised below have further demonstrated the ecological importance of sea turtles in maintaining terrestrial food webs.

Sea turtle eggs and hatchlings provide nutrition to coastal species during incubation or after emergence. Avenant *et al*. (2023) investigated the contributions of loggerhead turtle (*Caretta caretta*) eggs and hatchlings to the golden ghost crab (*Ocypode convexa*) diet at Ningaloo World Heritage Area, Australia. Golden ghost crabs predominantly scavenge on beach detritus, carrion, seagrass, and algal wrack with occasional consumption of turtle eggs and hatchlings (Rae *et al*., 2019; Avenant *et al*., 2023). This study employed multiple dietary techniques including stable isotope analysis (SIA), gut content analysis (GCA), DNA analysis, and feeding trials to assess ghost crab diets. Due to the different temporal scales captured by these techniques, GCA did not detect sea turtles in the crab diet; however, SIA and DNA analysis identified their presence through nitrogen and carbon isotopic signatures and reptile DNA respectively. Feeding trials demonstrated that ghost crabs preferentially consumed eggs and hatchlings over algal wrack, though not over fish carrion. This suggests that eggs and hatchlings may provide highly nutritious protein for ghost crabs during the nesting season. Avenant *et al*. (2023) effectively identified the inputs of sea turtles into coastal food web systems using complementary techniques.

In addition to coastal species, sea turtles can contribute to the diet of terrestrial predators like dingoes. Behrendorff *et al*. (2023) examined predator-prey interactions between dingoes and green (*Chelonia mydas*) and loggerhead turtles, revealing that dingo packs rely heavily on eggs as a nutrition source during the sea turtle nesting season. Turtle nests on K'gari

(formerly known as Fraser Island), Australia, were monitored for predation over two nesting periods and then compared across survey zones, years and dingo packs. The findings showed that dingoes predated on 84-94% of sea turtle nests, indicating that these nests potentially sustain the dingo population in northern K'gari during the turtle nesting season. Excessive dingo predation could cause a collapse of the turtle rookery so a nest translocation and *in situ* protection program was initiated to regulate the predation rate. However, given the cultural significance of dingoes to the traditional owners, the Butchulla community, and their protected status under Queensland law, restricting access to turtle nests may impact their populations. Therefore, conservation managers and policymakers must consider innovative approaches to ensure the survival of both sea turtle nests and dingoes. Behrendorff *et al*. (2023) highlighted that sea turtle nest consumption by protected or culturally important species can create a conservation challenge.

Several turtle rookeries globally focus conservation efforts on reducing predation impacts on their populations, which can inadvertently disrupt local seasonal food webs and affect other species. Lin *et al*. (2023) investigated the effect of green turtle nest protection on insular reptile and amphibian populations. On Orchid Island, Taiwan, predatory snakes such as the kukri snake and stink ratsnake predated turtle eggs until this resource was cut off after the initiation of a nest protection program. Lin *et al*. (2023) used 23-year population monitoring data on these predatory snakes and their alternative amphibian prey to assess the impact of removing turtle nests as a nutritional source. Additionally, they conducted feeding experiments and mark-recapture programs to estimate the daily turtle egg biomass consumed by snakes. Their results showed that in the absence of turtle eggs snake species predated on lizard eggs causing a sharp decline in lizard populations. Snakes consumed more eggs to maintain their daily mass intake, depleting recruits to lizard populations. Moreover, the change in prey availability prompted snakes to alter their habitats, moving closer to forests and concrete walls for easier access to lizard nests. Comparative analyses of lizard populations across different islands confirmed the removal of sea turtle resources as the primary cause of their decline. These findings highlight the role of sea turtles in supporting island food webs and the need to consider ecosystem-level consequences before implementing conservation strategies (Lin *et al*., 2023).

Collectively, these studies expand our understanding of the ecological role of sea turtles, revealing their functions in other ecosystems. Avenant *et al*. (2023) and Behrendorff *et al*. (2023) focus on their contributions as important prey for coastal species, while Lin *et al*. (2023) underscores their role in regulating terrestrial food webs by alleviating predatory pressure on other taxa. Furthermore, these studies address a key research priority identified by Hamann *et al*. (2010) and Rees *et al*. (2016) by assessing the role of sea turtles as nutrient transporters and prey. Further studies on the presence of sea turtles in the diets of other predators, particularly from coastal and terrestrial habitats, at different rookeries will be essential for determining the potential integration of sea turtles into non-marine food webs. Their value to terrestrial food webs should also be considered when developing or selecting conservation strategies, such as moving eggs to a hatchery, which may remove or centralise nutrients on a nesting beach.

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PREDATORS

Photo credit: Adhith Swaminathan, Dakshin Foundation, Bengaluru, India

Monitor lizard and wild pig scouring the beach for leatherback sea turtle nests and hatchlings at Little Andaman Island.

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