Inter-American Convention for the Protection and Conservation of Sea Turtles

CIT-CC18-2021-Tec.18

Best Practices to Monitor Sand Temperature on Sea Turtle Nesting Beaches

IAC Scientific Committee, Climate Change Working Group

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Preamble

Each year, Parties to the Inter-American Sea Turtle Convention (IAC) contribute sea turtle nest data from monitored index beaches as part of the IAC Annual Report. Periodically these data are analyzed, and summaries are published as technical reports (e.g. IAC Index Nesting Beach Data Analysis CIT-CC15-2018-Tec.14). Given that index beaches are monitored over multi-year time periods, there may be physical changes due to environmental factors or anthropogenic impacts on the nesting habitat that could cause the number of nests counted to increase or decrease for reasons other than actual changes in population abundance. For instance, the distribution of nesting on a nesting beach can be altered through sand erosion and accretion, as well as changes in vegetation cover or anthropogenic factors such as increased lights visible from the nesting beach, or construction behind the beach. In addition, changes in sand temperature can directly affect hatching success, sex ratio and survival of hatchlings, and may be a cue in nest site selection by nesting females. To date, collection of environmental data on nesting beaches has largely been *ad hoc*, usually as sub-components of other studies at the site. This site –specific study design often means that the collected environmental data cannot easily be used in trend analyses. Standardized collection of environmental data can be useful for documenting the physical characteristics of the index beaches, and if data are collected periodically, can detect changes over time.

To address this information gap regarding environmental data, the Climate Change working group of the IAC Scientific Committee (comprised of Dr. Julia Horrocks *Caribbean Netherlands*; Dr. Jeffrey Seminoff and Ann Marie Lauritsen *USA*; Cecilia Baptistotte *Brazil*; Rotney Piedra *Costa Rica*; Alberto Proaño *Ecuador*; Laura Sarti *México*, Marino Abrego *Panamá* and Cristiana de la Rosa *Dominican Republic*), through consultation with entities within IAC that are studying climate change, has developed this 'best-practices' document to help guide IAC Parties in their efforts to implement IAC Resolution CIT-COP4-2009-R5 Adaptation of Sea Turtle Habitats to Climate Change. The document incorporates feedback from the participants of the Workshop "Exchange of experiences: Actions to record the impact of climate change on sea turtles, perspectives from the beach", that was co-organized between the IAC Climate Change Working Group, the IAC Secretariat, the South Pacific Permanent Commission (CPPS) and the Action Plan for the Conservation of Marine Areas in the South Pacific, that took place on June 16th, 2021. This workshop was attended by experts from 17 countries of the Americas, including numerous IAC nations.

The document recommends best practices for participating IAC Parties to undertake sand temperature data collection as part of a Pilot Study. If data collection methodology and equipment are standardized across projects, this will allow comparisons to be made between participating Parties. For those Parties participating in the Pilot Study, we are recommending that each project should use similar temperature data loggers and protocols to increase consistency and comparability. Note that this may require replacement or re-purposing of equipment between years. Perhaps of more importance however, is the value of these data for detecting within-site trends in sand temperature to inform management of nesting beaches in country. Although this document recommends best practices in sand temperature data recording for IAC Parties as part of a specific Pilot Study, it can also be used as reference for other projects looking at the impact of climate change on sea turtle nesting beaches at a larger scale.

This technical document was presented and adopted at the 18th Meeting of the IAC Scientific Committee, which took place from November 3-5th, 2021.

Measuring Sand Temperature

Data collection frequency
It is recommended that continuous temperature data are collected on the index beach every year (see Data logger retrieval), but at minimum every 3 years.

Equipment
Currently, there are a variety of data logger types that are being used in nesting beach sand and incubation temperature research. The most common types are the HOBO Water Temp Pro and the HOBO Pendant data logger. Both are waterproof and will serve as good tools for conducting sand temperature research. The costs are different due to varying data storage capacities and resolution of data recording. The Pro v2 has also been shown to be more accurate than the Pendant loggers in water temperature experiments (Whittier et al 2020). There are other products on the market, but because of the ongoing existing use of these two loggers we encourage future research efforts to use either of these, and to use the same type consistently across years within each index beach. See below for a summary of each.

Hobo water-temp PRO v2 (US$129)

The HOBO Water Temp Pro v2 is durable with 12-bit resolution. Complete with a precision sensor for ±0.2°C accuracy, this logger measures temperatures between -40°C and 70°C (-40°F to 158°F) in air and up to 50°C (122°F) in water. Its waterproof, streamlined case allows for extended deployment in fresh or salt water. Moreover, the Water Temp Pro v2's optical USB interface makes it possible to offload data even while the logger is wet or underwater. A solar radiation shield is required to obtain accurate air temperature measurements in sunlight (RS1 Solar Radiation Shield, assembly required; or M-RSA pre-assembled Solar Radiation Shield).

HOBO Pendant (US$ 42 - 64)

The HOBO Pendant waterproof temperature/light level logger leverages the power of Bluetooth Low Energy (BLE) to deliver accurate temperature and light-level measurements straight to a mobile device with Onset's free HOBO connect app. The temperature range is -20° to 50°C (-4° to 122°F) with an accuracy of ±0.5°C. Measurement resolution is 0.04°C.

Data logger deployment

Data loggers should be programmed to record sand temperatures hourly, so that mean, minimum and maximum temperatures (^{o}C ±SD) per day and per calendar month can be calculated. Data loggers should be activated and deployed in the sand, not within egg clutches. This is because the objective is to characterize the baseline sand temperatures on the beach without the influence of metabolic warming from incubating eggs. For the Pilot Study, it is recommended that data loggers be positioned at least 2 m away from known egg clutches. If the beach is being regularly monitored, any nests laid/or hatching within 2 m of the deployed data logger should be noted.

Ideally, 30 data loggers should be deployed along 10 transects running perpendicular to the high tide mark (Figure 1). However, fewer data loggers can be used (see below), especially for smaller nesting beaches, or beaches on which nesting occurs over only a small portion of the total beach area (Figure 2). Ideally, the data logger location within each transect should be benchmarked (e.g., georeferenced with a GPS), so as to maintain consistency in sampling locations across years. Data logger deployment on each transect should sample zones of the beach where the sea turtle species of interest typically nest, e.g., for hawksbills – both open beach (no shade) and shade (vine and tree shade separately, if possible, as temperatures can differ under these types of vegetation). Distance above the high-water mark (HWM) should be standardized across transects, but it is suggested that no data loggers should be placed closer than 10 m from the HWM to minimize loss of equipment to high seas. This distance from the HWM may not be possible on narrow beaches however. We recognize that purchase of data loggers can be a challenge. If fewer data loggers are available, be strategic in their placement. For instance, choose locations for deployment in the middle section of the index beach and at either end, at least one in the open beach (no shade) and one under shade (if present). Even a few data loggers will provide information on how the sand temperature varies on the index beach.

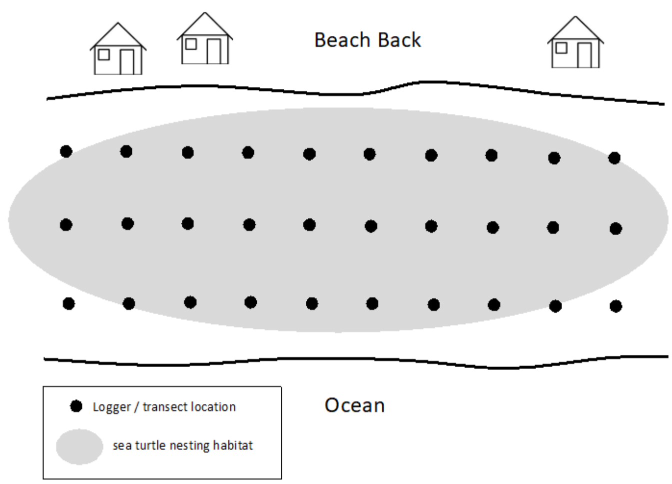

Figure 1. Schematic showing location of 10 temperature data logger transects on a beach with widespread nesting activity. Note that each transect runs perpendicular to the water's edge, and all transects are spaced in equal distances across the entire beach.

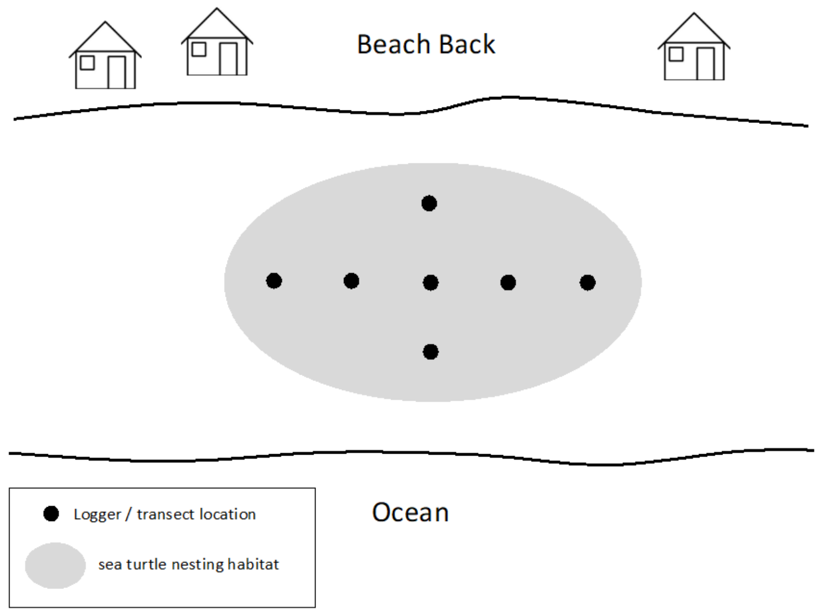

Figure 2. Schematic showing the placement of data loggers on beaches for which nesting is restricted to a small portion of the beach. Typically, these sites require fewer data loggers. At a minimum, as shown here, there should be at least 1 transect placed parallel to the water's edge, and one transect placed perpendicular to the water's edge.

The depth of data logger deployment should be guided by the species that uses the beach for nesting, aiming for the data logger to be positioned to approximate the depth of the middle of a clutch. The suggested data logger depths per species are as follows: hawksbills (35-40 cm), leatherbacks (55-65 cm), greens and loggerheads (45-50 cm), and olive and Kemp's ridleys (30 cm). It is important to bury each data logger at the same depth both within and between years. If more than one species uses the beach, data loggers may be positioned at the appropriate depth for each species.

One method that can be used to deploy the data logger to the correct depth, is to use a 1 m length of gutter downpipe (i.e., about 10 cm diameter PVC pipe), a heavy lump hammer, a piece of flat wood, and a rigid measuring tape. Mark the pipe with a permanent marker pen at the depth you wish to place the temperature logger (e.g., 60 cm). Place the pipe over the sand, put the wood over the end of the pipe and hammer the pipe into the sand until you reach the marked line. Remove the wood, place the palm of your hand over the end of the pipe to create a vacuum, and pull the pipe straight up out of the sand. The sand core should be intact inside. Check the depth of the hole with your tape measure and then place the data logger inside. Place the pipe back over the hole and hammer the pipe so that the sand falls back into the hole. In this way the sand that fills the hole has the same profile as it did when it was removed (Esteban et al 2018). Note that this should not be done if there is a danger of contacting an *in situ* clutch, so, if this method is used, consider deploying data loggers outside of nesting season to avoid piercing any eggs.

Data loggers can be tied to a numbered marker pole or to a tree branch for easy collection. If there is a danger that markers will attract unwanted attention, the tether can be buried across the width of the beach and tied discreetly to a shrub or structure. If any visible structures are likely to attract unwanted attention, a buried length of caution tape ribbon tied to the data logger can be used to increase relocation probability. Each site should be triangulated and photographed. A geo-position with a hand-held GPS can be taken, but often is not accurate enough to ensure that the data logger can be easily found later.

Data logger Retrieval

Ideally the data loggers should be left *in situ* for one year to allow sand temperatures to be taken both during and outside of the nesting season. This also makes logistical sense for data logger retrieval if the beach is remote. When data loggers are retrieved, the depth of the data logger should be recorded at removal. The data loggers can then be downloaded, the units switched off and, if possible, re-purposed for the next deployment.

Sand albedo

Albedo is the percentage of incident of solar radiation that is reflected by a surface. A darker sand will reflect less solar radiation than lighter sand. Therefore, collecting data on sand albedo will complement data collected by data loggers on sand temperature. A field technique for measuring sand albedo can be found in Hays et al. (2001).

Other environmental characteristics of the index beach

The focus of this best practices document is on the Climate Change Pilot Study measuring sand temperature, but back beach characterization and beach width are also useful parameters that might change between years and thus affect distribution and abundance of nests reported. Brief descriptions of the monitoring of these characteristics and useful references are provided below.

Back beach

Once per nesting season, record the habitat type or land use behind the index beach. This is known as the back beach. Measure the length of the beach and map the length of the beach backed by each of the habitat types or land use categories. For example, some habitat types might be coastal forest, mangrove, or sand dunes, and some land use categories might be buildings, road, carpark, etc. In the absence of a light meter, an indication of light levels can be obtained by counting the number of unshaded light bulbs that can be seen from benchmarked points on the beach. Ambient light intensity (sky glow) can also be assessed using a relatively inexpensive Sky Quality Meter (www.unihedron.com).

Beach width

Beaches can be described by their shape, width, elevation and slope, and changes can occur over days, weeks or longer time periods. Understanding the dynamics of beaches therefore requires regular monitoring over time, and interested Parties should consult the references below, and others, for suitable protocols.

We suggest measuring beach width to determine available nesting beach habitat at the beginning of the nesting season, or at the beginning and end of the nesting season. Note that these will be a snapshot of the condition of the beach at the time the measurements are taken. A transect that runs from the dune or back beach to the water, across the beach perpendicular to the water's edge can be used to measure beach width. Benchmarks should be used to locate transects, i.e., georeferenced with a GPS, or aligned with a specific built structure, or large tree etc. This ensures that the location(s) is constant between the beginning and the end of the nesting season. The width of dry beach on the transect should be recorded. The width of dry beach is measured from the normal high tide line landwards to the point where the substrate becomes too compacted for a turtle to dig or where there is an obstruction which prevents a sea turtle nesting any further. If the berm is too steep for a sea turtle to climb above the high-water mark, this should be noted.

Additional references
Additional useful reference documents are provided in Appendix 1.

Recommendations from the IAC Scientific Committee

1. Circulate this technical document CIT-CC18-2021-Tec.18 “Best Practices to Monitor Sand Temperature on Sea Turtle Nesting Beaches” with the IAC membership to help guide IAC Parties in their efforts to implement IAC Resolution CIT-COP4-2009-R5 Adaptation of Sea Turtle Habitats to Climate Change, by studying the impacts of climate change on index nesting beaches.

2. For IAC member countries participating in the Climate Change Pilot Project to monitor sand temperature on sea turtle nesting beaches, it is recommended to use this document CIT-CC18-2021-Tec.18 as the guideline to collect data.

3. For IAC member countries participating in the Pilot Project, it is recommended that each project should use similar temperature data loggers and protocols, to increase consistency and comparability. Note that this may require replacement or re-purposing of equipment between years.

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Appendix 1. Useful Reference Documents

Baker-Gallegos J, Fish MR, Drews C (2009). *Temperature monitoring manual. Guidelines for monitoring sand and incubation temperatures on sea turtle nesting beaches*. WWF report, San José, 20 pp.

Binhammer, M., Beange, M., and Arauz, R. (2019). Sand temperature, sex ratios and nest success in Olive ridley sea turtles. *Marine Turtle Newsletter* 159: 5-9.

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