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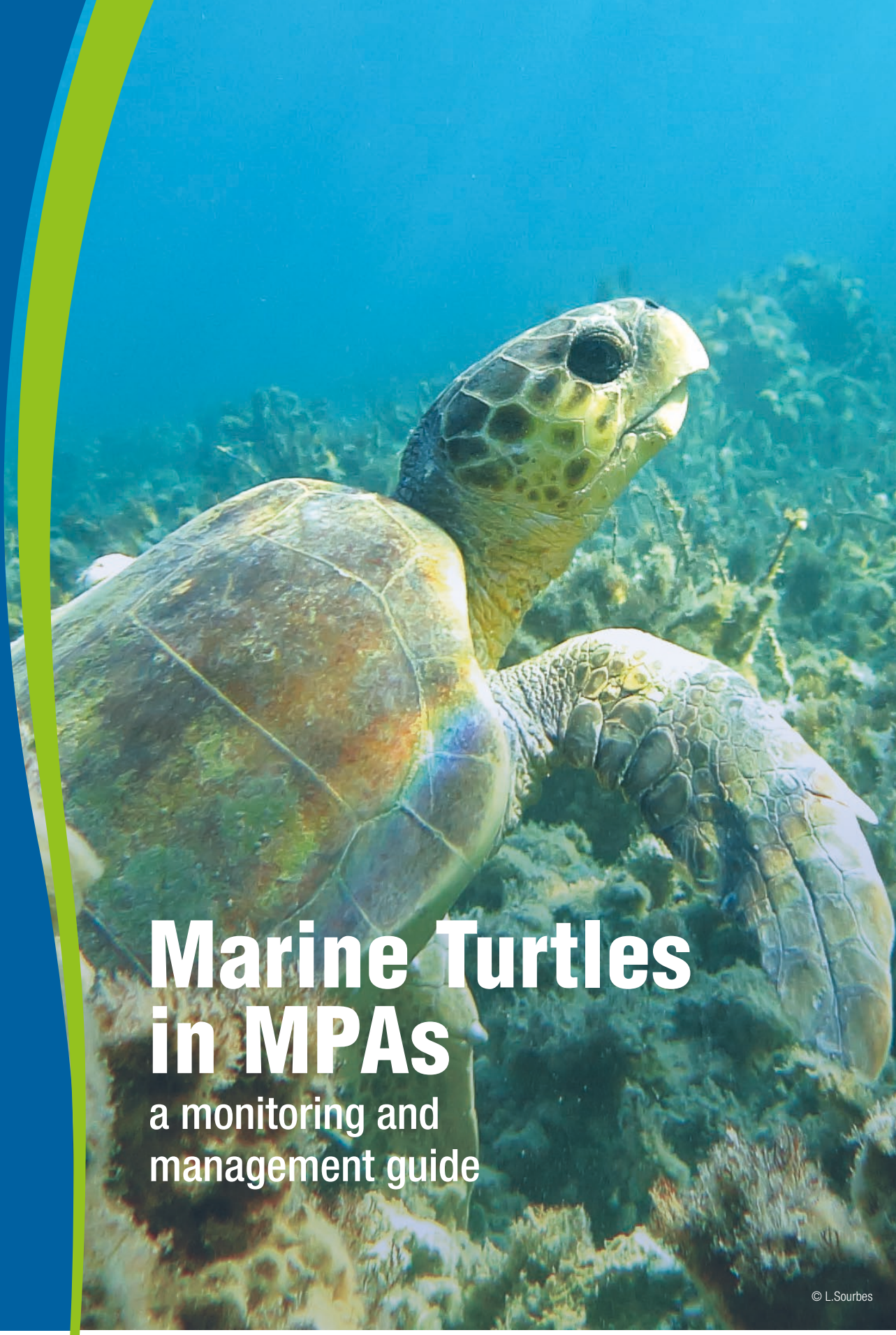

Marine Turtles in MPAs

a monitoring and management guide

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A tribute to Boris Daniel (1974 - 2020)

Boris was an active member of MedPAN's Marine Turtle Working Group since its creation in 2017. Within this group, Boris was a key contributor to the methodological guide for the monitoring of marine turtles in Mediterranean MPAs. His ideas and suggestions greatly improved the guide throughout its development. Passionate about the sea, Boris was committed, cheerful and enthusiastic. Moreover, he was a driver for change who developed practical solutions to the challenges faced by MPA managers at the Mediterranean level.

Boris had recently taken up a new position as Director of the Côte Bleue Marine Park and he was eagerly immersing himself in this new challenge. It was a return to an MPA close to his heart, since he had started his career with this team 20 years ago before spending 10 years acquiring skills and experience with the French Marine Protected Areas Agency.

Boris is deeply missed not only by his colleagues in MedPAN's Marine Turtle Working Group but by all those that he encountered who are passionate about the sea and the protection of the environment. We feel a yearning loss by his absence. We miss our brilliant companion, a great human, and a friend.

Goodbye Boris

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Date: 2020

Author: ALan F. Rees

With the support of: Susan Gallon, MedPAN

Editor: The Marine Turtle Working Group

Acknowledgement

The Marine Turtle Working Group in Torre Guaceto - Italy in June 2018
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MPA MARINE TURTLE WORKING GROUP

MedPAN, with the support of the National Marine Park of Zakynthos, established in 2017 a MPA Marine Turtle Working Group bringing together MPA managers and involving NGOs and researchers working on marine turtles conservation from 10 Mediterranean countries.
The Marine Turtle Working Group (MTWG) enables exchanges to tackle site-specific issues and allow a real-time exchange of information and thus, the possibility to take adaptive management decisions at MPA level. At network level, this group also supports an integrated management strategy for these species.
For more info: http://medpan.org/marine-protected-areas/themes-2/marine-turtles/marine-turtle-working-group/

We would like to warmly thank all those that contributed to the development of this guide, the MTWG members for their continuous support and especially Manel Ben Ismail (Notre Grand Bleu), Boris Daniel (French Agency of Biodiversity), Charalampos Dimitriadis (Zakynthos National Marine Park), Yakup Kaska (Dekamer), Antonios Mazaris (Aristotle University of Thessaloniki), Almoktar Saied (Environment General Authority) and Laurent Sourbes (Zakynthos National Marine Park) for their detailed review of the guide. We would also like to thank Pierre Vignes (MedPAN) and Reda Neveu (MedPAN) for facilitating exchanges among the Marine Turtle Working Group.

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Archelon, Aristotle University of Thessaloniki, Department of Fisheries and Marine Research of Cyprus, Environment General Authority, L'Office Français de la Biodiversité, National Marine Park of Zakynthos, Notre Grand Bleu, SPA/RAC, Torre Guaceto MPA, Tyre Coast Nature Reserve

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The majority of clutches are laid in Cyprus, Greece and Turkey © DEKAMER Archives

1.INTRODUCTION

What's all the fuss about turtles?

Only 1 in 1000 hatchlings will survive to adulthood © L.Sourbes

Why monitor marine turtles

Marine turtle species are all listed on the IUCN red lists of endangered species and included in Annex 1 of CITES. Even populations that are considered to be faring relatively well, such as the Mediterranean loggerhead *Caretta caretta*, are only doing so because of the vast amounts of effort put into long-term monitoring and conservation activities.

Accordingly, marine turtle populations are acknowledged to be of conservation concern and have, in the Mediterranean been the subject of Action Plans for their protection, compiled under direction of the Barcelona Convention, since 1989. Marine turtles are umbrella species in that conserving them and their habitats will help protect numerous other species and sustain marine biodiversity.

According to the updated UNEP MAP Action Plan for the Conservation of Mediterranean Marine Turtles (UNEP/MAP-SPA/RAC 2019) the most important threats to marine turtles are currently:

- deterioration of critical habitats for the life cycle of marine turtles, such as nesting and feeding areas and key migratory passages;
- direct impacts on turtle populations of incidental capture in fisheries, intentional killing, consumption, egg exploitation and boat strikes;
- pollution, which can have impacts on both habitats and species.

What is currently happening in the Mediterranean?

Marine turtles are legally protected around the Mediterranean and conservation and management programmes are taking place to some extent in most countries. The nature of the bodies carrying out the work ranges from governmental agencies to non-governmental organisations (NGOs) and university research groups. The UNEP/MAP action plan covers all areas of the Mediterranean, but its adoption and levels of action vary greatly between countries.

A marine protected area (MPA) in the Mediterranean context is a blanket term that covers multiple national and international designations with varying levels of protection, management and conservation measures associated with each. Some MPAs in the Mediterranean have been established since the 1950s and in 2016 there were a total of 1,215 MPAs across the Mediterranean covering 6.8% of the sea - rising to almost 17% of shallow seas less than 50m deep. The size and distribution of MPAs and other sites of interest for the conservation of the Mediterranean are shown in the figure below with the most up to date map available from https://www.medpan.org/SIG/MAPAMEDvisualisation.html.

MPAs play an important role in conserving marine turtles, helping achieve good conservation status for all populations in all countries. For example, some of the main areas for nesting sites conservation are protected by MPAs in Cyprus, Greece and Turkey, which host the majority of clutches laid (Casale et al. 2018).

In addition, MPA managers can be considered the front-line operatives when it comes to putting in place and monitoring conservation measures in these critical habitats. This is why, they need access to the best methods and data in a time-sensitive manner so that they may predict and hence avoid conservation issues developing or speedily counter emerging problems and threats.

In 2018 MedPAN distributed a questionnaire on aspects of marine turtle conservation and a total 214 answers were received from 20 Mediterranean / Black Sea countries. Of the respondents, 49% were from science and research organisations, 21% were from NGOs, and 16% were MPA management. The remaining 14% were from a range of other entities.

A total of 49% of respondents to the marine turtle survey indicated they were involved with marine turtles with only 57% of those (i.e. 28% of all respondents) indicated that monitoring or management activities for marine turtles were carried out.

Further, 25% of all respondents indicated they had marine turtles in their area. Of those, the main reason for the turtles' presence was foraging at 72% followed by nesting at 47%, wintering at 40% and mating 36%. Turtle presence was reported for other reasons by 26% of respondents and 11% did not know the reason for the turtles' presence. Note that values add to more than 100% as some responses had more than one area listed.

Stranding networks are important mechanisms that can identify presence of turtles in an area, causes of death and changes in threat levels, however 74% of respondents gave no response or did not know of a stranding network operating in their area. Of those that had positive knowledge on the matter, 33% indicated no stranding network existed in their area, 67% indicated there was a stranding network with 39% operated by external partners and 28% having direct involvement.

Similar to the operation of stranding networks, marine turtle recovery/rescue centres can generate useful data on population status, with the two-fold added benefit of 1) rehabilitating and releasing individual turtles and 2) providing an important opportunity for public education. In this case again, 74% of survey respondents gave no response or did not know about recovery centres operating in their area. Oddly, given the extra resources and efforts required to operate rescue centres compared to stranding networks, there were very slightly less indications of the lack of presence of rescue centres 31% and 56% indicating a centre was present but operated by external partners and only 13% being operated directly.

Management goals

Marine protected areas are established to preserve habitats, biodiversity and specific species. In the case of marine turtles, conservation goals include ensuring their critical habitats are protected to enable successful completion of basic biological requirements, such as feeding and breeding, and the protection of individuals from threats in these locations. In this way marine turtle populations can be maintained and increased, so that they are fulfilling their ecological role in marine and coastal ecosystems.

As marine turtles are highly migratory species, not recognising geopolitical boundaries, each MPA needs to contribute as best it can to the protection and preservation of the species. Using best practice and efficient deployment of resources it should bring about the most favourable results for turtles relative to the specific needs presented within the MPA. Further background on designing conservation programmes can be found in Eckert (1999).

GOAL 1: Conserve species	GOAL 2: Eliminate threats
1.1 Maintenance of populations	**2.1** Remove terrestrial threats impacting nesting activity
1.2 Maintenance of ecosystem functions	**2.2** Remove marine threats impacting turtle survival
1.3 Maintenance of habitats	**2.3** Remove marine threats affecting critical habitats

How can this guide help?

This guide is based on a previous one commissioned by MedPAN (Centro Studi Cetaci, 2019) and aims to provide extensive but not exhaustive advice on factors to consider for the conservation of marine turtles within specific marine protected area settings, which are tailored to address the themes of species and habitat management, related to varying degrees of capacity. The guide will help MPA managers determine the best management strategies applicable in their area. This is done by identifying relevant data requirements and monitoring and research methods to be able to acquire and understand vital population metrics and assess current and future needs to ensure good conservation status.

The core of this guide is a suite of Decision Trees that systematically and progressively deal with the assessment and management process that an MPA authority should consider in order to ensure any turtles present are protected from harm and their critical habitats are preserved in a state as to sustain turtles at or above current population levels. For marine turtle conservation, the decision-making process should be balanced between the relative importance of a specific habitat type present in the MPA, the number of turtles present at these habitats and the capacity within the MPA to monitor the situation and enforce special protection measures.

Annexed to this guide are scientifically valid and internationally approved protocols that indicate how to carry out appropriate work for marine turtle conservation and how to use the results garnered from them. Where applicable, the protocols cite source literature so that the MPA managers can read deeper into the topic.

This guide on its own will not turn the reader into an expert on all matters relating to marine turtle conservation, but it will provide a robust baseline understanding of relevant issues and the best ways to deal with them using a broad suite of management techniques. Additionally, the guide gives indications on how and where collaboration with external agencies can afford benefits in terms of reducing the need for inhouse capacity and extending the potential for population assessments using relatively expensive hitech research tools and techniques.

Shells layd at the bottom of a beach at the National Marine Park of Zakynthos, Greece - © L.Sourbes

The nesting beach of Crystal in the Marine National Park of Zakynthos is closed to public access from May 1st to October 30th every year, from sunset until 7.00 in the morning - Greece - © L.Sourbes

Further reading

Several review and recommendation documents exist that supplement and complement the information and guidelines presented herein and were used as reference material in compilation of this document. MPA managers are encouraged to review these documents where possible to broaden their understanding of the conservation status and monitoring methods applicable to Mediterranean marine turtles.

Eckert KL, Bjorndal KA, Abreu-Grobois FA and Donnelly M (Editors) (1999). **Research and Management Techniques for the Conservation of Marine turtles.** IUCN/SSC Marine Turtle Specialist Group Publication No. 4.

- *"The IUCN Marine Turtle Specialist Group believes that proper management cannot occur in the absence of supporting and high-quality research, and that scientific research should focus, whenever possible, on critical conservation issues. We intend for this manual to serve a global audience involved in the protection and management of marine turtle resources. Recognizing that the most successful marine turtle protection and management programs combine traditional census techniques with computerized databases, genetic analyses and satellite-based telemetry techniques that practitioners a generation ago could only dream about, we dedicate this manual to the resource managers of the 21st century who will be facing increasingly complex resource management challenges, and for whom we hope this manual will provide both training and counsel."*

National Marine Fisheries Service Southeast Fisheries Science Center (2008) **Sea Turtle Research Techniques Manual**. NOAA Technical Memorandum

NMFS-SEFSC-579. 92 p.

- "This document is a compilation of the current research techniques and protocols of the National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) [USA]. This marine turtle research techniques manual was developed in support of NMFS/SEFSC research permit applications and to provide a comprehensive training document for NMFS researchers and fishery observers. Methods vary among researchers, but the techniques described here are accepted by the SEFSC after consultation with research, academic, and veterinary colleagues."

UNEP/MAP (2017a) **Guidelines to standardize methodologies to estimate demographic parameters for marine turtles[sic] populations in the Mediterranean.** SPA/RAC, Tunis. 32 p.

- *"The aim of this document is to a). Summarise the information about population status and b) To guide the Mediterranean countries to implement the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean with its related regional action plans and c). Provide the needed tools for those procedures. This document describes the standardized methodologies to estimate demographic parameters for population dynamic analysis, such as population modelling. This document also contains the guidelines on; species distribution range, population abundance and population demographic parameters."*

UNEP/MAP (2017b) **Guidelines for the long term monitoring programmes for marine turtles nesting beaches and standardized monitoring methods for nesting beaches, feeding and wintering areas.** SPA/RAC, Tunis. 56 p.

- *"This Guideline describes and suggests improvement on the methodology for the long-term standardized collection and assimilation of data on adult and juvenile loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) marine turtles at nesting, foraging and wintering areas throughout the Mediterranean. In particular, it suggests (i) standardised monitoring techniques for establishing the current distribution of nesting, wintering and feeding areas in parallel to detecting shifts in distribution over time and (ii) standardised monitoring techniques for establishing the population size of selected nesting, wintering and feeding areas, along with proposed selection criteria to assimilate a representative cross-section of sites nationally based on the provisions of the UNEP(DEPI)/MED IG.22/Inf.7, the IMAP and the Common Indicators factsheets. The combined use of a variety of assessment techniques is suggested to facilitate demographic analyses, which should be covered in the 'Standardization of methodologies to estimate demographic parameters for population dynamics analysis, such as population modelling'."*

SWOT Scientific Advisory Board (2011) **Minimum Data Standards for Nesting Beach Monitoring.** Technical Report. 24p. / Handbook v.1. 28 p.

- *"As of 2011, the SWOT (State of the World's Sea Turtles) database has expanded to include more than 5,700 individual data records contributed by more than 550 data providers (and literature sources) from more than 2,800 distinct nesting beaches. As such, it is currently the most comprehensive global marine turtle nesting database in existence, and is well positioned to serve as the world's premier data clearinghouse and monitoring system for marine turtles. With this in mind, the SWOT Scientific Advisory Board (SAB) recognized the need to establish minimum data standards (MDS) for data provided to the database 1) to identify datasets that could be included in future analyses of abundance and long-term trends, and 2) to provide SWOT Team members (i.e. data providers) with guidelines for improving their existing monitoring schemes to enhance effectiveness of documenting local temporal sea turtle nesting abundance patterns."*

Casale P, Broderick AC, Camiñas JA, Cardona L, Carreras C, Demetropoulos A, Fuller WJ, Godley BJ, Hochscheid S, Kaska Y, Lazar B, Margaritoulis D, Panagopoulou, Rees AF, Tomás J and Türkozan O (2018) **Mediterranean marine turtles: current knowledge and priorities for conservation and research**. Endangered Species Research 36: 229-267.

- *"The available information regarding the two marine turtle species breeding in the Mediterranean (loggerhead turtle* Caretta caretta *and green turtle* Chelonia mydas*) is reviewed, including biometrics and morphology, identification of breeding and foraging areas, ecology and behaviour, abundance and trends, population structure and dynamics, anthropogenic threats and conservation measures. Although a large body of knowledge has been generated, research efforts have been inconsistently allocated across geographic areas, species and topics. Significant gaps still exist, ranging from the most fundamental aspects, such as the distribution of major nesting sites and the total number of clutches laid annually in the region, to more specific topics like age at maturity, survival rates and behavioural ecology, especially for certain areas (e.g. south-eastern Mediterranean). These gaps are particularly marked for the green turtle. The recent positive trends of nest counts at some nesting sites may be the result of the cessation of past exploitation and decades of conservation measures on land, both in the form of national regulations and of continued active protection of clutches. Therefore, the current status should be considered as dependent on such ongoing conservation efforts. Mitigation of incidental catch in fisheries, the main anthropogenic threat at sea, is still in its infancy. From the analysis of the present status a comprehensive list of research and conservation priorities is proposed."*

The reproduction of the *caretta caretta* marine turtle coincides with the vacation season in the National Marine Park of Zakynthos - Greece - © L.Sourbes

Florida Fish and Wildlife Conservation Commission (2016) **Marine turtle conservation handbook.** https://myfwc.com/media/3133/fwc-mtconservationhandbook.pdf

- *Though based on Florida nesting activity and regulations, this handbook covers all aspects of marine turtle conservation and management, with details for both green and loggerhead turtles covered. Sections cover: General information for permit holders, Nesting beach survey activities, Stranding and salvage activities, Holding marine turtles in captivity, Tagging turtles, Research activities and Educational activities. It also supplies templates for standard forms to be used for different data recording purposes and a glossary of terms. Associated training materials available from https://myfwc.com/research/wildlife/sea-turtles/nesting/training-materials/ include videos of nest surveying.*

IUCN Med (2020) **Conservation of Marine Turtles in the Mediterranean Sea.** https://www.iucn.org/sites/dev/files/content/documents/2020/conservation_of_mediterranean_turtles_in_the_mediterranean_sea.pdf

- *To support effective conservation measures, the IUCN Centre for Mediterranean Cooperation together with the IUCN Marine Turtles Specialists Group and the Spanish Herpetological Society have compiled the most relevant knowledge on marine turtles in the Mediterranean, followed by a set of 10 recommendations aimed at managers, policy-makers, as well as the public general, for all to contribute to the conservation of these exceptional animals.*

2. MARINE TURTLE FACTS

Which turtles? and what might they be doing?

The *Chelonia mydas* is herbivorous and swims at 20-50m
© DEKAMER Archives

"Know your enemy" is an expression used to indicate that to be able to better someone you need to know their behaviours and weaknesses. The same philosophy can be applied to species conservation and in this case marine turtle conservation, as the better you understand the biology and ecology of the species, the better you can understand what can be done to effectively protect them.

In this section you will first be given a grounding in basic marine turtle life-history, to highlight the lengthy lifespans and widespread habitat use of these enigmatic creatures. This is followed by written and visual description of the two main turtle species found breeding in the Mediterranean and their distribution across the region, which will indicate what species you are likely to encounter in your MPA and when. The section closes by briefly indicating the current conservation status of marine turtles and the threats they face in both marine and terrestrial habitats, to give context to the work that is needed.

The chelonia mydas hatchlings wait until night to head for the sea - © DEKAMER Archives

Life Cycle of Mediterranean Marine Turtles

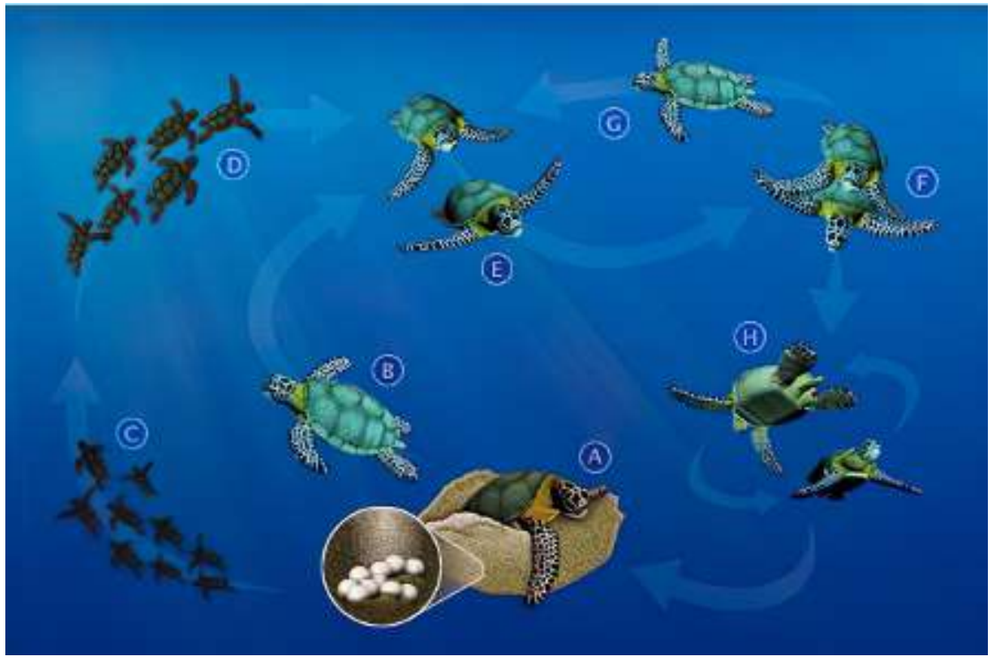


Figure 2.1 Life cycle or marine turtles. https://www.seaturtlestatus.org/sea-turtle-lifecycle with minor modifications

The following text describes the various stages in marine turtles' lifecycles and corresponds to the lifecycle diagram above. https://www.seaturtlestatus.org/sea-turtle-lifecycle

A. NESTING BEACHES: ADULT FEMALE

During nesting season, late May to August, females come ashore to lay eggs within a few weeks of mating.

After making their way above the high-tide line, they use their front flippers to dig a large depression called a "body pit," using such force that they send sand flying through the air.

Females then use their back flippers to dig a smaller hole at the far end of the body pit called an "egg chamber," into which they deposit around 100 soft-shelled eggs. After refilling and covering their nests with sand, they return to sea.

B. ADULT FEMALES RETURN TO FEEDING AREAS AFTER NESTING SEASON

Females must return to feeding areas – generally nearshore (neritic) areas – after each nesting season to replenish her energy stores for the next reproductive season. This period typically takes more than a year, and in many cases, several years. Other adults (females and males) and large juveniles also feed in these areas.

C. HATCHLINGS TO OPEN WATER AND EARLY YEARS IN OCEANIC HABITAT

When fully developed, hatchlings break through their eggshell and slowly dig their way to the surface, typically en masse. This process can take a few days. Hatching season may last from mid-July to October.

Hatchlings generally wait until night to head for the sea, when they can use the cover of darkness to avoid detection by many predators on the beach and in the water.

After reaching the water, hatchlings enter into a multi-day «swimming frenzy,» during which they swim almost continuously, fuelled only by leftover egg yolk, to reach deeper water away from shore.

Little turtles are transported by strong currents to open-water (oceanic) habitats, where they live in flotsam and have an omnivorous diet. This oceanic stage can last from a few years to decades.

D. DEVELOPMENTAL MIGRATIONS TO NERITIC FEEDING AREAS

After this oceanic period, the juvenile turtles move into highly productive neritic (near shore) feeding areas to finish growing, a process that can take as little as a few years and as long as a few decades. These foraging grounds tend to offer a greater abundance and variety of food than the open ocean.

Adult turtles also occupy neritic feeding areas. Adult turtles remain in these areas until they have accumulated sufficient energy reserves to migrate to breeding areas for reproduction. This period typically takes more than a year, and in many cases, several years.

E. MIGRATION OF ADULTS TO NATAL BEACHES FOR MATING

After acquiring sufficient resources, adult males and females migrate to breeding areas to mate and, in the case of females, to nest.

The distance between feeding and breeding areas can be hundreds, to around two thousand, kilometres.

Each nesting season, most females return to nest at the same beach, or group of beaches, from which they themselves emerged as hatchlings. The return migration by an adult turtle to the beach of its birth is called natal homing.

F. MATING IN COASTAL AREAS NEAR NESTING BEACHES

Although a female typically only need mate with one male to obtain enough sperm to fertilize all of her eggs in a season, multiple paternity is common in marine turtles. This is most likely due to the fact that male marine turtles generally attempt to mate with as many females as possible.

Males are quite aggressive during the mating season, both with other males and with females.

G. ADULT MALES RETURN TO FEEDING AREAS

Like females, male turtles show natal homing, but visit broader areas and more sites than females do. Males will try to mate with as many females as they can during a season. Once males have mated and are unsuccessful in finding more mates, they return to their feeding areas.

H. INTERNESTING HABITATS

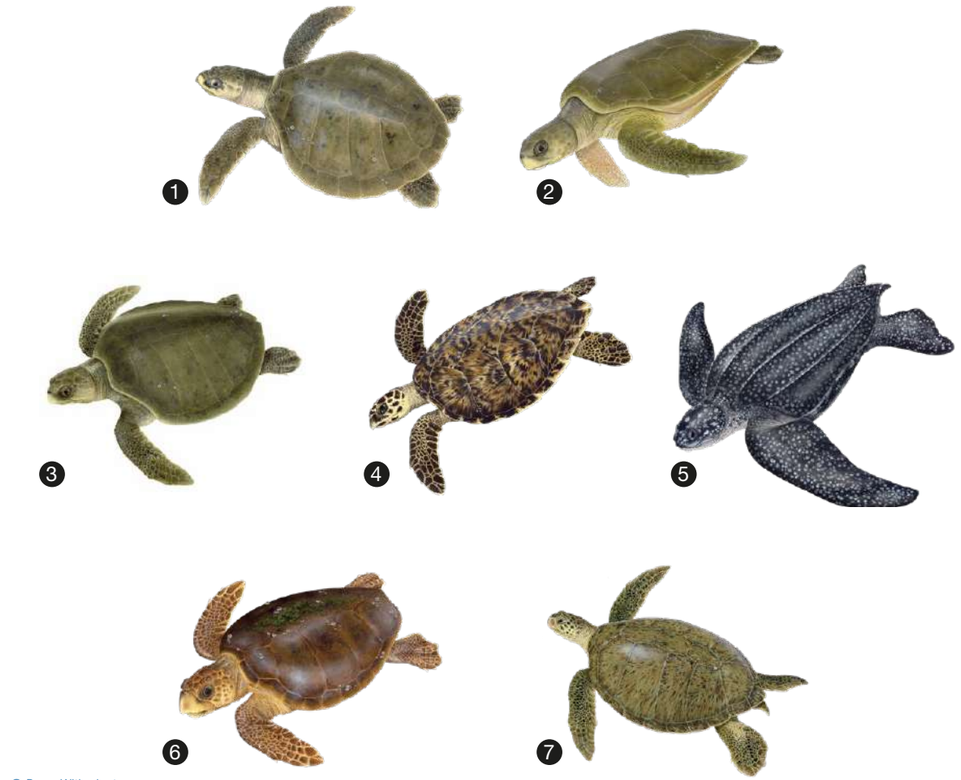
Females remain near their nesting beach during the nesting season, which can last one to two months.

Depending on the species, female turtles lay between two and five clutches (a group of eggs deposited during one egg-laying event), in a season – one clutch every 12 to 16 days.

A Cotylorhiza tuberculata jellyfish eaten by loggerhead turtles at the National Marine Park of Zakynthos, Greece - © L.Sourbes

Marine turtle species of the world and the Mediterranean

Seven species of marine turtle live in the world's oceans and seas. The Kemp's ridley (*Lepidochelys kempii* ❶ breeds almost exclusively in the Gulf of Mexico and the flatback (*Natator depressus* ❷) is restricted to the Australasian continental shelf. The other five species have pan-global distribution. Olive ridleys (*Lepidochelys olivacea* ❸) are the smallest and most numerous, whereas hawksbills (*Eretmochelys imbricata* ❹) are larger but far rarer. The remaining three species are found commonly in the Mediterranean. Leatherback turtles (*Dermochelys coriacea* ❺) are the largest species and are found mainly in the western Mediterranean but do not nest anywhere in the region. Loggerheads (*Caretta caretta* ❻) and green turtles (*Chelonia mydas* ❼) are the two species that breed in the Mediterranean with nesting mainly occurring in the eastern basin, *(see section Distribution, page 24).* For more information on global marine turtle species refer to Márquez (1990). [Turtle images presented here are from SWOT; https://www.seaturtlestatus.org/meet-the-turtles; created by Dawn Witherington]



© Dawn Witherington

Species identification

Major nesting sites of loggerhead marine turtles are distributed across the eastern Mediterranean - This loggerhead hatched on a beach on Crete in Greece - © ALan Rees / ARCHELON

The three species of marine turtle commonly present in the Mediterranean are relatively simple to distinguish from each other using simple morphological traits. The leatherback is unmistakeable given its shell is covered in rubbery black skin and has seven longitudinal ridges running along it instead of the usual hard shell covered with keratinised scutes present in all other marine turtle species. For information describing all marine turtle species, the reader is directed to Prichard and Mortimer (1999). The two species indigenous to the Mediterranean are fully described below.

Loggerhead turtles

These are the most common marine turtles in the Mediterranean, found in large numbers in both the eastern and western basins. The following characteristics are diagnostic for the species. The carapace is reddishbrown to dark brown, somewhat heart shaped and often has one or more large barnacles present. It typically has a central row of five vertebral scutes flanked by five costal scutes on either side with the foremost smaller costal scutes not abutting the nuchal scute. The plastron and underside of the turtle is yellow with three inframarginal scutes on either side of the plastron bridging between the plastron and the underside of the marginal scutes. The head is proportionately large compared to body size and typically has at least four prefrontal scales on the forehead and three postocular scales behind each eye. See Figure 2.2 for presentation of body parts.

Hatchling loggerhead turtles present the same scalation pattern as more mature individuals but, in the Mediterranean, are a uniform charcoal grey colour.

Loggerhead turtles are opportunistic foragers, feeding not only on crustaceans, shellfish and gelatinous prey but also fisheries discards, which brings them into close proximity to humans.

Loggerhead turtle hatchlings head for the Mediterranean sea in Tunisia's Kuriat Island - © Notre Grand Bleu

Size classifications / maturity

Hatchling loggerheads are around 4cm carapace length. The epipelagic juveniles generally inhabit oceanic waters until they are at least 25 cm (Casale et al. 2008a) and more commonly to around 45cm in carapace length (Rees et al. 2013). From this size they often recruit to more coastal and neritic areas where they develop to maturity, however some turtles may remain oceanic wanders for the majority of their lives. Female loggerheads mature and breed at minimum of 66.5 cm and average adult size is 79.1 cm (Casale et al. 2018). With over 15 cm difference between minimum and average size at maturity and given growth as adults is less than 0.5 cm per year (Omeyer et al. 2018), it is clear that a single length measurement to distinguish between subadult and adult turtles will incorporate a large degree of error. Mean size of nesting turtles has previously been used to separate the mature individuals from subadults (Casale et al. 2015, Snape et al. 2020) therefore this value, most recently estimated at 79.1 cm (Casale et al. 2018), will be used, which is likely to include a notable proportion of adult turtles as subadults. Male loggerheads are assumed to mature at a similar size (Casale et al. 2014). Size classes (in terms of Curved Carapace Length (CCL); see Protocol for Measuring turtles) of loggerhead turtles are classified as neonates ≤10 cm< oceanic juveniles ≤45 cm< neritic juveniles ≤66 cm< subadults ≤79 cm< adults.

Green turtles

These are the second-most common marine turtles in the Mediterranean, found mainly in the eastern and southern parts of the eastern basin. The following characteristics are diagnostic for the species. The carapace is olive to grey, often with darker spots in mature individuals or radiating marks in juveniles and is white or creamy white colour plastron with four inframarginal scutes on either side of the plastron; bridging between the plastron and the underside of the marginal scutes. The head is proportionately small compared to body size and typically has a single pair of prefrontal scales on the forehead and 4 postocular scales behind each eye; see Figure 2.2. for presentation of body parts.

Hatchling green turtles present the same scalation pattern and a white underside as more mature individuals, but their dorsal aspect is a uniform charcoal grey colour except for the margins which are the same colour as the underside.

As neonates and oceanic juveniles (see on the next page), green turtles are opportunistic foragers consuming any animal and plant matter they encounter. However, their ontogenetic shift to becoming neritic bottom feeders coincides with a switch to a primarily herbivorous diets of algae and some sea grasses, leading the turtles to inhabit shallow nearshore habitats where these plants exist.

Size classifications / maturity

There is generally less information on size classifications of green turtles, but their ontogenetic habitat shift from epipelagic to benthic foragers is more defined. Hatchling green turtles are around 4.5 cm in carapace length and juveniles settle into neritic habitats around 30 cm CCL (Cardona et al. 2010). There is some evidence they may utilise more than one distinct foraging habitat as they grow and mature (Margaritoulis & Teneketzis 2003). Minimum breeding size for adult females is reported as 77 cm and mean 91.5 cm CCL (Casale et al. 2018). There are no data on size ranges for adult male green turtles. Using similar criteria as for loggerhead turtles, with the same caveats, green turtle size classification can be described (in terms of CCL) as neonates ≤10 cm< oceanic juveniles ≤30 cm< neritic juveniles ≤77 cm< subadults ≤91 cm< adults.

Other Species (leatherbacks and ridleys)

As indicated above, leatherback turtles, the third most common turtle in the Mediterranean are unmistakable having an elongate shell with a notable vertebral keel, covered in black rubbery skin.

Ridley turtles are extremely rare in the Mediterranean with only a few cases reported (Casale et al. 2018). Both species (Kemp and Olive) are somewhat similar in appearance to loggerhead turtles, with which they may be confused, but have four pairs of inframarginal scutes rather than the three of loggerheads. Additionally, olive ridleys typically have more than 5 costal scutes on either side of the carapace with numbers frequently not being symmetrical. Further details on these species can be found in Pritchard and Mortimer (1999).

Visual guide to turtle identification

Several visual keys to marine turtle species have been published, often based on the imagery of Pritchard and Mortimer (1999). For example, the marine turtle chapter of the Identification Guide of Vulnerable Species incidentally caught in Mediterranean Fisheries (https://www.iucn.org/sites/dev/files/content/documents/2020/sea_turtles.pdf) presents such a key with six species of marine turtle and adds the African softshell turtle (*Trionyx triunguis*) which lives in rivers but may venture onto coastal beaches to nest. A simple guide specific to Mediterranean marine turtles is published as part of the FAO Good Practice Guide for the Handling of Marine turtles Caught Incidentally in Mediterranean Fisheries and is reproduced below.

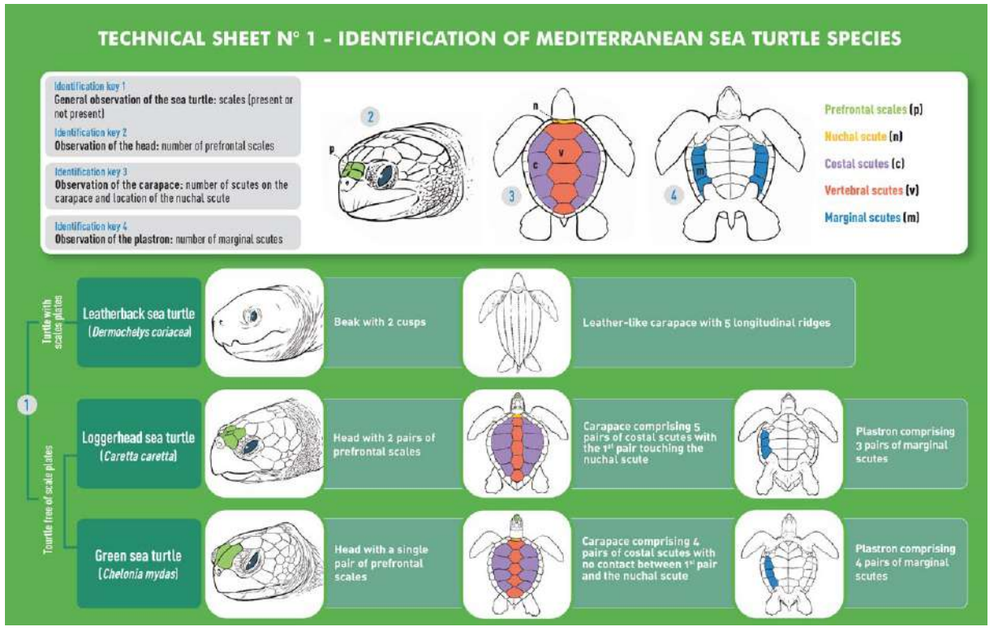


Figure 2.2 Visual identification key for Mediterranean marine turtles.

Distribution

As indicated, loggerhead turtles are widespread and common across the entire Mediterranean whereas green turtles as less common and more restricted to the eastern Mediterranean. The following section places the turtles' most important known breeding, migratory and neritic foraging sites, relevant to adult, subadult and neritic juveniles *(see section called Species identification, page 21)*. Habitats for neonates and oceanic juveniles are poorly known or defined. Further details can be found in Casale et al. (2018).

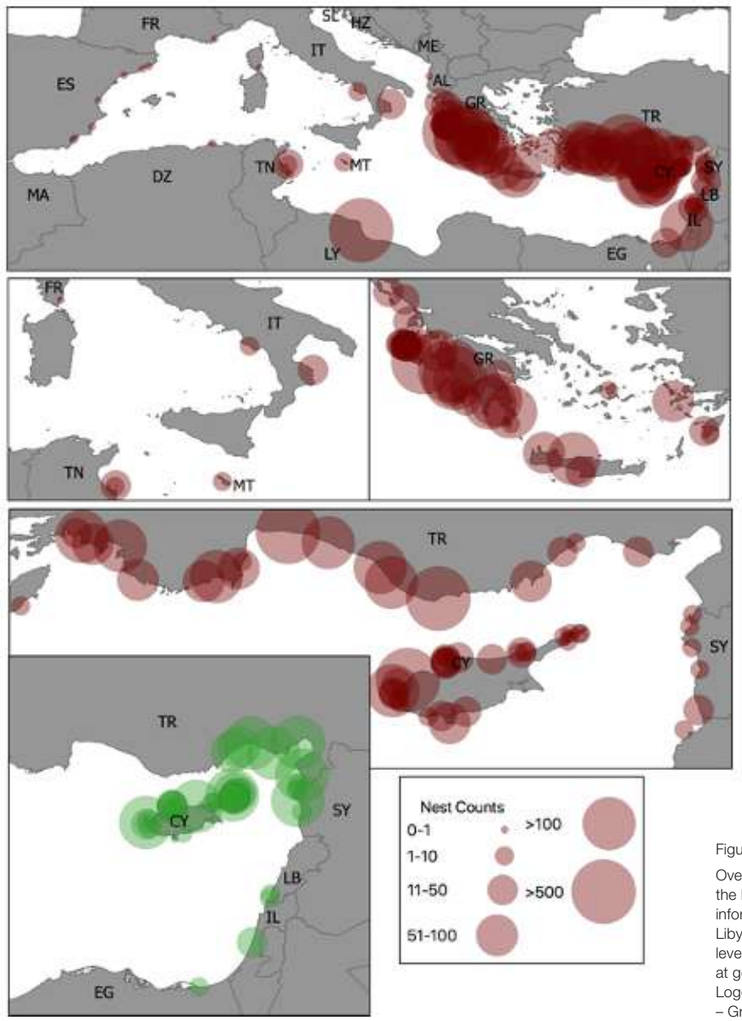


Figure 2.3.

Overview of marine turtle nesting across the Mediterranean region. Nesting site information from Italy, Israel, Egypt and Libya are only available at sub-national levels and are summed and presented at generalised locations. Red circles – Loggerhead nesting sites. Green circles – Green turtle nesting sites.

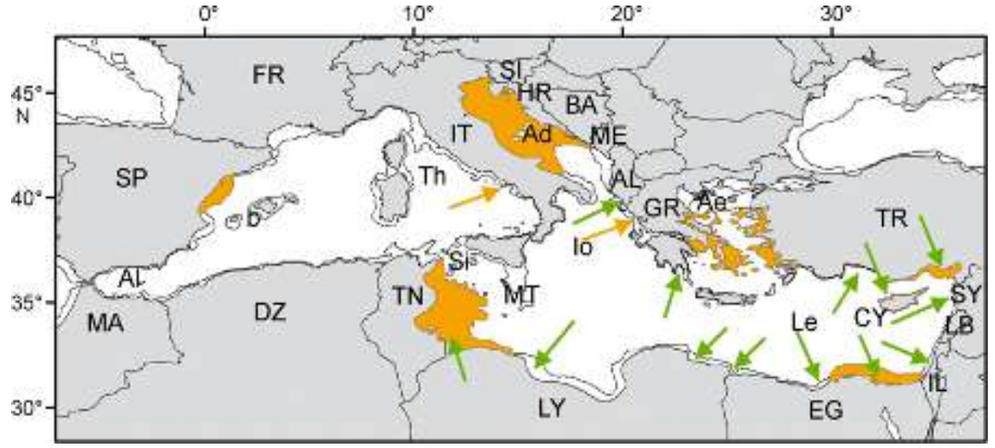


Figure 2.4

Neritic foraging and wintering sites for loggerhead turtles *Caretta caretta* (orange areas and arrows) and green turtles *Chelonia mydas* (green arrows). Neritic areas correspond to the continental shelves, which are conventionally delimited by the 200 m isobath (solid line) Taken from Casale et al (2018).

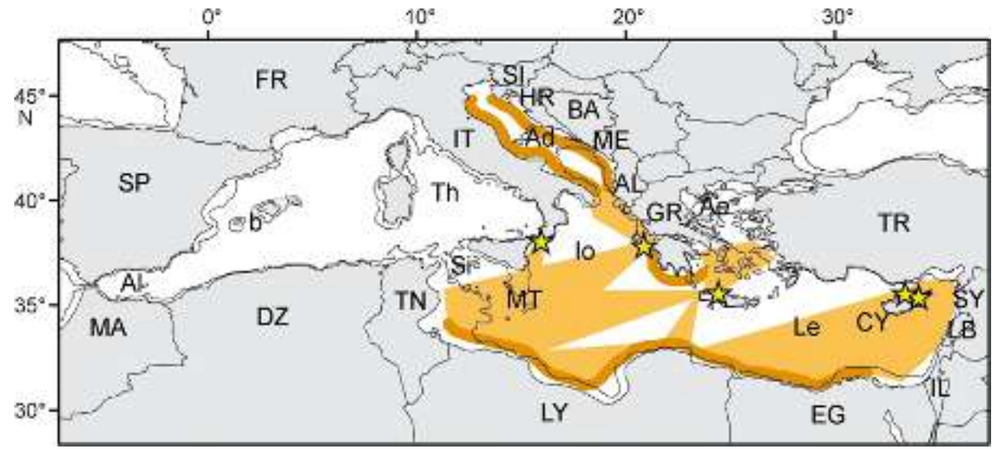


Figure 2.5 Main known migratory corridors for adult loggerhead turtles *Caretta caretta* (females and males) during reproductive migrations from and to the breeding sites (☆). Light brown areas represent migratory funnels in the open sea while darker strips represent paths along the coasts, typically in shallow waters. Taken from Casale et al. (2018).

Loggerhead turtles

Major nesting sites are distributed across the eastern Mediterranean with nesting concentrated in Greece, Turkey and Cyprus. Less frequented nesting sites occur in the western Mediterranean with Spain and Italy hosting most of these minor sites (Fig 2.3).

Neritic foraging sites occur mainly in the Adriatic Sea (Ad) and the Tunisian shelf (Fig 2.4)

Dispersed oceanic, and more restricted coastal migratory corridors from nesting areas have been defined through satellite tracking (Fig 2.5).

The National Marine Park of Zakynthos in Greece is a crucial area for the Loggerhead turtle © L.Sourbes

The species of turtle can be identified from the style of the track, here a green turtle. © ALan Rees / ARCHELON

Green turtles

Major nesting sites are restricted to the easternmost part of Mediterranean (Fig 2.3) with most nesting occurring in Cyprus, Syria and Turkey.

Neritic foraging sites occur around the eastern Mediterranean, with turtles present at specific locations in shallow coastal waters (Fig 2.4)

Dispersed oceanic funnels, and more restricted coastal migratory corridors from nesting areas have been defined through satellite tracking (Fig 2.6).

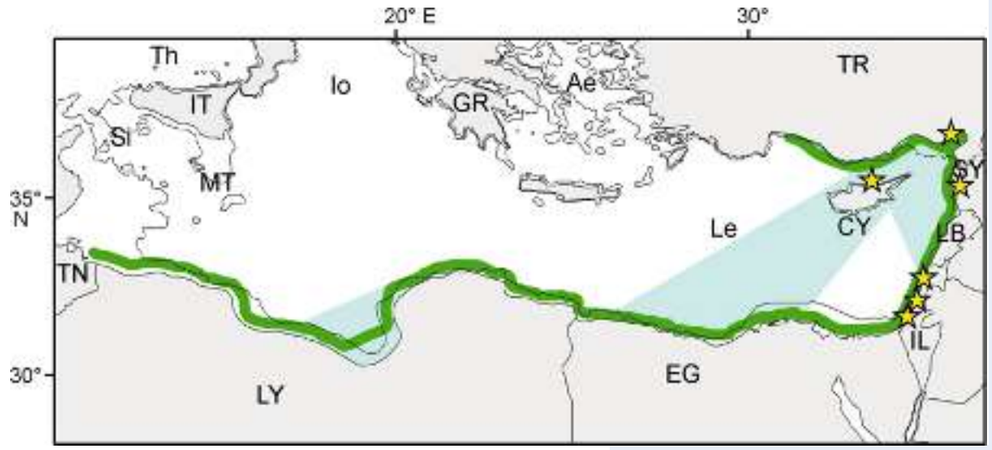


Figure 2.6 Main known migratory corridors for adult female green turtles *Chelonia mydas* during reproductive migrations from the breeding sites (☆). Light green areas represent migratory funnels in the open sea while darker strips represent paths along the coasts, typically in shallow waters. Taken from Casale et al. (2018).

Threats and conservation status

All marine turtle population segments in the Mediterranean are subject to differing levels of anthropogenic threats, both at the nesting beach critical habitats and oceanic and neritic marine habitats. Coastal development is regarded the main threat to nesting sites followed by animal predation on eggs and hatchlings. Fisheries interaction is considered the most important marine threat across the Mediterranean with others including recreational activities, human exploitation and entanglement in debris. It is likely that climate change will impact both critical terrestrial and marine habitats through topographical changes, further skewing of sex ratios and biodiversity alterations. Despite these threats, there is a positive outlook for both species in the Mediterranean.

Using the IUCN red lists of threatened species to determine conservation status, the Mediterranean loggerhead turtle is categorised, based on trends in nest numbers, as Least Concern (Casale 2015) however the metapopulation has reached this status due to extensive long-term conservation programmes. Population trend data based systematic studies at in-water index sites is lacking. It is believed that the positive conservation status would be lost if these nest protection programmes were cancelled as the current situation is largely conservation dependent.

No regional red listing for Mediterranean green turtles has been completed, despite the process of data compilation being initiated over a decade ago (Rees AF, Pers. Obs.). In lieu of this, Casale et al. (2018) assessed green turtle nest counts at 7 nesting sites in Cyprus and Turkey, where suitable time-series of data were available, and revealed an overall positive trend, with indications of increased numbers of neophytes (nesting females encountered during their assumed first breeding season) suggesting population growth. Again, no in-water monitoring programs have been established to determine trends away from nesting beaches. Similar to loggerheads, the Mediterranean green turtle population should be considered as 'conservation dependent'.

The placement of protection cages can be a valuable turtle conservation strategy - National Marine Park of Zakynthos, Greece - © L.Sourbes

3. USE OF THE GUIDE

Why are turtles relevant to me?

Nesting monitoring in Kuriat Island - Tunisia © Notre Grand Bleu

As stated in the *Introduction Section, page 9*. Marine turtles are protected by national and international laws and conventions and can act as umbrella and flagship species for preservation of biodiversity and ecosystems. Consequently, their conservation is mandated at locations where they are known to be present, and none more so than at designated marine protected areas (MPAs).

Efficient use of MPA resources is important for effectively dealing with all conservation issues facing the management body. For marine turtles, targeted initiatives should address the most pressing needs in term of data acquisition and priority conservation actions. To this end, management objectives and priorities need to be identified.

What questions do I need answers to? Management objectives

An MPA manager needs to determine what information is relevant for them, to be effective in their work. At the most obvious of levels, there is no point in expending resources to establish monitoring programme of a rocky coastline for marine turtle nesting. The MPA manager needs to know several basic facts about the turtles they have in the MPA. They fundamentally need to ascertain:

- Where do I have turtles?
- Are they present year-round or seasonally?
- Why are they present; breeding, foraging or both?

When this information is known, conservation oriented information gathering that will lead to management and protection measures needs to be completed so that the MPA manager knows:

- Are the turtles safe; what threats are they facing?
- What are the trends in numbers of turtles?

Answering these questions is best achieved through a multi-step, logical approach of data gathering and assimilation.

A loggerhead turtle swimming in the National Marine Park of Zakynthos, Greece © L.Sourbes

How do I get these answers? Investigative steps

Obtaining information to answer these fundamental questions can be achieved through a variety of means that initially can be of negligible cost and require no field time. A best-case desk-based scenario would be the prior existence of scientific reports and publications on turtles within the MPA boundary and these can be supplemented with recent press or social media posts reporting on turtle sightings etc.

At the outset of investigations into the status of marine turtles in the MPA, the manager should take advantage of all potential data sources. This guide should be used to direct the investigation process and advise on the most appropriate subsequent monitoring and conservation protocols.

Identification of habitats and turtle presence

As stated, knowing your site and marine turtle presence is fundamental to being able to address what are the management needs. Section 4 of these guidelines outlines a range of simple and effective actions to take to acquire this information, thus arming an MPA manager with ammunition of knowledge.

Tracks of a loggerhead marine turtle © DEKAMER Archives

Decision Trees to identify appropriate actions

Once these fundamental understandings are obtained an MPA manager needs to see how these translate into courses of action to further improve this understanding, mitigate against threats and report monitoring findings in internationally acceptable formats. The Decision Trees of Section 5 present, in a simple manner, the process of determining what actions are required for marine turtle monitoring based on habitats present, MPA capacity and management objectives. The outcome of following these Decision Trees is that the MPA manager is prescribed a set of monitoring and conservation protocols to be adopted specific to the situation presented on-site.

Protocols to ensure scientifically sound and repeatable accepted actions carried out

The suite of suggested protocols *(see Annex 1)* is based on international standard methods and best practice for marine turtle monitoring and conservation. They range from simple data logging exercises for monitoring turtle presence records supplied by third parties to in-depth monitoring and research techniques requiring hi-tech equipment for data acquisition and analysis.

4. BASELINE DATA ACQUISITION

Where to start?

Nesting monitoring and hatchling in Kuriat Island - Tunisia
© Notre Grand Bleu

Indicating a marine turtle nest in Kuriat Island, Tunisia
© Notre Grand Bleu

Scope

To fully understand the importance of an MPA to marine turtles involves detailed knowledge including what turtle life stages occur, in what habitats and at what times of the year. Time, resources and effort required to acquire that data, up front, across all habitats in the MPA would be considerable and impractical if not impossible. Instead MPA managers should seek to gather indicators on turtle presence, which form a foundation on which to build more extensive research and monitoring programmes.

During the preliminary data gathering stage, in addition to building up direct understanding of marine turtle ecology relating to the MPA, MPA managers should look to establish or strengthen links with environmental NGOs and academic institutions. Collaborations with such groups strengthens capacity and can distribute tasks relating to monitoring and research to relevant groups and individuals that remain under the direction of the MPA authority.

Gathering information

The following sections on data gathering methods are listed in order of increasing effort and resources required to obtain information from desk-based historical information to field-based current information collection.

Collating such information will give an MPA manager a basis on which to develop further initial investigatory efforts that, in combination with data derived from additional methods listed below, will be the foundation of more extensive monitoring and research activities in subsequent years.

Indicators for turtle presence (tracks/hatchlings/strandings)

In the absence of scientific literature, existing indications that marine turtles are present and use terrestrial or marine areas of the MPA at certain periods in of the turtle's life cycle or season of the year are likely to come in the form of media reports. These may be that a nesting turtle or its track has been seen on the beach or that hatchlings have been recorded on a beach -indicating nesting habitat, or records of turtles stranded on the beach may indicate the marine habitat is a development/foraging area etc.

Internet search / literature review

- Search engine queries: (e.g. name of location of MPA and the word turtle, including image searches) will produce indicative results on the presence of marine turtles in the MPA. These results can be classified into scientific documents, social media posts and news items etc., which intrin-

Once all aspects of recording have been completed, tracks should be erased or otherwised marked. © ALan Rees / ARCHELON

sically contribute differing levels of authoritative information.

- Social media exploitation: A social media campaign can be developed to encourage all marine turtle sightings to be reported. This could take the form of posting pictures of turtles seen on Instagram/ Facebook or recording the turtle observation on dedicated apps such as eTurtle (available on the Internet and as an app on iOS and Android devices). Compilation of the feedback will support analysis of potential and likely marine turtle presence or hotspots that will warrant further attention.

Interviews (guidelines on how to extract knowledge)

Coastal residents, fishers and local boat owners are going to be the most important stakeholders in terms of knowledge of turtle presence within the MPA and this knowledge should be sensitively gathered so as to obtain truthful records of turtle encounters etc. Insights from fishers and other boat owners are likely to give the most useful indications of the threats that turtles are facing in the sea.

Because of the potentially sensitive nature of the information being sought, it is useful to enlist the help of social scientists. They can ensure interviews and questionnaires are devised to produce the desired results. For example, properly formed social science tools should not contain questions that lead the respondent to give a certain type of answer and should contain several questions around each topic to check for internal consistency. For more details on the topic how to ask sensitive questions in conservation the reader is referred to Nuno and St John (2015) and Protocol 35 *(in Annex 1)*.

Field surveys

Field surveys can be considered as occurring any time that MPA staff visit the MPA area for any reason, as long as information on the visit and information on turtle presence/absence and habitat suitability is correctly recorded. For example if MPA staff are called to the coast to respond to a cetacean stranding, the visit can be used to assess the suitability of that area of coast to support marine turtle nesting, or if staff are called out to sea to recover ghost gear, observations made during those times can be counted towards a database on turtle presence. However, dedicated low-level surveys can be factored into MPA staff schedules in order to more promptly assess the coastline for strandings and suitability of nesting habitat. To rapidly assess the suitability of coast for marine turtle nesting at any time of the year, the Sea Turtle Nesting Beach Indicator Tool (STNBIT; Cousins et al. 2017) can be used and is available for download from http://bluedotassociates.com/rapid-data/.

Interpreting findings

Analysis of the information gleaned from the methods listed above should focus on determining the following parameters:

- Which locations are turtles encountered and are there any hotspots or concentrations of turtles? So that targeted follow-up work can be undertaken over appropriate spatial scales.
- Is there any seasonality in the turtle presence? To formulate possible temporally delimited protection measures. Bearing in mind that the breeding season (including the mating period, which precedes nesting) lasts from April to August (and hatchlings may emerge from their nests until October), so if nesting occurs in the MPA then turtle presence is likely to be higher during this time. Or the area may be part of a migratory corridor that will show higher turtle presence before and after the breeding season.
- What threats are identified? Important so that concrete conservation actions can be taken to eliminate or reduce these confirmed threats.
- What size classes of turtles are present? To answer if the MPA contains any developmental or adult foraging/overwintering habitats.
- What species are present? Understanding the differences between species, whilst not important intrinsically for conservation, will place the turtle presence in the MPA in the correct regional management unit context and better contribute to understanding of population size, distribution and dynamics.

Involving the local community in the hatchling allows public awareness Kuriat Island - Tunisia © Notre Grand Bleu

5. HOW TO CHOOSE PROTOCOLS?

Use Decision Trees!

Delineation nesting area on a sandy beach at the National Marine Park of Zakynthos - Greece / © L.Sourbes

At the inception of an MPA or when marine turtle presence is first considered, preliminary investigations should be undertaken to identify extant knowledge of marine turtles in the area in combination with minimal contemporary data collection (Section 4). Subsequently the following Decision Trees should be referred to identify what general realm of monitoring should be undertaken and which protocols to follow.

Activities relating to the presence of turtles at sea and nesting on beaches should be scaled according to the importance of the area in national and regional terms. For example, one would not carry out nocturnal monitoring to tag nesting turtles on a 10km beach that receives one or two nests in the summer, nor would one carry out only one or two daytime surveys on a 2km beach that receives 20 or more nests in a summer where nest predation is a known problem.

As the first year of monitoring will be based on findings from preliminary research that may be derived from scant data, the monitoring levels chosen for subsequent years should be adjusted to reflect the reality of turtle presence in the area, which may be fewer or more turtles than originally believed. These priorities and associated actions can then be reviewed after a set number of years to ensure that resources to monitor and protect turtles in the MPA are being most effectively assigned and utilised.

The following Decision Trees have been constructed around the three precepts of: monitoring according to habitats present, MPA capacity and management goals.

Actions according to MPA habitat for marine turtles

Marine turtle habitats comprise three main geographical types that generally influence what the turtles are doing there.

Coast

The coast, and especially sandy beaches, is the habitat for adult female turtles that come ashore to breed every two to three years, their incubating eggs that remain in the warm sand for around 7 weeks and then the hatchling turtles that dash to the sea under the cover of darkness.

Nearshore

Nearshore, shallow, waters may host marine turtles through several parts of their life cycle. Turtles settle as neritic juveniles *(see section Species identification, page 21)* into these waters where they develop and grow into adulthood in year-round foraging locations. Whereas other nearshore locations are part of migratory corridors used by reproductively active adult turtles for their highly seasonal breeding migrations.

Offshore

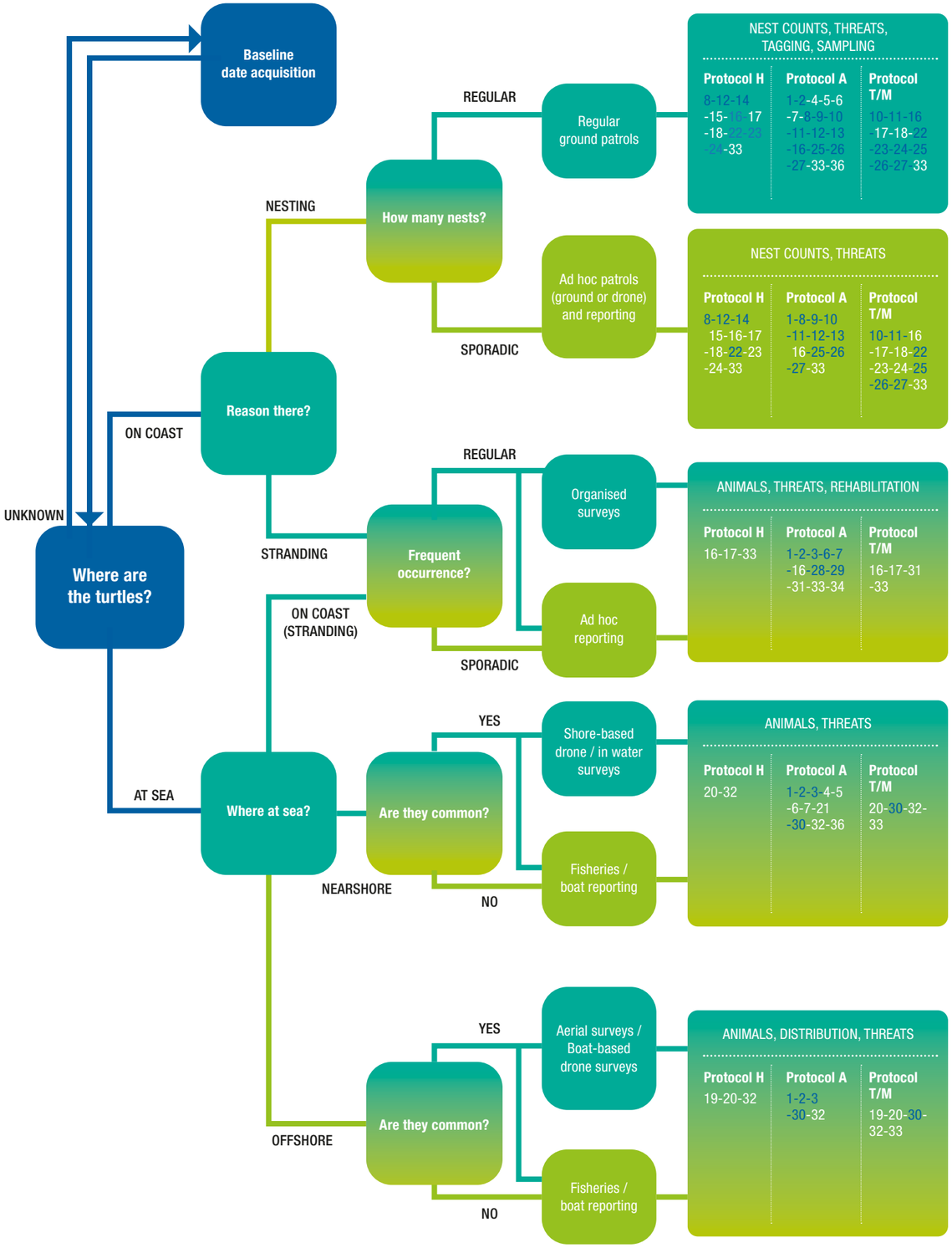
Offshore oceanic habitats are where neonate and smaller oceanic juvenile marine turtles reside (*see section Species identification, page 21)*, with these deeper waters providing food and relatively safety for turtles that cannot fully control their buoyancy. Offshore waters may also form part of migratory funnels used by reproductively active turtles during their highly seasonal breeding migrations. A small proportion of loggerhead turtles remain in offshore, often oceanic habitats through into adulthood, when their conspecifics settle into nearshore habitats.

Decision Tree based on MPA habitats

The following Decision Tree guides the reader towards recommended monitoring protocols to be adopted based on the habitats present in the MPA.

Habitat-Based Monitoring Decision Tree

Protocol H = Habitats
Protocol A= Interaction with Animals (turtles/eggs).
Protocol T/M = Threats or management.
Essental protocols.



Actions according to MPA capacity

MPA management have numerous and diverse tasks to carry out with limited funding, but this varies per country or per MPA. MPA resources are directed to manage the main purpose of the MPA, which may not be the protection of marine turtles and because of this, internal resources and capacity for turtle conservation may be restricted. How the MPA authority manages turtle populations within its capacity varies both in terms of amount of work carried out and 'delegation' or assigning conservation measures to capable third parties. Amount of work warranted within the MPA is determined by the number of turtles that are present *(see section According to MPA habitat for marine turtles, page 37)*.

Levels of work possible

If baseline data acquisition (Section 3) has identified only low levels of turtle presence at sea and breeding, then organising frequent monitoring surveys is a poor use of resources, and reactive data gathering from reports originating from the general public and other sectors is sufficient. Conversely if the MPA is shown to have frequent nesting or concentrations of turtles present at sea reactive monitoring is not sufficient and, especially for nesting, frequent monitoring and management actions are required.

Minimum standards

To be scientifically useful, in addition to informing management programmes, all activities carried out relating to marine turtle conservation should be performed and recorded according to set standards. Systematically recorded information based on minimum standards can be compared from year to year and between MPAs and across the region and therefore contribute more to widescale marine conservation. Although accepted methods for most marine turtle monitoring techniques have been established (See Protocols in Annex 1), monitoring marine turtle nesting has been subject to a global initiative for data collection and set minimum standards. The Status of the World's Sea Turtles 'Minimum Data Standards for Nesting Beach Monitoring' were established almost a decade ago (SWoT 2011). They are the widest used standards and contribute to the IUCN Marine turtle Specialist Group's Regional Reporting initiative (https://www.iucn-mtsg.org/regional-reporting).

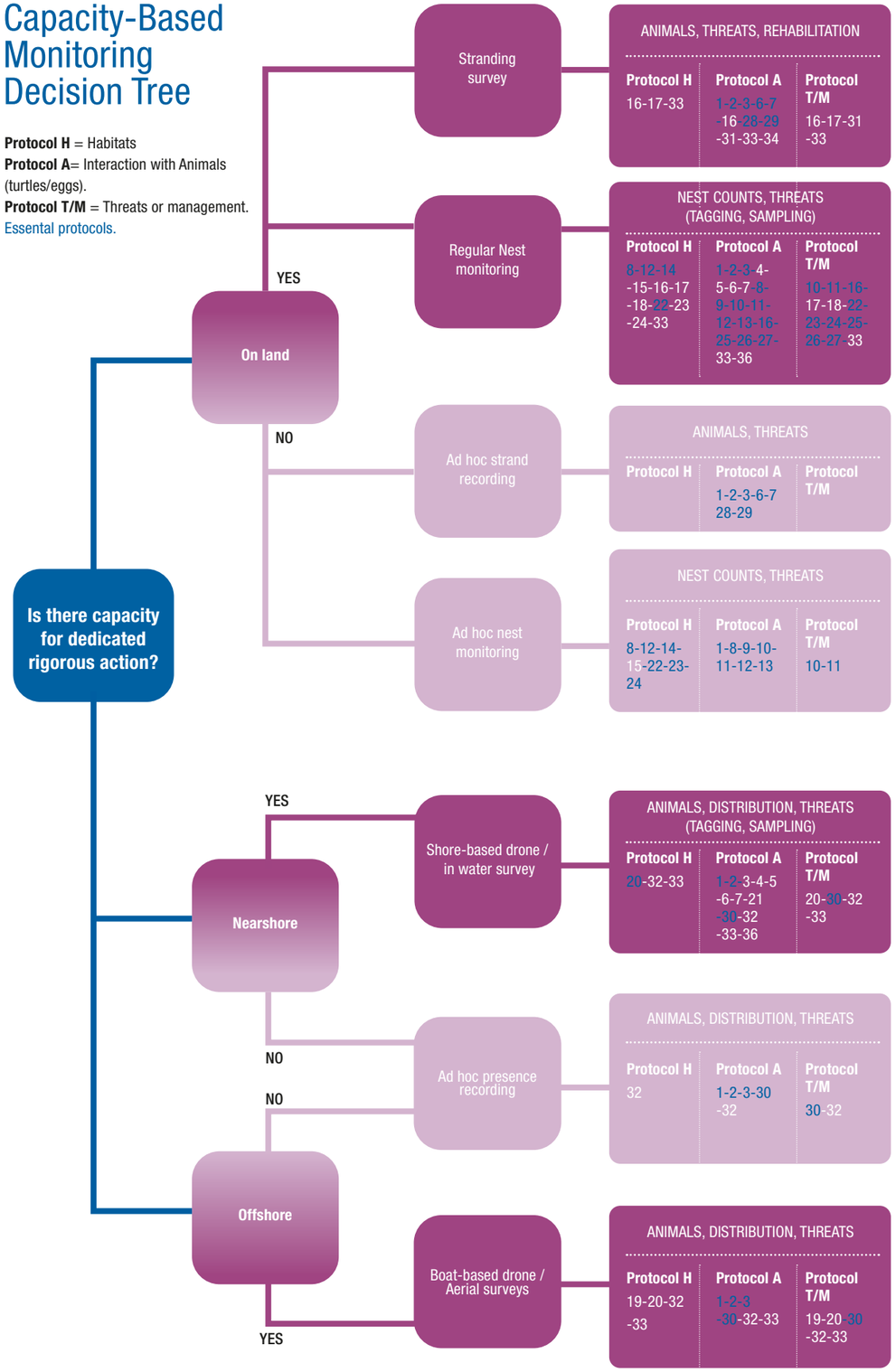
Collaborations

Where internal MPA management capacity is limited for marine turtle monitoring, the MPA authority can form long-term collaborations with third party organisations to undertake the work who report back their findings to the MPA in a timely manner. These third parties are most often local or national environmental NGOs or research groups affiliated with academic institutions. A third option is for the MPA authority to hire short-term contract staff or volunteers to undertake the marine turtle monitoring, which can be considered a halfway measure as the MPA does not need full time employees to carry out the monitoring work but it does need the infrastructure and capacity to recruit, train and supervise a number of external researchers for specific monitoring tasks.

Nesting monitoring by Notre Grand Bleu - Tunisia - © Notre Grand Bleu

Capacity-Based Monitoring Decision Tree

Protocol H = Habitats
Protocol A= Interaction with Animals (turtles/eggs).
Protocol T/M = Threats or management.
Essental protocols.



When collaboration with a third party is the chosen option, creation of a memorandum of understanding (MoU) for cooperation and close communication ties are strongly recommended, often with direct personal involvement between parties to facilitate smooth operations and minimise disruption and miscommunication. The MoU should at minimum include expectations on types of data collected under what monitoring regime and requirements for data sharing in terms of timeliness of data provision, access by the MPA to raw or processed datasets and usage agreements for data use other than direct impact on management activities. For example, data on nest numbers and locations etc from a standard year can be supplied at the end of the nesting season (though interim values could be made available on request by the MPA authority), but information on new and emerging threats and MPA rule violations should be shared immediately through established channels for the MPA to be able to react efficiently and effectively.

Decision Tree based on MPA capacity

The Decision Tree guides the reader to the monitoring protocols applicable to the internal capacity present in the MPA staffing structure.

Actions according to management objectives

The overall management objective is to ensure that the status of marine turtle population segments present in the MPA is favourable to them fulfilling their ecological role without any undue impacts from human activities. This can be broken down into several subgoals such as the elimination of threats to turtles on the nesting beaches or in the sea and the elimination of threats impacting on habitat quality both for nesting beaches and in the marine realm. The outcome of successful management and monitoring will be stable or increasing numbers of turtles in the MPA.

Management goals for marine turtle nesting

A successfully managed nesting population requires some marine management measures as turtles remain in nearshore waters between nesting events *(see section Management goals for marine turtles at sea, page 41)*, however most measures need to ensure beach habitat is maintained in a way it is suitable for nesting to take place, that the incubating clutches are safe from harm and the emerged hatchlings can make it to the sea without hindrance. For areas with regular nesting, threat management needs to be proactively carried out to ensure high levels of hatchling recruitment. For areas of sporadic nesting, threat management needs to be put in place at the nest site for the duration of its incubation and hatching.

Management goals for marine turtles at sea

Marine turtles, especially those inhabiting nearshore waters, are likely to be affected by a number of threats that may injure or kill them and these threats should be identified and restricted according to specific marine zone conservation measures. The temporal and spatial extent of these marine zones and restrictions should be based on good science and err towards more conservative measures protecting turtles rather than liberal measures that lead to impacts on turtle survival.

Management goals for marine habitats

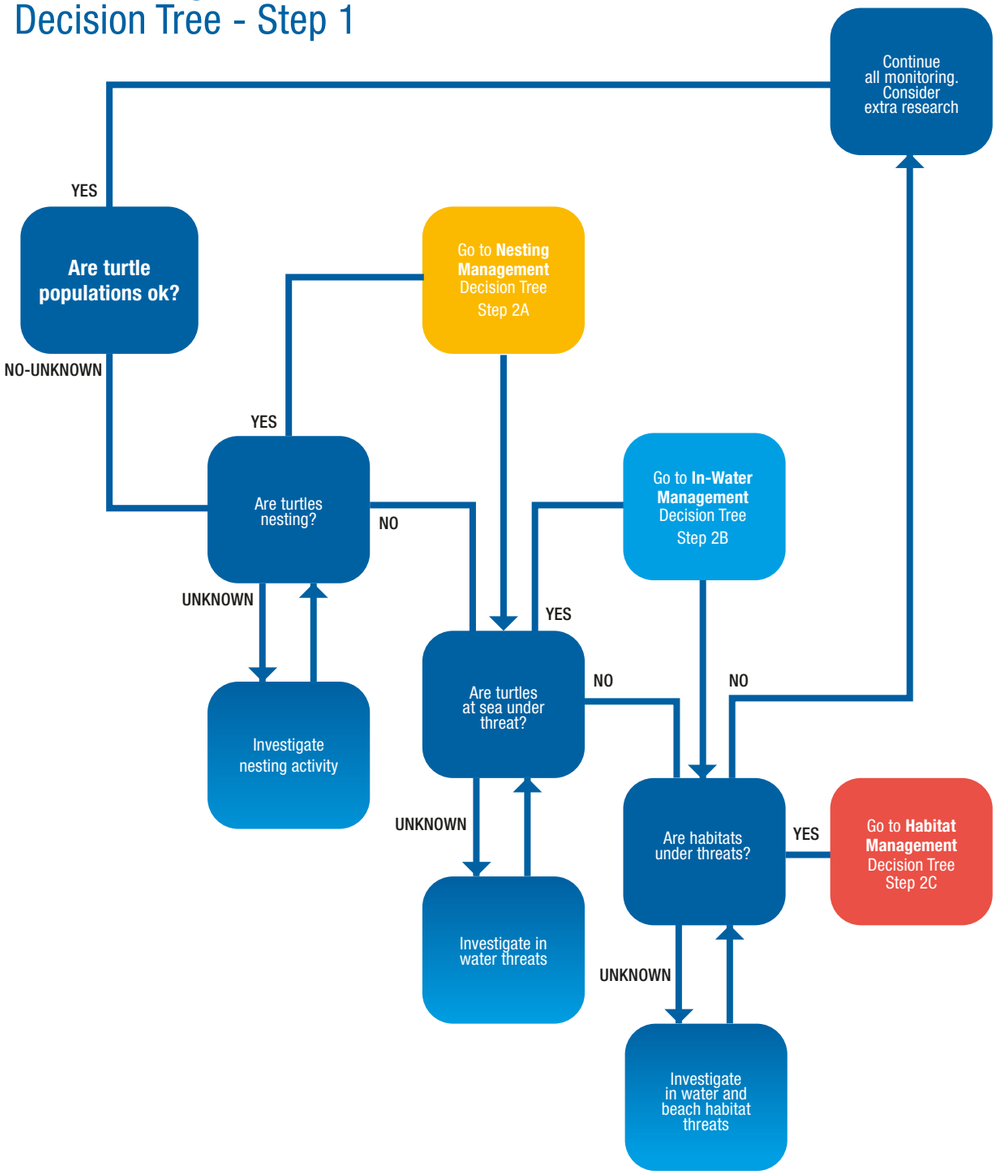
Shallow marine coastal habitats are subject to more threats than oceanic offshore locations. This is espe-

cially true for green turtle foraging habitats that are fragile sea grass meadows and algal mats. These habitats require appropriate measures in place to preserve them for current and future turtle populations, for other protected species that may use them for forage and refuge and, in the case of *Posidonia oceanica* sea grass meadows they are themselves important protected habitats (Boudouresque et al. 2012). Offshore habitats are also potentially impacted by threats such as pollution, but are far harder to monitor and enforce, and may go unnoticed except for major incidences of pollution such as oil spills.

Decision keys based on management objectives

The following multistage Decision Tree guides the reader to actions that identify and manage threats to marine turtles and their habitats present in the MPA to ensure populations are stable or increasing.

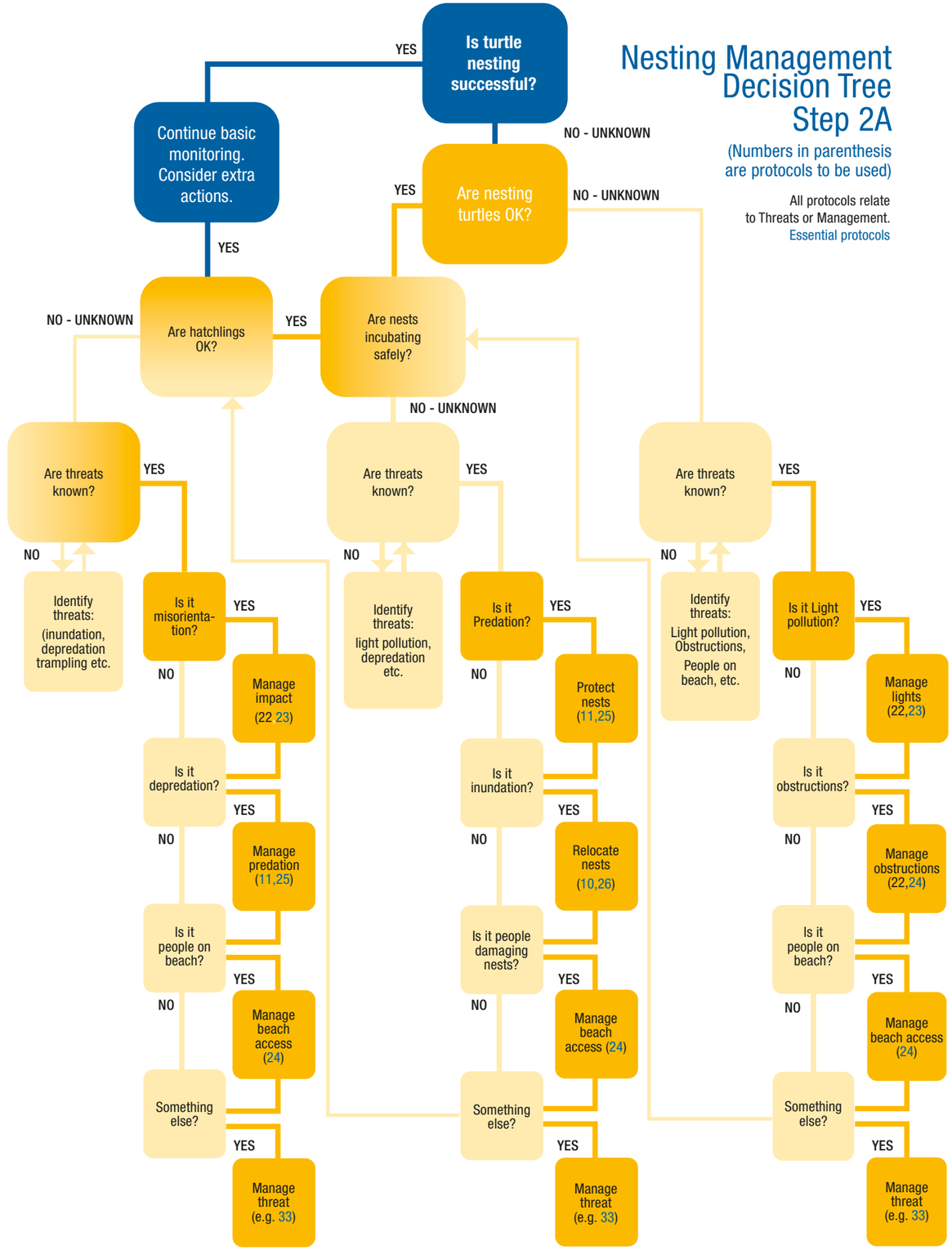
Main Management Decision Tree - Step 1



Nesting Management Decision Tree Step 2A

(Numbers in parenthesis are protocols to be used)

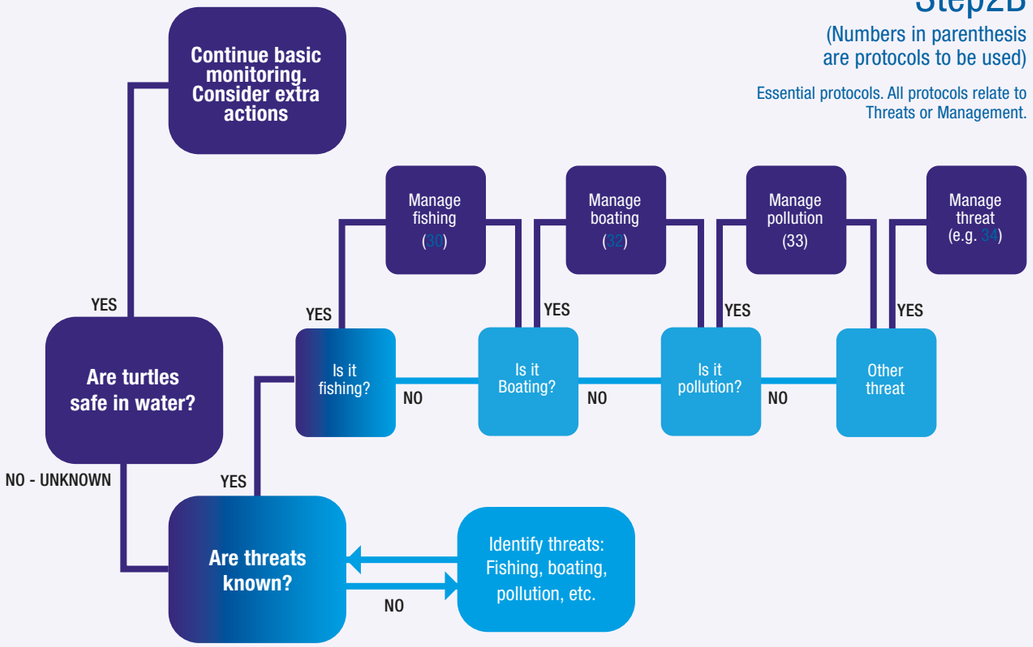
All protocols relate to Threats or Management. Essential protocols



In-Water Management Decision Tree Step2B

(Numbers in parenthesis are protocols to be used)

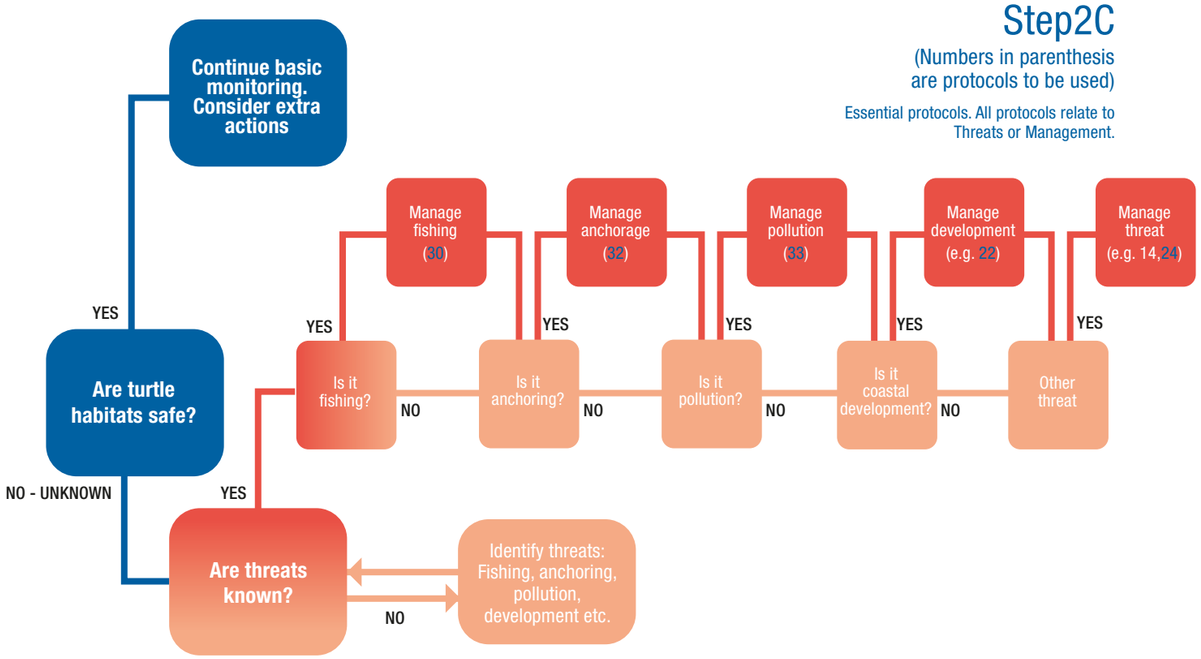
Essential protocols. All protocols relate to Threats or Management.



Habitat Management Decision Tree Step2C

(Numbers in parenthesis are protocols to be used)

Essential protocols. All protocols relate to Threats or Management.



6.

Monitoring and research protocols

Green turtle eggs in a man-made chamber
© ALan Rees - ARCHELON

Users can, in a playful way, be aware of the life of marine turtles at the Kuriat Islands «Awareness Hut» with Notre Grand Bleu. Kuriat Island - Tunisia © Notre Grand Bleu

To simplify access to relevant information on the numerous aspects of marine turtle monitoring and research, each topic has been described in a specific protocol. Carrying out all protocols as indicated in Section 5 at levels suggested below *(See Section Monitoring levels, page 49)* will supply the MPA authority with sufficient scientifically valid data that will contribute to the protection of turtles in the MPA and can be shared for regional meta-analysis. Each protocol is composed of a standard number of sections for simple comparison.

In addition to these listed protocols, additional measures for the conservation of marine turtles and their habitats may play important roles.

Raising stakeholder awareness and environmental education is key to resolving issues as threats requiring mitigation and avoidance are of anthropogenic origin. For example, uninformed tourists may unwittingly directly cause disturbance or harm to turtles, their nests and hatchlings, whereas informed tourists avoid these issues and can bring pressure on local businesses to act in environmentally sound ways, through avoiding patronising operations that do not comply with MPA regulations. If all stakeholders were aware of and adhered to MPA regulations, then the management aspect of the authority would require minimal effort!

Furthermore, in-water surveys of the marine environment provide useful data on the condition of the habitat that marine turtle populations rely on during their stay in the MPA. In-water surveys such as snorkel surveys provided by Imbert & Bonhomme (2014) and monitoring rocky sea beds (RAC/SPA – UNEP/MAP 2015) complement the Marine survey (drone) *(See Protocol Factsheet n°20)* protocol presented in the Annex 1 that focusses on the abundance and distribution of marine turtles in the environment. Although this guide is specifically compiled for marine turtle monitoring and management, the process of conserving marine turtles in MPA settings should be part of an integrated monitoring and management system such as that suggested by UNEP/MAP (2016).

Lastly, the effects of climate change on marine turtles and their habitats cannot be understated. Sex ratio of turtles hatched each year depends on the incubation temperatures experienced by the eggs, and with increasing beach temperatures populations are likely to become increasingly skewed towards females. Also, sea level rise and increased extreme weather events that will result from climate change will affect nesting beach structure, with the likelihood of suitable beach platform for nesting being reduced due to erosion and elevated water tables. Several of the Annexed protocols already refer to the effects of climate change, such as Beach temperatures (protocol factsheet n°15) and Beach mapping (protocol factsheet n°18), but the reader should also refer to resources such as the MPA Engage project (https://mpa-engage.interreg-med.eu/) and T-MedNet website (http://www.t-mednet.org/) for guidelines on long-term monitoring the effects of climate change in an MPA setting.

Protocol scheme

Each numbered protocol is divided into 17 sections as indicated below:

NAME:

Indicates what the protocol covers.

STANDARD:

A three-star categorisation where ★ indicates a typical protocol used broadly across different situations - part of a minimum standard of protocols, ★★ indicates protocols used in more extensive monitoring and ★★★ indicates a protocol used to achieve gold standard results *(see section Monitoring levels page 49)*. Star levels may vary according to the context the protocol is used in. Additionally, a ✦ indicates exceptional protocols used for gathering additional data.

TOPIC:

This is divided into three categories with each protocol covering at least one of them. The categories are **Animal** – where direct interaction with turtles, their tracks, **Habitat** – where the protocol covers actions directly relating to the turtles' environment is required and **Threat/Management** where actions relate to reducing impacts of threats to turtle survival.

REASON:

A brief description of the purpose of the protocol.

CONTEXT: A fuller description of the protocol incorporating related information.

ASSOCIATED PROTOCOLS:

A list of protocols that should or can be carried out relating to this protocol. Protocols in italics are those typically used at the same time as the current protocol and those in normal type are additional ones that may be required in certain circumstances.

EQUIPMENT:

A notebook and writing implement are accepted equipment for all protocols. Here additional equipment is listed, in some cases together with examples of specialist suppliers.

MANPOWER:

The minimum number of people required to carry out the protocol. Where a range is given, the lower number covers one incidence of the protocol being carried out, but several incidences may be required simultaneously (e.g. more than one section of beach being checked for nests each morning).

COST:

The range is from € to €€€€€. This rough costing is focussed on equipment and running costs and less so on staff time. Protocol listed with € incur only minimal costs of a few Euro. Those listed with €€€€€ costs tens of thousands of Euro. If a range is given the lower value is that required for one incidence of the protocol or that the cost to implement the protocol can vary.

FREQUENCY:

How often the protocol should be carried out. Can be given in a temporal scale or based on frequency of the subject of the protocol being presented. E.g. Nesting surveys can be carried out to a set schedule over a defined time period, but nest protection activities only occur when there is a new nest.

ACTIONS:

A list of activities to be carried out associated with the protocol. For more in depth protocols, only a broad outline of activities is given and references to more detailed instructions are provided.

A *caretta caretta* ready to face the Mediterranean Sea in Turkey - © DEKAMER Archives

ETHICS:

This section highlights occasions where direct involvement with turtles, their eggs or interaction with people implies some ethical considerations are raised and need to be accounted for. It additionally indicates where permits to carry out the protocol are likely to be required, due to involvement with endangered species.

DATA TO RECORD:

Essential data to be obtained from carrying out the protocol are indicated here to ensure results from the protocol are useful and accurate.

MANAGEMENT RELEVANCE:

How data produced by the protocol can be used for management purposes and trigger additional management actions in a situational context.

REPORTING:

This section indicates what data to report, how it should be presented and how frequently. It is closely tied in with the Data to record and *Collaboration potential sections*. Ideally, all reports should be shared with the regional marine turtle conservation community and potentially adapted for peer-reviewed scientific publication.

COLLABORATION POTENTIAL:

Should the MPA carry out the work internally or should it 'outsource' completion or analysis of the protocol to third parties, such as NGOs and academic groups is indicated here. This is based on MPA capacity and availability of external expertise.

REFERENCES:

Any documentation or scientific literature referred to in the protocol is listed here, often with a URL if they are freely available online.

Nest monitoring is labour intensive and can be carried out by NGO or University, here the NGO Notre Grand Bleu in Kuriat Island - Tunisia © Association Notre Grand Bleu

Monitoring levels

As indicated in the Decision Trees and associated protocols, the level of monitoring required on a specific topic – nesting, in-water presence, prevalence of threats – varies according to the expected and actual relative importance of those topics and the implications for management of each data type. Marine habitat monitoring currently receives far less attention than nesting beach monitoring, probably due to the relative simplicity of monitoring geographically limited terrestrial habitats during a well-defined breeding season. This is probably the reason that SWoT –Status of the World's Sea Turtles–, partly an initiative of the IUCN Marine Turtle Specialist Group, has so far only elaborated on minimum data standards for nesting beach monitoring studies and nothing for data standards for in-water monitoring. Never-the-less, aspirational levels of monitoring can be stated for both nesting and in-water habitats that will supply MPA authorities with information to inform and update applicable management practices.

Nesting area monitoring

From preliminary research and surveys (Section 4), you have identified at least some of the coast in the MPA is suitable for marine turtle nesting. Therefore, the data acquisition goal is to quantify presence of nesting, by species, the nests' success, and identify threats and the management goal is to alleviate threats and ensure successful nesting.

Gold standard activities

This level of monitoring not only involves acquisition of daily nest count data but also capture-mark-recapture

Nesting beach in National Marine Park of Zakynthos - Greece © Laurent Sourbès

data on the individual nesting turtles that can only be obtained from exhaustive nocturnal patrols. In this way more detailed abundance and demographic data can be generated (SWoT 2011). The level of survey effort to acquire gold standard data is extreme and is not likely to be achieved solely by permanent MPA staff, but through close collaboration with NGOs and academic groups. This level of surveying is not required to supply on-going management orientated data and is definitely not recommended for low-level and dispersed nesting areas. Currently only one nesting area in the Mediterranean is surveyed fully to this level (see for example Stokes et al. 2014).

Minimum standard activities

Minimum data standards, defined by SWoT (2011), require a sampling error of ≤20% for a nesting season, which can be achieved in a number of ways (SWoT 2011). They define five recommended protocols based on research question to be answered and amount of surveying required. Protocol A is a basic survey to identify species and nesting season, Protocol B involves surveying three times per week, Protocol C covers different monitoring levels at different parts of the nesting season, Protocol D is for assessing multiple sites that are used by the same population and Protocol E is short term monitoring during mid-season. Given the Mediterranean's established nesting season and limited nesting species, SWoT Protocols B, C and D are recommended. However, for remote sites, SWoT Protocol E can be used. Where nesting is sporadic, reactionary surveying in response to reports of turtle nesting activity from members of the public etc. is sufficient. Accurately monitoring the number of nests is good for identifying long-term trends but effective beach and nest management are the actions that will provide immediate and measurable conservation benefit within an MPA.

Protocols used for nesting beach monitoring

Nest (and track) identification by species [8], Threat assessments [16, 22, 23, 24], Clutch location [9], Clutch relocation [10], Nest protection [11], Hatching assessment [12, 27], and Nest success evaluation [13] are essential protocols used if the clutches are to be protected against threats and effectiveness of protection measures to be assessed for all levels of nesting – even sporadic nesting. When nesting is expected, ground and possibly drone based nesting beach surveys are needed to proactively identify and protect turtle nests.

Species identification (nesting turtle) [1], Measuring turtles [2], Flipper Tagging [5], PIT tagging [4] (and possibly Photo ID [6]) are used where nocturnal surveying for capture-mark-recapture data are sought and contribute to long-term understanding of the demography of marine turtles in the MPA.

Tissue sampling from nesting turtles or hatchlings / embryos [7] can also be carried out to build an archive of tissues for future analysis -such as genetic characterisation of the population, or this can be undertaken when a specific (regional) project with defined conservation goals is instigated.

Once hatched the Loggerhead turtle face the gravest danger on their first trip to the sea © DEKAMER Archives

Coastal area monitoring (strandings)

All MPAs that have some distance of coastline may experience marine turtle strandings at any point of the year. The goals of coastal area monitoring for stranding is to quantify presence of marine turtles, species, size classes, seasonality and threats, and to gain insights into habitat use that can, through appropriate management measures, improve the conservation status of turtles that are present. Prompt attention to live strandings can additionally result in successful rescue and rehabilitation of these individuals. At all monitoring levels, attention needs to be paid to the number and distribution of turtles and the causes of strandings within the MPA so that the MPA authority is alerted to emerging issues, such as deliberate injury or bycatch, and can instigate management actions to investigate causes and counter the threats. There is currently an initiative to develop a pan-Mediterranean marine turtle stranding protocol and database (Rae & Touloupaki 2020), which may result in a unified system for all MPA managers to adopt.

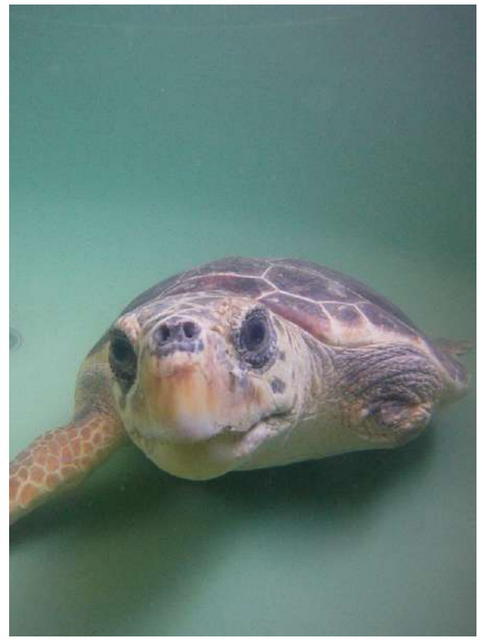
Gold standard activities

The following provides a suggested list of actions and logistical considerations for a gold standard strand monitoring regime.

On foot or ATV patrols to record data on turtle presence/absence, pollution presence/absence type etc. Turtle species, biometrics, threats/impacts (e.g. fishing interaction – hook ingestion or net/line entanglement) should be scheduled bimonthly.

Depending on level of decomposition: Tissue sampling for genetics (which population the turtle belongs to), pollutants (what is the turtle experiencing in the environment) and stable isotopes (what the turtle has been eating), and stomach contents gathering and analysis (quantifying plastic ingested) should be carried out. Supplementing the bi-monthly stranding surveys, a publicised stranding network 'hotline' number for citizens to report stranded turtles and illicit a timely response is a useful tool – this could be a national initiative or specific to the MPA.

Live stranded turtles reported or encountered during the scheduled surveys to be transported to dedicated rescue centre for rehabilitation or compassionate euthanasia. All dead stranded turtles are disposed of in hygienic manner according to local laws after samples and other data have been collected. Ideally, all collected data should contribute to a National Stranding Database that is aligned and shared with a regional database in a standard format.



Any injured turtles found along the Mediterranean coast of Turkey are brought to the DEKAMER marine turtle rescue center © DEKAMER Archives

A Green turtle hiding in *posidonia* meadows in Turkey © DEKAMER Archives

Minimum standard activities

No scheduled surveys but strandings are reported to the MPA by beach users or observed from *ad hoc* encounters by MPA staff. All the reported strandings are attended and basic data collected i.e. species, biometrics, threats/impacts (e.g. fishing interaction – hook ingestion or net/line entanglement) and tissue samples.

Live stranded turtles should be transported to a veterinary centre for basic treatment (and release) or compassionate euthanasia. Dead stranded turtles are disposed of in hygienic manner according to local laws -or marked *in situ* to avoid taking duplicate records of the same individual. Ideally, all collected data should contribute to a National Stranding Data-base that is aligned and shared with a regional database in standard format.

Protocols used

Species ID [1], Measuring turtles [2], Sexing turtles [3], Photo ID [6], Tissue sampling [7], Dealing with dead strandings [28], Dealing with live strandings [29], Fisheries interactions (bycatch) [30], and Necropsy [31] are all used for minimum strand monitoring. For gold standard strand monitoring, Beach surveys (ground) [16] or Beach surveys (drone) [17], Pollution [33] and Plastic ingestion [34] are to be used in addition to the minimum monitoring.

Nesting monitoring at Kuriat island / Tunisia © Notre Grand Bleu

Nearshore monitoring

All MPAs that contain some areas of coastline, will host some nearshore marine habitats that have the potential to be developmental and foraging, or migratory habitats for juvenile and adult marine turtles or summer habitats for breeding adult turtles. The goal of this assessment is to quantify presence of marine turtles, species, size classes, seasonality and threats, and to improve conservation status of turtles that are present. Activities to monitor and protect marine turtles at sea has traditionally lagged behind equivalent actions on their nesting beaches but should not be overlooked. An MPA manager needs to determine a baseline indication of the importance of nearshore habitats to which results from monitoring can be compared. Monitoring data are useful for long-term trend determination, but the main management triggers here are identification of emerging threats such as fisheries interactions (such as bycatch or ghost gear entanglement) and of degradation to the habitat itself, such as erosion in seagrass meadows.

Gold standard Activities

Quantification of the number of turtles present in the nearshore habitats throughout the year to be achieved through large surveys carried out bi-monthly (i.e. drone, plane or boat surveys). A citizen science data collection and reporting initiative can supplement the scheduled survey and other data collection methods. Fishery bycatch records (if applicable) should be maintained year-round together with threat assessments including pollution and boat traffic etc.

In areas where a high abundance of turtles is proven, a capture-mark-recapture study using tagging, Photo ID and tissue sampling should be adopted to better define demographic parameters for the marine turtles that are present. Data from this study can be complemented with those acquired from telemetry to give more fine scale understanding of turtle movements and residency.

Minimum standard activities

Fishery bycatch records (if applicable) should still be collected when capacity is limited and there are low numbers of turtles present in the nearshore region. A citizen science data collection and reporting initiative can also be maintained as a low-resource tool to monitor turtle presence. Reports of threats such as important pollution events etc. should still be responded to in a timely manner.

Protocols used

Species ID [1], Measuring turtles [2], Sexing turtles [3], Fisheries interaction (bycatch) 30] and Pollution [33] protocols are all used for minimum nearshore monitoring. Ramping up to gold standard monitoring requires the addition of Marine survey (drone) [20], Marine turtle survey at sea (turtle capture) [21], Marine traffic management [32] for surveying with the addition of Flipper tagging [5], PIT tagging [4], Photo ID [6] and Tissue sampling [7] required for a capture-mark-recapture study.

Offshore monitoring

Offshore areas extend from 1 km or more from shore into the open sea, with the parts nearest to the coast still accessible by land-based drones. These areas can be oceanic and/or neritic habitats used by marine turtles for development, foraging/over wintering or transitory

Beach clean-ups can be done before the start of the nesting season and before the start of hatching season - Kuriat Island - Tunusia © Notre Grand Bleu

Flipper tagging can provide information on a wide variety of important life-history traits - Tunisia © Notre Grand Bleu

Hatchling baby turtles in Kuriat Island - Tunisia © Notre Grand Bleu

migratory corridors. The goal of this assessment to quantify presence of marine turtles, species, size classes and seasonality and threats, and to improve conservation status of turtles that are present. Offshore monitoring generally receives the least frequent monitoring effort, as when monitoring occurs it is relatively costly, and turtles are rarely present in densities equal to those in coastal habitats. It is highly unlikely that through the predicted infrequent monitoring offshore sites that management measures will change to any great degree over time, with the exception of revision of permitted fishing activity, however the MPA authority should be prepared to manage large-scale acute threats such as major pollution events.

Gold standard Activities

Similar to nearshore monitoring, fishery bycatch records (if applicable) should be obtained year-round and a citizen science data collection and reporting programme established. Annual aerial surveys using light aircraft supplemented by quarterly boat-based drone surveys to acquire seasonal data on the presence of turtles and threats over large spatial scales.

Minimum standard activities

Fishery bycatch records (if applicable) should still be collected when capacity is limited and there are low numbers of turtles that are present. A citizen science data collection and reporting initiative can also be maintained as a low-resource tool to monitor turtle presence. Reports of threats such as important major pollution events etc. should still be responded to in a timely manner.

Protocols used

Fisheries interactions (bycatch) [30], Species ID [1], Measuring turtles [2], Sexing turtles [3], Photo ID [6] and Pollution [33] are the monitoring protocols associated with minimum level offshore monitoring. Gold standard monitoring requires the additional effort of Marine survey (plane) [19], Marine survey (drone) [20] and Marine traffic management [32] protocols to be incorporated in MPA activities.

7.

What do I do with the data I have collected?

Hatchlings try to reach the sea by following the moonlight - Turkey
© DEKAMER Archives

Timely acquisition of relevant information on status of threats within the MPA permit efficient reactive measures to be applied and minimise ecological harm. Following even the minimum data collection requirements for marine turtle monitoring will mean the MPA acquires a body of data that will be internally useful to validate MPA designation and its conservation measures for marine turtles. This is, after all, the main reason for which these data have been collected. However, data collected by and for the MPA management should not be solely limited to use within the individual MPA context. There are several levels the data can be used and promoted.

Reassess MPA monitoring and zonation

Populations and habitats evolve over time, driven by both positive conservation actions and negative anthropogenic threats including climate change. MPA management should adapt in a predictive and reactive way to anticipated and actuals changes in local conditions (Mazaris et al. 2020). Accordingly, MPA management activities and even MPA designated zonation should be reviewed at intervals, based on a large dataset of valid scientific data. Monitoring activities can be adjusted yearly, in the case of known increase in nesting activity requiring protection against threats such as predation and light pollution, or less frequently (5-10 yearly) when there are firm signs that populations have unfortunately dwindled and maintaining higher levels of monitoring is no longer viable. Marine zonation in the MPA should be systematically reviewed up to a maximum of every 25 years, to ensure that measures in place at sea and on nesting beaches accurately reflect the reality of the current needs of the turtles present in the area. For example, nesting densities may systematically change among locations sufficient enough to introduce night-time and day-time prohibitions for beach use within the MPA. Likewise, marine zones designed to protect turtles in nearshore waters should align with the density and distribution of turtles, with high use areas covered by the most stringent conservation measures.

Marine turtle monitoring in Kuriat Island - Tunisia © Notre Grand Bleu

Shared nationally and internationally

Turtle monitoring data should feed into national strategies for conservation, so the competent governmental ministry is aware of the status of turtle populations within its jurisdiction and can act to improve the national situation. Or conversely the data can be used as evidence to deter development and other activities in the region of the MPA that are likely to negatively impact the conservation status of marine turtles and other protected species and habitats. Data should also be shared across the MPA community to identify regionwide trends in population sizes and to quantify the relative importance of threats. Furthermore, the data can be used and promoted through publication in peer-reviewed scientific literature, making it available to the broader, global conservation community.

Marine Turtle Specialist Group

The Species Survival Commission of the International Union for Conservation of Nature has established over 150 taxon specific specialist groups to act as global authorities on conservation status of their subject species and generate species by species red list assessments on the various species' threatened status. A global Marine Turtle Specialist Group (MTSG) was established in 1966 and today it is organised into ten geographic regions, each with its own Regional Vice Chair(s). The Mediterranean is one of these global regions and is generating regional assessments of marine turtle population status based on the two endemic marine turtle species. The most recent and pertinent activity of the MTSG is its Regional Reporting Initiative in which MTSG representatives and colleagues produce chapters on the biology and status of marine turtles per country (https://www.iucn-mtsg.org/). Data gathered by MPA authorities should be shared with the MTSG membership so that the national reports are based on the most extensive and up-to-date data possible. MPA authorities should contact the MTSG regional co-chairs (mtsgmed@gmail.com) to identify the main author of their relevant country chapter in any given year.

Mailing lists

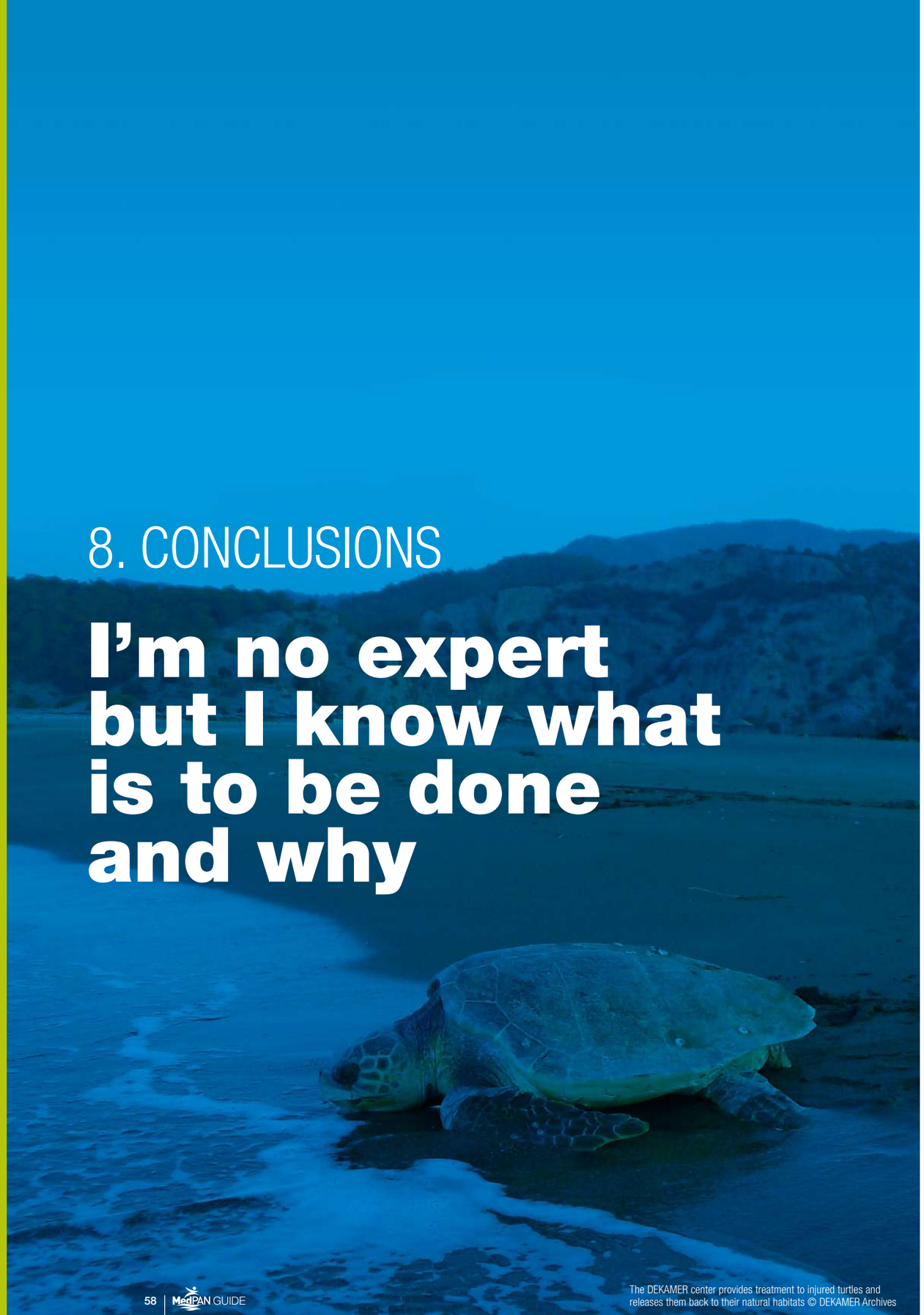
There are two main mailing lists for marine turtle researchers, conservationists and enthusiasts over which data can be shared and information and advice can be sought. The global list (CTURTLE) is run by the Archie Carr Centre for Sea Turtle Research, based in Florida, USA. Information on registering for that list is available from https://accstr.ufl.edu/resources/cturtle/. The Mediterranean has its own list (MedTurtle) with well over 100 subscribers from across the region. MedTurtle is overseen by MTSG members and is regularly used to share updates on conservation issues, recent publications and other news from across the region. The MedTurtle landing page is found here https://groups.io/g/MedTurtle and includes instructions on how to subscribe to the list. An additional online global directory of more focussed scope has been established to contact organisations involved in the rescue, treatment and rehabilitation of marine turtles. The link to send an email to the group or register your organisation in the directory is available from http://www.seaturtle.org/mtrg/firstaid/.

Subject specialists

A number of nodes of specialist expertise have been established covering all topics on research and conservation of marine turtles from across the region. Key individuals can be approached with whom to share MPA specific data or form collaborations that can maximise the usefulness of tissue sampling, tracking and other data gathering activities carried out in the MPA. To avoid recommending researchers that are no longer active in the field, or unintended bias, no individuals or specific research groups will be mentioned in this guide. Instead the MPA authorities are suggested to 1) send a message over the MedTurtle mailing list stating the purpose of the email and/or 2) examine recent scientific literature and approach the corresponding author of relevant research papers.

8. CONCLUSIONS

I'm no expert but I know what is to be done and why



The DEKAMER center provides treatment to injured turtles and releases them back to their natural habitats © DEKAMER Archives

Over the preceding seven sections of this guide the reader has been offered insights into the biology and conservation of marine turtles and how this knowledge applies to MPA management of these protected species. The guide indicates, through following logical Decision Trees what actions should be undertaken given individual MPA circumstances relating to habitat, capacity and management objectives. These actions are presented as specific, but interrelated, monitoring protocols covering all aspects of monitoring and management that will help provide the knowledge required for informed conservation. Following this guide will streamline the MPA managers workflow to determine the most appropriate management measures that should be adopted, saving time and resources and helping to avoid any missteps that may take place at the outset of a new monitoring and conservation programme.

From the outset this guide has indicated that following its directions will not make the reader an expert on marine turtle conservation, but it will arm them with the tools required to suitably manage and protect turtles under their jurisdiction. The guide also indicates how MPA managers can reach out to others, be they scientists or other managers, for collaborations to strengthen and expand the findings from one MPA so that they can be applied nationally and regionally.

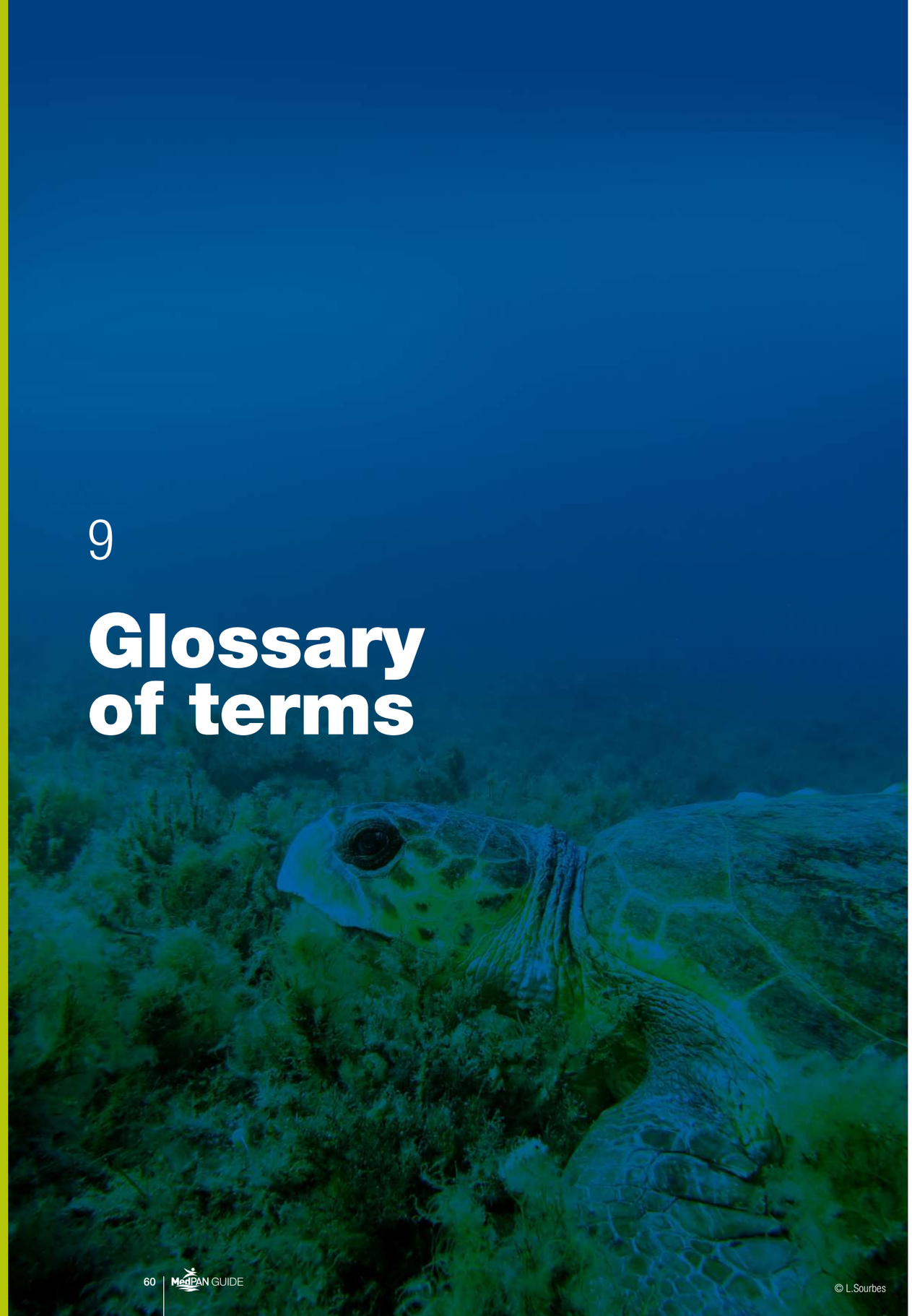
Relevant scientific literature has been cited throughout this document to broaden the reader's understanding on the individual topics raised and a list of authoritative texts is provided (Section 1) should the reader wish to gather a broader understanding on the status of marine turtles in the Mediterranean and internationally accepted methods providing standardised data.

Finally, an MPA manager should know that they will not be the first person to encounter the issues that they are facing within their area, and in addition to this guide and helpful literature, there are a large number of colleagues and experts who can guide and advise actions that will bring about successful solutions.

First trip to the Mediterranean Sea © DEKAMER Archives

9

Glossary of terms



© L.Sourbes

Anthropogenic: Relating to or resulting from the influence of human beings on nature.

ATVs: All Terrain Vehicles such as Quad Motorbikes.

Barcelona Convention: Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean.

Benthic / benthos: Relating to the sea bed / organisms living on the sea bed.

Body pit: The pit excavated by a female turtle while stationary and attempting to nest.

Bycatch: The incidental capture of non-target species such as dolphins, marine turtles and seabirds.

Callipers An instrument for measuring external dimensions.

Camouflage: The mound of sand created by an adult turtle after successful nesting.

Carapace: The dorsal shell of a marine turtle.

CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora. It is a multilateral treaty to protect endangered plants and animals.

Cloaca: The cloaca is the external vent (hole) in the underside of the tail from which the turtles excrete or lay eggs.

Demographic/demography: Relating to the structure of populations.

Drone: Unmanned aerial vehicle, flown by a ground-based controller.

Emergence: The event of a female turtle coming ashore to nest.

Epibiont: An organism living harmlessly on the surface of a host organism. E.g. barnacles on a turtle's shell.

Epipelagic: Referring to the upper layer of marine habitats where enough light is present for photosynthesis to occur.

Foraging area/site: An area where a marine turtle resides when not in its breeding site. Relating to its main purpose of eating to survive in contrast to the drive to breed.

Geo-reference: To assign one or more geographic coordinates to an image.

Ghost net: An abandoned fishing net that has the possibility to entangle and endanger marine life.

GIS: Geographic Information System is software that can manipulate two- and three-dimensional geographic data.

Ground control points: Some readily identifiable (natural or user-placed) points on the surface of the earth of known location used to geo-reference aerial imagery.

Habitat: The natural home or environment of an animal.

Hatching: The process of an embryo turtle emerging from its egg or of hatchling turtles emerging onto the surface of the beach.

Hatchling: A newly emerged baby turtle.

IUCN: International Union for Conservation of Nature. It is a membership Union composed of both government and civil society organisations.

Morphological: Relating to the form or structure.

Neonate: A young turtle no more than a year old (<10cm CCL).

Neritic: Relating to the shallow part of a sea (<200m deep) overlying the continental shelf.

Nest site selection: The process of an adult female turtle choosing the location to deposit her clutch of eggs.

NGO: Non-Governmental Organization.

Oceanic: Referring to a region of water greater than 200m deep.

Ontogenetic habitat shift: A change in habitat based on development stage in marine turtles.

Orthomosaic: A group of combined aerial images that are geometrically corrected ("orthorectified") such that the scale is uniform. i.e. there is the same lack of distortion as a map.

Overwash: The passage of waves over a nest site that may saturate the sand over a clutch of eggs and cause sand to seep into the airspace between the eggs, thus harming their incubation.

Photogrammetry: The use of photography in surveying and mapping to ascertain measurements between objects.

PIT tag: A small radio transponder that contains a specific code, which allows individual turtle, as well as amphibians, fish, birds and even rocks, to be assigned a unique 10- or 15-digit alphanumeric identification number.

RAC/SPA: See SPA/RAC.

RTK GPS: Real Time Kinematic Global Positioning Sys-

tem is a satellite navigation technique used to enhance the precision of position data derived from satellite-based positioning systems.

Recruitment: The entry of a turtle into a population through hatching or moving into a defined geographic area / nesting population.

Rodeo: The process of capturing turtles at sea by jumping from a boat.

Secondary body pit: The pit left from the sand that has been displaced by a nesting turtle creating a camouflage.

Sex ratio: The ratio of male and female turtles, most studied during the production of hatchlings at a nesting beach.

Site fidelity: An animal's tendency to return to a previously occupied place.

Size class: A range of turtle sizes grouped in reference to development stage.

Soak time: The time during which fishing gear is active in the water.

Stable isotope (analysis): Stable isotope analysis of elements such as Carbon, Nitrogen and Sulphur is used in ecology to trace the flow of nutrients through food webs and assess trophic levels.

Stakeholder: a person with an interest or concern in something, especially a business.

Strand/Stranding: The washing ashore of a weak, injured or dead marine turtle.

Scute: A hard keratinised plate on a turtle's shell.

Scale: A defined hard patch of skin on a turtle's head and flippers.

SPA/RAC: Specially Protected Areas Regional Activity Centre. Established to assess the condition of the Mediterranean's natural heritage. https://www.rac-spa.org/

Swim: The formation in sand produced when a nesting turtle commences the actions of creating a body pit but is moving forward.

Telemetry: Remotely tracking marine turtles using devices that are usually attached to the carapace.

UNEP/MAP: United Nations Environment Program / Mediterranean Action Plan. Is the institutional framework for cooperation in addressing common challenges of marine environmental degradation in the Mediterranean.

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10.

References

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B

Boudouresque CF, Bernard G, Bonhomme P, Charbonnel E, Diviacco G, et al. (2012) Protection and conservation of *Posidonia oceanica* meadows. RAMOGE and RAC/SPA Publisher, Tunis. 202 p.

C

Casale P, Abbate G, Freggi D, Conte N, Oliverio M, Argano R (2008) Foraging ecology of loggerhead sea turtles *Caretta caretta* in the central Mediterranean Sea: evidence for a relaxed life history model. Marine Ecology Progress Series 372: 265-276.

Casale P, Freggi D, Maffucci F, Hochscheid S (2014) Adult sex ratios of loggerhead sea turtles (*Caretta caretta*) in two Mediterranean foraging grounds. Scientia Marina 78: 303-309.

Casale, P. 2015. *Caretta caretta* (Mediterranean subpopulation). The IUCN Red List of Threatened Species 2015: e.T83644804A83646294. https://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T83644804A83646294.en. Downloaded on 23 March 2020.

Casale P, Freggi D, Furii G, Vallini C, et al. (2015) Annual survival probabilities of juvenile loggerhead sea turtles indicate high anthropogenic impact on Mediterranean populations. Aquatic Conservation: Marine and Freshwater Ecosystems 25: 690–700.

Casale P, Broderick AC, Camiñas JA, Cardona L, et al. (2018) Mediterranean sea turtles: current knowledge and priorities for conservation and research. Endangered Species Research 36: 229-267. https://doi.org/10.3354/esr00901

Centro Studi Cetaci, 2019 (2019) Guide to marine turtles [sic] monitoring protocols for MPAs managers operating in the Mediterranean basin. MedPAN. 111 p.

Cousins N, Rees AF, Godley BJ (2017) *A Sea Turtle Nesting Beach Indicator Tool* to help identify area with potential for sea turtle nesting. Marine Turtle Newsletter 153: 13. http://bluedotassociates.com/rapid-data/

E

Eckert KL (1999) Designing a conservation program. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 6-8.

I

Imbert M, Bonhomme P (2014) Snorkel surveys of the marine environment, methodological guide. Parc National des Calanques, CEN PACA, GIS Posidonie. MedPAN Collection. 68 p.

M

Margaritoulis D, Teneketzis K (2003) Identification of a developmental habitat of the green turtle in Lakonikos Bay, Greece In: Margaritoulis D & A Demetropoulos (Eds.), Proceedings of the First Mediterranean Conference on Marine Turtles. Barcelona Convention - Bern Convention - Bonn Convention (CMS), Nicosia. pp. 170-175.

Márquez M, R (1990) Sea turtles of the world. An annotated and illustrated catalogue of sea turtle species known to date. FAO Fisheries Synopsis No. 125, Vol. 11. Rome. 81 p. http://www.fao.org/3/t0244e/t0244e00.htm

Mazaris, A.D., Dimitriadis, C., Kyprioti, A., Papazekou, M., Almpanidou, V., Kalli, E., Liakopoulos, V., Sourber, L. 2020. Monitoring biotic, abiotic and socio-economic data by using novel, innovative technologies. NMPZ, pp. 103

N

Nuno A, St John FAV (2015) How to ask sensitive questions in conservation: A review of specialize questioning techniques. Biological Conservation 189: 5-15.

O

Omeyer LCM, Fuller WJ, Godley BJ, Snape RTE, Broderick AC (2018) Determinate or indeterminate growth? Revisiting the growth strategy of sea turtles. Marine Ecology Progress Series 596: 199-211.

R

RAC/SPA - UNEP/MAP (2015) A guide on environmental monitoring of rocky seabeds in Mediterranean Marine Protected Areas and surrounding zones. RAC/SPA - MedMPAnet Project, Tunis: 482 p. + annexes.

Rae V, Touloupaki E (2020) Development of a Pan-Mediterranean Sea Turtle Stranding Protocol & Database: Technical Report. Unpublished report by the Mediterranean Association to Save the Sea Turtles (MEDASSET). 36 p.

Rees AF, Margaritoulis D, Newman R, Riggall TE, Tsaros P, Zbinden JA, Godley BJ (2013) Ecology of loggerhead marine turtles *Caretta caretta* in a neritic foraging habitat: movements, sex ratios and growth rates. Marine Biology 160: 519–529.

S

Stokes KL, Fuller WJ, Glen F, Godley BJ, Hodgson DJ, Rhodes KA, Snape RTE, Broderick AC (2014) Detecting green shoots of recovery: the importance of long-term individual-based monitoring of marine turtles. Animal Conservation 17: 593-602.

SWoT Scientific Advisory Board (2011) The State of the World's Sea Turtles (SWOT) Minimum Data Standards for Nesting Beach Monitoring, version 1.0. Handbook. 28 p. https://www.seaturtlestatus.org/minimum-data-standards

U

UNEP/MAP (2016) Integrated monitoring and assessment guidance. UNEP(DEPI)/MED IG.22/Inf.7, Athens. 162 p. + annexes.

UNEP/MAP SPA/RAC (2019) Draft updated Action Plan for the Conservation of Mediterranean Marine Turtles. UNEP/MED WG.461/6, Tunisia. 41 p.

ANNEX 1

Data Acquisition Protocols (What do I do to get my answers?)

MONITORING AND RESEARCH PROTOCOLS

	Name	Topic	Standard
1.	Species ID	A	★
2.	Measuring turtles	A	★
3.	Sexing turtles	A	★
4.	PIT tagging	A	★★★
5.	Flipper tagging	A	★★
6.	Photo ID	A	★★★
7.	Tissue sampling	A	★★
8.	Nest (and track) identification by species	A H	★
9.	Locating clutches	A	★★
10.	Relocating / Translocating clutches	A TM	★★
11.	Nest protection against predation	A TM	★★
12.	Identification of nest hatching	A H	★
13.	Post-hatch excavation of clutches	A	★★
14.	Beach suitability assessment for nesting	H	★
15.	Beach temperatures	H	★★
16.	Beach surveys (ground)	A H TM	★
17.	Beach survey (drone)	H M	★★
18.	Beach mapping	H TM	✦
19.	Marine survey (plane)	H TM	✦
20.	Marine survey (drone)	H TM	★★
21.	Marine turtle survey at sea (turtle capture)	A	★★★
22.	Coastal development monitoring	H TM	★
23.	Light pollution monitoring and mitigation	H TM	★
24.	Beach use monitoring and control	H TM	★
25.	Nest predation (repairing)	A TM	★★
26.	Nest inundation (repairing)	A TM	★★
27.	Hatchling disorientation (recording and mitigation)	A H TM	★★
28.	Dealing with dead strandings	A TM	★
29.	Dealing with live strandings	A TM	★
30.	Fisheries interactions (bycatch)	A TM	★
31.	Necropsy	A TM	★★
32.	Marine traffic management	A H TM	★
33.	Pollution	A H TM	★
34.	Plastic ingestion	A TM	✦
35.	Questionnaires and interviews	A H TM	✦
36.	Deploying animal mounted data gathering and tracking equipment	A	✦

ANIMAL

Species ID

FACTSHEET 1

Standard ★

ASSOCIATED PROTOCOLS

ALL protocols where turtles are encountered.

MANPOWER

1 or more. The number of people required depends on other protocols being carried out.

COST

-

FREQUENCY

On encounter with a turtle.

Reason

To understand which species is being encountered.

Context

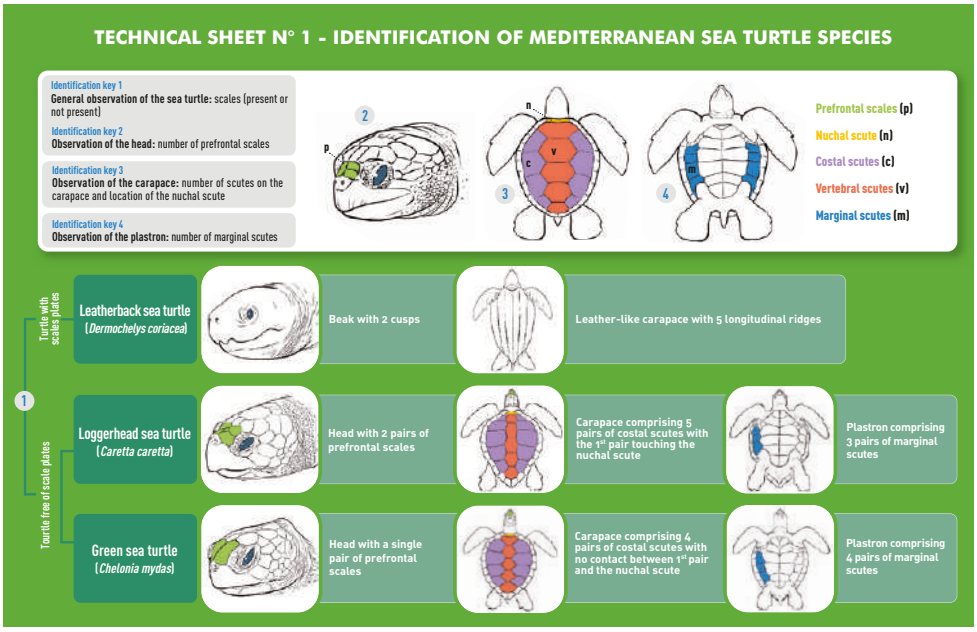
There are two main species present and breeding in the Mediterranean with different distributions and population status. A further species not closely related to the others is sometimes encountered but does not breed in the region. Knowing the species of turtles present in the MPA will help identify which populations they belong to and their specific conservation needs. This protocol needs to be known by all data recorders so that it is accurately recorded for every turtle encounter.

Equipment

No specialist equipment. But essential that this information is included in all data records – notebooks, data sheets and databases etc.

Actions

Follow the key to identify species of turtle encountered:



(taken from FAO & ACCOBAMS 2018) Species ID for all seven marine turtle species can be found in Pritchard & Mortimer (1999)

Ethics

No ethical issues relating to this protocol but may arise from associated protocols being carried out.

Data to record

Species name or name code. I.e. common names: loggershead / green / leatherback, scientific names *Caretta caretta* / *Chelonia mydas* / *Dermochelys coriacea*, species codes: Cc / Cm / Dc.

Management relevance

Using this protocol to identify species enables the manager to determine the presence of uncommon species of turtle in the area, which might signal species habitat range extensions or other ecological shifts.

Reporting

No reporting specific to this protocol but reporting by other protocols should present results by species.

Collaboration potential

N/A

References

- FAO & ACCOBAMS. 2018. Good Practice Guide for the Handling of Sea Turtles Caught Incidentally in Mediterranean Fisheries. http://www.fao.org/3/i8951en/I8951EN.pdf

ANIMAL

Measuring Turtles

FACTSHEET 2

Standard ★

ASSOCIATED PROTOCOLS

All protocols associated with encountering turtles larger than hatchlings [1, 3, 4, 5, 6, 7, 21, 28, 29, 30, 31,34, 36]. Can also be used during encounters with hatchlings for specific, directed research projects [13, 27].

MANPOWER

1-2 persons required for taking and recording measurements.

COST

€

FREQUENCY

On encounter with a turtle.

Reason

Measuring a turtle gives an idea of a turtle's life stage and sex

Context

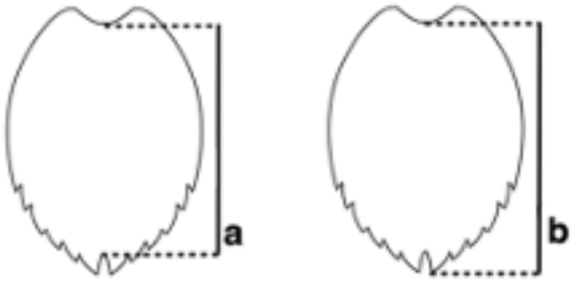
Knowing a turtle's life stage and sex help identify the reason that the turtle may be in the MPA – especially when combined with date of the record – and hence guide appropriate management actions.

Equipment

Flexible 1.5m fibreglass tape measure with 0.5cm or smaller divisions and / or 1.5m metal callipers with 1mm divisions.

Actions

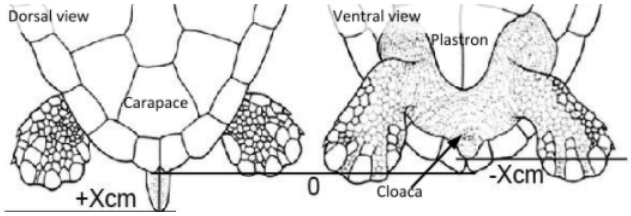
- Carapace measurements are the standard measure of turtle size, and tail measurements aid in sex identification. Other standard body measurements can be recorded (Bolten 1999) but are less common and of less use for conservation management purposes.
- Carapace measurements comprise straight carapace (SC#) measurements which are recorded using a calliper and ignore the amount of doming of the carapace, and curved carapace (CC#) measurements that are recorded using a tape measure and follow the dome of the carapace. Length measurements (##L) are taken along the midline of the carapace and width measurements (##W) are taken perpendicular to the midline with the maximum value for the individual recorded. Curved measurements are the simplest to record and require the most basic of equipment (a tape measure), but care should be taken to ensure accurate measurements are made.



The two most common carapace length measurements based on anatomical points are CCL/SCLmin, as shown above (a) extends from the anterior point of the midline of the nuchal scute (notch) to the posterior notch at the midline between the supracaudal scutes, i.e. the minimum distance from front to back of the carapace, and CCL/CCLn-t, as shown above (b), which extends from the anterior point from the midline of the nuchal scute (notch) to the posterior tip of the longest supracaudal scute, i.e. notch-to-tip (Bolten 1999).

Example of measuring SCLn-t (left) using a calliper and CCLn-t (right) using a flexible tape measure over the dome of the carapace taken from NMFS SEFSC (2008).

- Tail lengths can be measured in a number of ways (Limpus and Limpus 2003) but the two that were found most useful for sexing turtles are Tail-Carapace & Cloaca-Carapace. Both these measurements are taken from the supracaudal tips and are measured, with the tail held straight, dorsally to the tip of the tail and ventrally to the middle of the cloaca, respectively. Positive values are recorded when the tail tip or cloaca are extended past the edge of the carapace and negative values if they are under the carapace.



Indications of positive (left image) or negative (right image) value measurements for Tail-Carapace from tail tip to the supracuadal tip. Measuring Cloaca-Carapace is similarly performed. The cloaca is the external vent (hole) in the underside of the tail from which the turtles excrete or lay eggs.

Ethics

Permits to handle marine turtles are usually required and hence relate to this protocol. The protocol itself is non-invasive but raises ethical concerns for correct treatment and handling of the subject animals.

Data to record

CCLnt/CCLmin and SCLn-t/SCLmin should be recorded as the main measurements to take. Width measurements are frequently recorded but are seldom used. Tail measurement are useful for turtles in subadult and adult size classes, to aid sex identification, though for adult turtles there is a binomial distribution of males with long tails and females with short tails. There is no need to record tail length for nesting loggerhead turtles as this has been documented, but this datum has yet to be published for green turtles.

Management relevance

Using this protocol to record turtle size enables the manager to determine the presence of uncommon size classes of turtle in the area, which might signal species habitat range extensions or other ecological and demographic shifts.

Reporting

Mean, standard deviation, range and sample size for each carapace measurement should be presented over a reporting period. Carapace length measurements can also be plotted in a frequency distribution in bins of up to 5cm (based on sample size) to examine if there is a normal distribution of sizes or perhaps bi- or multi-modal distribution. Carapace sizes should be presented separately for nesting turtles and turtles that are stranded or captured at sea. Tail lengths themselves need not be reported, but the inferred turtle sexes should be reported as ratios. Size and sex are reported to indicate what demographic segments of the population are present *(see Section 2.3 of the Methodological Guide, page 21 for information on how size relates to life-stage).*

Collaboration potential

No collaboration required to carry out this protocol, but size data sharing (through reporting) is useful in context of collaboration for more general research purposes.

References

- Bolten AB (1991) Techniques for measuring sea turtles. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 110-114.
- Limpus CJ, Limpus DJ (2003) Biology of the loggerhead turtle in western South Pacific Ocean foraging areas. In: Bolten AB & BE Witherington (Eds.) Loggerhead Sea Turtles. Smithsonian Institution, Washington, DC. Pp. 93-113.
- NMFS SEFSC (National Marine Fisheries Service Southeast Fisheries Science Center) (2008) Sea Turtle Research Techniques Manual. NOAA Technical Memorandum NMFS-SEFSC-579. 92 p.

ANIMAL

Sexing turtles

FACTSHEET 3

Standard ★

ASSOCIATED PROTOCOLS

Measuring turtles [2]

MANPOWER

1

COST

-

FREQUENCY

On encounter with any subadult and adult turtle at sea.

Checking on a marine turtle at the marine turtle care center (INSTM) in Monastir, Tunisia
© Notre Grand Bleu

Reason

To identify sex ratios of animals present at sea or stranded on the shore.

Context

Little is known on the whereabouts and movements of male marine turtles or the sex ratio of turtles in the sea. With female skewed hatchling production, it is likely that males will become increasingly rare. Being able to verify any sex ratio trends will highlight important conservation needs.

Equipment

None (No equipment is needed as this protocol derives results from other protocols. However, a tape measure is needed for the obligatory Measuring turtles step).

Actions

This protocol uses information from the Measuring turtles protocol to determine a turtle's sex. The observer interprets the turtle's carapace and tail measurements to infer sex. For loggerheads, female tails almost never extend more than 5 cm beyond the tip of the carapace (Tail-Carapace; Casale et al. 2014) and the cloaca only grows to be located past the end of the carapace in males (Cloaca- Carapace; Casale et al. 2005). Similar data are lacking for green turtles, so assignation of sex should be more conservative with shorter tailed individuals. Turtles smaller than subadult size *(see Section 2.3 of the Methodological Guide, page 21)* may not display sexually dimorphic tail length and sex ratios based on external morphology should not be estimated. An additional dimorphic character in mature male turtles is that the claws on the fore flippers grow long and hooked, as they are used to hold on to female turtles during mating.

Ethics

Permits to handle turtles are usually required and hence relate to this protocol, however the protocol itself is non-invasive and raises no ethical concerns.

Data to record

Sex should be recorded as male, female or undetermined based on a combination of tail and carapace lengths.

Management relevance

Using this protocol to identify sex enables the manager to determine the sex ratios of turtles in the area, which might signal shifts in sex ratios and other demographic changes.

Reporting

Sex ratios should be presented for sub-adult and adult turtles recorded at sea or stranded over a given reporting period that is determined by the requirements of the associated protocols.

Collaboration potential

No collaboration required to carry out this protocol, but sex ratio data sharing (through repor-

ting and publication) is useful in context of collaboration for more general research purposes.

References

- Casale P, Freggi D, Basso R & Argano R (2005) Size at male maturity, sexing methods and adult sex ratio in loggerhead turtles (*Caretta caretta*) from Italian waters investigated through tail measurements. Herpetological Journal 15: 145-148.
- Casale P, Freggo D, Maffucci F, Hochscheid (2014) Adult sex ratios of loggerhead sea turtles (*Caretta caretta*) in two Mediterranean foraging grounds. Scientia Marina 78(2): 303-309

ANIMAL

PIT tagging

FACTSHEET 4

Standard

★★★

ASSOCIATED PROTOCOLS

Species ID [1], Flipper tagging [5], Photo ID [6], *Measuring Turtles [2]*, *Sexing turtles [3]*, Tissue sampling [7].

MANPOWER

1-2 persons

COST

€€

FREQUENCY

On encounter with a turtle.

Reason

To create unique ID for each turtle encountered for life-history investigations.

Context

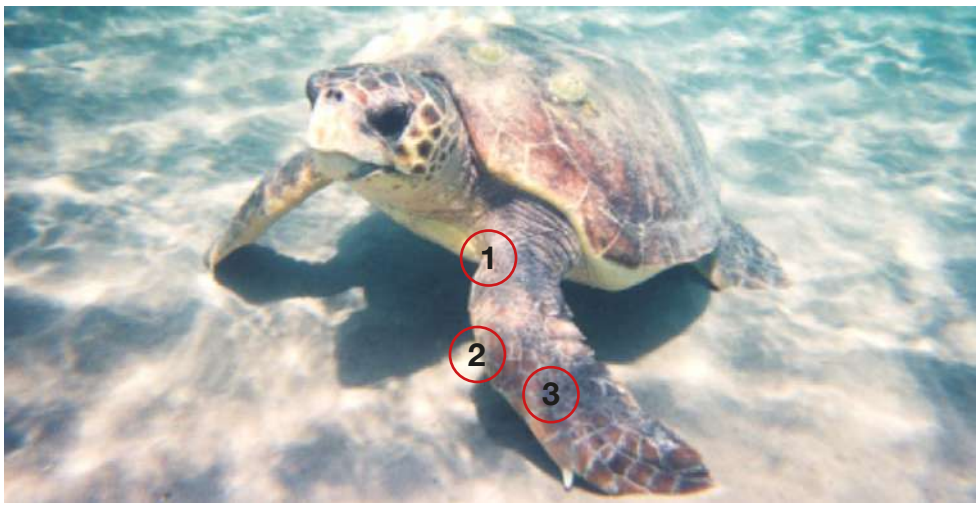
- PIT tagging individual juvenile or adult turtles creates unique identities for these individuals so that they can be recognised on re-observation by application of uniquely coded internal tags. Gathering data on re-observed individuals can provide information on a wide variety of life history traits, such as growth rates, site fidelity, migratory destinations etc., which in turn can inform management for topics such as population size and purpose for habitat use. However, tagging should only be carried out when there are specific identified goals of the action. Tagging a turtle is not a conservation action in itself.
- PIT tagging is regarded as giving a more long-term resilient ID to an individual turtle than flipper tagging *(see Flipper Tagging, Protocol Factsheet n°5)*. PIT tag codes can only be read using electronic scanners and are therefore not useful for obtaining reports of casual encounters of turtles, thus should normally be carried in combination with flipper tagging.

Equipment

PIT tags, PIT tag applicator. Main manufacturers are Destron-Fearing, Biomark, Trovan and Avid.

Actions

There is little international standardisation on where to insert PIT tags, other than it is generally the front of the turtle (Shoulder, or flipper). The PIT can be placed subcutaneously or intra-muscularly on either the right or left side of the turtles. Accordingly, when assessing a turtle for the presence of a PIT tag, the scanner needs to be swiped over most of the front of the turtle – from the neck to the flipper tips. However, focussing on PIT tagging on the left side of the turtle is suggested (UNEP/MAP 2019). It is recommended to select ISO standard PIT tags to maximise their cross-compatibility among scanner manufacturers. PIT tagging turtles should be only be carried out by fieldworkers who have received appropriate training.



Most common locations of PIT tag insertion, as illustrated on the left side of a loggerhead turtle.
1) Neck/shoulder,
2) triceps area and
3) dorsal flipper surface.
Photo: ALan Rees/ARCHELON.

Ethics

PIT tagging is a mildly invasive technique and that requires ethical justification and probably a permit from the relevant national authority.

Data to record

Tag number (newly applied or existing) and on-turtle location should be recorded. This data to be entered together with other data on the Turtle Encounter Record Sheet (see Annex 2) and stored in a database that may be as simple as a logically constructed Spreadsheet or more complicated, such as a bespoke relational database.

Management relevance

PIT tagging and tag recovery provides a manager with information on residence of turtle in the MPA and linkages with other foraging/breeding sites, which help confirm the importance of MPAs on a national and regional level.

Reporting

Indicators derived from flipper tagging include changes in population size, recruitment and survivorship. The tag codes themselves are irrelevant for reporting it the uniquely identified turtles that are the metric. For nesting turtles, the number of individuals nesting within a season and how many are new or re-migrant turtles should be reported. Additionally, the average number of clutches deposit within a season can also be estimated from re-observation of the same turtles in a season. For turtles at sea, given a defined reporting period (1 week, summer or year etc.) the number of new and resident/remigrant turtles should be reported. Population size can be estimated from the number of new turtles observed in reporting period compared to the number of recaptures, but the methods for this are beyond the scope of this guide.

Collaboration potential

Nesting beach PIT tagging patrols need not be undertaken by MPA staff but can be carried out by trained personnel as part of a volunteer program led by an NGO or University Group. Likewise, at-sea PIT tagging can be carried out by similar third parties. In both cases detailed data summaries must be reported back to the MPA managers after each field period.

If necessary, records of PIT tag codes found within the MPA that originate from elsewhere can be shared over the MedTurtle mailing list, where most tagging groups have representatives *(see section 7.2.2, page 57 of the Methodological Guide)*.

References

- UNEP/MAP (2019) Draft updated Action Plan for the conservation of Mediterranean marine turtles. SPA/RAC, Tunis. 43p.

ANIMAL

Flipper Tagging

FACTSHEET 5

Standard ★★

ASSOCIATED PROTOCOLS

Species ID [1], PIT tagging [4], Photo ID [6], *Measuring Turtles [2]*, *Sexing turtles [3]*, Tissue sampling [7].

MANPOWER

Minimum 2 persons.

COST

€

FREQUENCY

On encounter with a turtle.

Flipper tagging in Kuriat Island - Tunisia
© Notre Grand Bleu

Reason

To create unique ID for each turtle encountered for important life-history investigations.

Context

- Flipper tagging individual juvenile or adult turtles creates unique identities for these individuals so that they can be recognised on re-observation by application of uniquely coded external tags. Gathering data on re-observed individuals can provide information on a wide variety of vitally important life-history traits, such as growth rates, site fidelity, migratory destinations, survivorship etc., which in turn can inform management for topics such as population size and purpose for habitat use. However, tagging should only be carried out when there are specific identified goals of the action. Tagging a turtle is not a conservation action in itself.
- Flipper tag codes can be read and reported by any observer and are an effective way to of conveying unique ID. Longevity of ID through flipper tagging is bettered by PIT tagging *(see PIT Tagging protocol factsheet n°4)*. Flipper tags have the advantage that they can provide reports from casual encounters with turtles, whereas PIT tag codes can only be read using electronic scanners. Photo ID of turtle head scales is also a long-term/ permanent method of determining individual turtle ID that can be shared by anyone able to photograph the turtle. However, searching through databases to match up individual turtles based on facial scales is time consuming.

Equipment

- Purpose-designed tagging pliers and tags.
- National Band and Tag Co. USA is the most common flipper tag supplier (tag types 681, Inconel or Monel). Flipper tags can be coded as per the purchaser's instructions, which includes a unique alphanumerical code on the upper part of the tag and a return or contact address on the lower side. These tags may be present on turtles for decades so ensure that the return address to be embossed on the tag is somewhat permanent. The following on-line inventory should be consulted before new tag series codes are chosen, to avoid duplication, and all new tag series purchased should be reported to the inventory keepers to add them there. https://accstr.ufl.edu/resources/tag-inventory/

Actions

All turtles should be double tagged (one tag per front flipper) so that if one tag is lost the ID of the turtle is maintained at the next observation. Flipper tagging turtles should be only be carried out by fieldworkers who have received appropriate training.

- Tags should be applied to the front flipper near to the body through the membranes or scales at the rear of the flipper – there is no clear evidence as to which is better.
- Care must always be taken to ensure that the gap within the tag is wider than the thickness of the flipper where tagging will occur.
- Tags, with their closed design, should never be attached too far onto the flipper in a manner that inhibits the full range of free movement of the tissue within the tag.

See Balazs (1999) for full discussion and instructions.

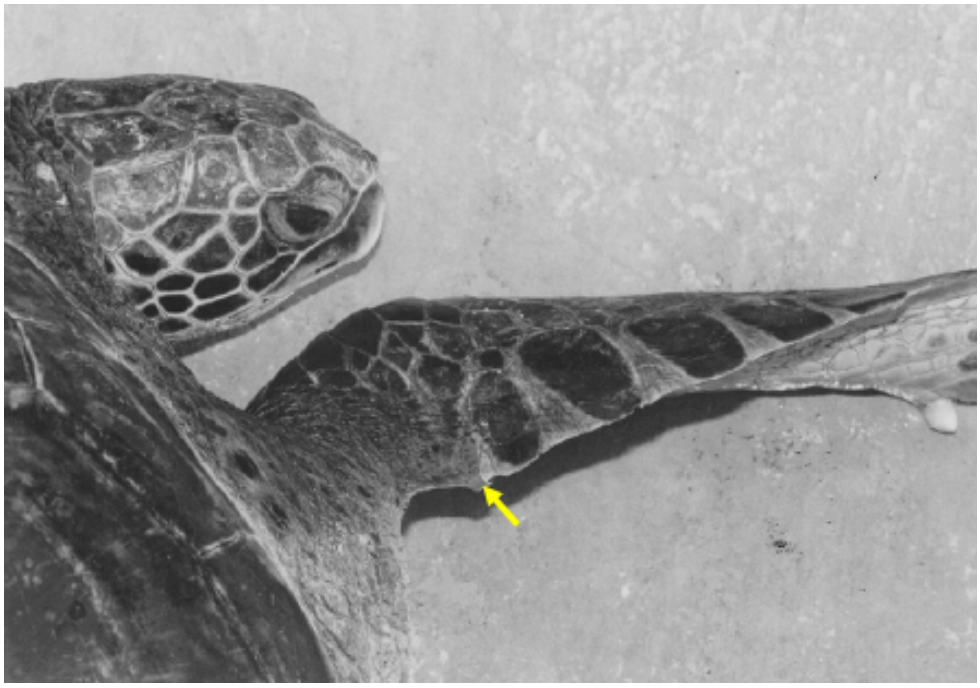


Image from Balazs (1999)

Ethics

Flipper tagging is a mildly invasive technique and that requires ethical justification and probably a permit from the relevant national authority.

Data to record

Tag number (newly applied or existing), flipper and on-flipper location. Presence of any holes or scars that can be attributable to previously applied tags. This data to be entered together with other data on the Turtle Encounter Record Sheet (see Annex 2) and stored in a database that may be as simple as a logically constructed Spreadsheet or more complicated, such as a bespoke relational database.

Management relevance

Flipper tagging and tag recovery provides a manager with vital information on population dynamics such as abundance, survival rates, recruitment and residence of turtles in the MPA, and linkages with other foraging/breeding sites, which help confirm the importance of MPAs on a national and regional level.

Reporting

Indicators derived from flipper tagging include changes in population size, recruitment and survivorship. The tag codes themselves are irrelevant for reporting it the uniquely identified turtles that are the metric. For nesting turtles, the number of individuals nesting within a season and how many are new or re-migrant turtles should be reported. Additionally, the average number of clutches deposit within a season can also be estimated from re-observation of the same turtles in a season. For turtles at sea, given a defined reporting period (1 week, summer or year etc., which is based on the fieldwork carried out) the number of new and resident/remigrant turtles should be reported. Population size can be estimated from the number of new turtles observed in reporting period compared to the number of recaptures but the methods for this are beyond the scope of this guide.

Collaboration potential

- Nesting beach tagging patrols need not be undertaken by MPA staff but can be carried out by trained personnel as part of a volunteer program led by an NGO or University Group. Likewise, at-sea tagging can be carried out by similar third parties. In such cases, where the MPA is not undertaking the work directly, data summaries should be reported back to the MPA managers at the end of a nesting season for tagged nesting turtles or at the end of the field period in other circumstances.
- If necessary, records of flipper tag codes found within the MPA that originate from elsewhere can be shared over the MedTurtle mailing list *(see section 7.2.2, page 57 of the Methodological Guide)*, where most tagging groups have representatives.

References

- Balazs GH (1999) Factors to consider in the tagging of sea turtles. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 101-114.

ANIMAL

Photo ID

FACTSHEET 6

Standard

★★★

ASSOCIATED PROTOCOLS

Species ID [1], Flipper tagging [5], PIT tagging [4], *Measuring Turtles [2]*, *Sexing turtles [3]*, Tissue sampling [7].

MANPOWER

1

COST

€

FREQUENCY

On encounter with a turtle.

Reason

To create unique ID for each turtle encountered for life-history investigations

Context

- Photo ID of individual juvenile or adult turtles creates unique identities for these individuals so that they can be recognised from photographs taken on re-observation. Gathering data on re-observed individuals can provide information on a wide variety of vitally important life history traits, such as growth rates, site fidelity, migratory destinations, survivorship etc. For example, Schofield et al. (2020) use a long-term Photo ID catalogue of loggerhead turtles to determine sex-specific survival rates.
- Photo ID of turtle head scales is a long-term/permanent method of determining individual turtle ID that can be shared by anyone able to photograph the turtle. However, searching through databases to match up individual turtles based on facial scales is time consuming. There are some possibilities to use software to assist with matching turtles from reobservations.

Equipment

(Underwater) Camera / Computer archive

Actions

Take photographs of the both sides of the turtle's head so that facial scales are clear. It is also useful to take photographs of any other characteristic injuries etc. of the turtle so that if a follow-up head shot is missed then a body shot displaying notable characteristics can be used.

Ethics

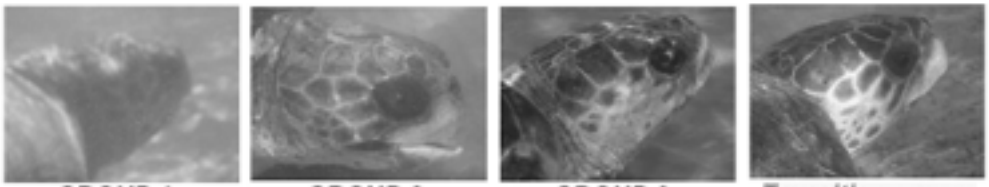
The protocol itself is non-invasive but raises ethical concerns for correct treatment and handling of the subject animals where appropriate and permits to handle turtles are usually required.

Data to record

A good starting place in developing a database of turtle Photo ID can be found in Schofield et al. (2008), as shown in the identification tree here:

IDENTIFICATION TREE: GROUP ASSIGNATION of the right lateral facial scales

FIELD 1: General features



GROUP 1: Not visible

GROUP 2: Unique features *i.e. protruding lower jaw*

GROUP 3: Partial scaling

Transition group: Full scaling

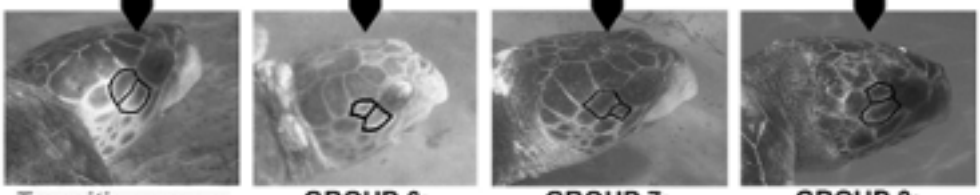
FIELD 2: Post-ocular scale numbering

GROUP 4: 2 post-ocular scales

Transition group: 3 post ocular scutes

GROUP 5: 4 post-ocular scales

FIELD 3: 1st & 2nd post-ocular scales



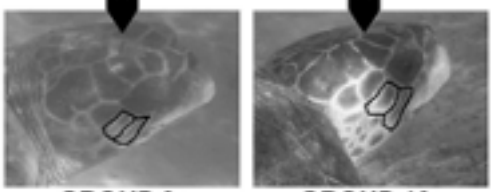
Transition group: Same length

GROUP 6: Forked

GROUP 7: 1st scale longer

GROUP 8: 1st scale shorter

FIELD 3: 2nd & 3rd post-ocular scales



GROUP 9: Same length

GROUP 10: Forked

A semi-automated system for cataloguing green turtles, that prefers whole body shots, is available to use for free, but the system is currently not set up for loggerhead turtles. The Internet of Turtles is available at: https://iot.wildbook.org/

Management relevance

Photo ID and ID re-sightings provides a manager with vital information on population dynamics such as abundance, survival rates, recruitment and residence of turtles in the MPA, and linkages with other foraging/breeding sites, which help confirm the importance of MPAs on a national and regional level.

Reporting

Indicators derived from Photo ID include changes in population size, recruitment and survivorship. The individual IDs themselves are irrelevant for reporting it the uniquely identified turtles that are the metric. For nesting turtles, the number of individuals nesting within a season and how many are new or re-migrant turtles should be reported. Additionally, the average number of clutches deposit within a season can also be estimated from re-observation of the same turtles, on a nesting beach, during a season. For turtles at sea, given a defined reporting period (1 week, summer or year etc.) the number of new and resident/remigrant turtles should be reported. Population size can be estimated from the number of new turtles observed in reporting period compared to the number of recaptures, but the methods for this are beyond the scope of this guide.

Collaboration potential

Photographic data on turtles can be collected by MPA staff, NGOs, citizen science projects and even from scanning social media for posts containing turtles. Sharing photo data with other projects or combining datasets into a larger repository can aid cross referencing turtle reports from different locations, building up a more complete understanding of turtle movement and ecology. The designated data manager if not an MPA employee needs to regularly report updates and novel findings from the data to the MPA authorities.

References

- Schofield, G, Katselidis KA, Dimopoulos P, Pantis JD (2008) Investigating the viability of photo-identification as an objective tool to study endangered sea turtle populations. Journal of Experimental Marine Biology and Ecology 360: 103-108.
- Schofield G, Klaassen M, Papafitsoros K, Lilley MKS, Katselidis KA, Hays GC (2020) Long-term photo-id and satellite tracking reveal sex-biased survival linked to movements in an endangered species. Ecology 101(7): e03027. Doi:10.1002/ecy.3027

ANIMAL

Tissue Sampling

FACTSHEET 7

Standard

★★

ASSOCIATED PROTOCOLS

Species ID [1], Flipper tagging [5], PIT tagging [4], Photo ID [6], *Measuring Turtles [2], Sexing turtles [3].*

MANPOWER

1-2

COST

€

FREQUENCY

On encounter with a turtle.

Reason

Sampling tissues from animals provides an archive of individual turtles that can be used for specific current research topics, such as genetic analyses and stable isotope/diet analyses, and for research topics that are yet to be developed.

Context

Analysis of turtle tissue samples can provide a wealth of information at individual and population level. Current uses of tissue samples include genetic characterisation to define or identify source breeding populations (Clusa et al. 2013), stable isotope analysis to determine foraging ecology and to some degree foraging location within the Mediterranean (Bradshaw et al. 2018, Haywood et al. 2020), and testing for pollutants (Maffucci et al. 2005). In the near future, samples are likely to prove useful for studies of genomics and there are likely to be other techniques in development.

Equipment

Labelled sample tubes, scalpel blades and fine forceps or biopsy punches, storage medium (alcohol or other liquid depending on the purpose of the sampling).

Actions

- All sampling should only be undertaken by trained personnel. The standard tissue sample to take from a live or freshly dead marine turtle is a small skin biopsy (<1cm square), obtained using a scalpel or biopsy punch from a flipper or the neck area. Muscle tissue can be sampled from dead turtles to ensure a sterile sample is taken, which is especially important in genetic studies. Each sample should be stored in its own, uniquely labelled container to avoid cross contamination – even if more than one sample is taken from an individual.
- For further details on sampling methods, illustrated by tissue sampling for genetic analysis see Fitzsimmons et al. (1999) and for more general sampling including from dead turtles see Jacobson (1999).

Ethics

Handling a live or dead marine turtle is likely to require ethical approval by relevant authorities and as tissue sampling is mildly invasive it will probably require specific permitting. Furthermore, as sampling involves cutting a turtle's skin it should only be undertaken when either a specific project need is identified or if long-term safe storage and archiving of samples and associated electronic metadata can be assured.

Data to record

Each sample container should be uniquely labelled. This labelling could be a diagnostic code relating to the sample, e.g. Date-Species-number of the individual for that day with an alphabetised sample code of the individual. E.g. the label for the second sample of the only loggerhead sampled on 29 Feb 2020 would read 200229-Cc-1b. Metadata to be recorded with the sampling observation would include size of the individual, is it alive or dead, location of observation and reason/method for encounter.

Management relevance

Tissue sampling and analysis provides a manager, through genetics, with information on linkages with other foraging/breeding sites, which help confirm the importance of MPAs on a national and regional level. It also acts as a forward-looking activity when in the future new analyses and techniques may determine more on the turtle's biology and origin.

Reporting

There is no requirement to report on tissue sampling in its own right, but when analysis is carried out on the samples, the number of samples contributing to the study should be included.

Collaboration potential

Current and expected future techniques that involve analysis of data derived from tissue samples are relatively costly and the analytical methods complicated. It is suggested that tissue samples are shared in collaborative, potentially regionwide projects, led by subject experts, to ensure maximum gain in terms of scientific knowledge is obtained, which can be turned into conservation management priorities. *(see section 7.2.3, page 57 of the Methodological Guide for accessing knowledge hubs).*

References

- Bradshaw PJ, Broderick AC, Carreras C, Fuller W, Snape RTE, Wright LI, Godley BJ (2018) Defining conservation units with enhanced molecular tools to reveal fine scale structuring among Mediterranean green turtle rookeries. Biological Conservation 222: 253-260.
- Clusa M, Carreras C, Pascual M, Demetropoulos A, Margaritoulis D, Rees AF, Hamza AA, Khalil M, Aureggi M, Levy Y, Turkozan O, Marco A, Aguilar A, Cardona L (2013) mitochondrial DNA reveals Pleistocenic colonisation of the Mediterranean by loggerhead turtles (*Caretta caretta*). Journal of Experimental Marine Biology and Ecology 439: 15-24.
- FitSimmons N, Moritz C, Bowen BW (1999) Population identification. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 72-82.
- Haywood JC, Fuller WJ, Godley BJ, Margaritoulis D, Shutler JD, Snape RTE, Widdicombe S, Zbinden J, Broderick AC (2020) Spatial ecology of loggerhead turtles: insights from stable isotope markers and satellite telemetry. Diversity and Distributions 26:368-381.
- Jacobson ER (1999) Tissue sampling and necropsy techniques. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 214-220.
- Maffucci F, Caurant F, Bustamente P, Bentivegna F (2005) Trace element (Cd, Cu, Hg, Se, Zn) accumulation and tissue distribution in loggerhead turtles (*Caretta caretta*) from the Western Mediterranean Sea (southern Italy). Chemosphere 58: 535-542

HABITAT / ANIMAL

Nest and track identification

FACTSHEET 8

Standard ★

ASSOCIATED PROTOCOLS

Locating clutches [9], Relocating clutches [10], Nest protection against predation [11], Beach surveys (ground) [16], Beach survey (drone) [17].

MANPOWER

1-2

COST

€

FREQUENCY

On encounter with a track.

Fresh green turtle's nest with stones showing the turtles tag numbers © ALan Rees / ARCHELON

Reason

To identify species of turtle that has emerged to nest and if the emergence resulted in clutch deposition. If eggs were laid, they can be located and appropriately protected.

Context

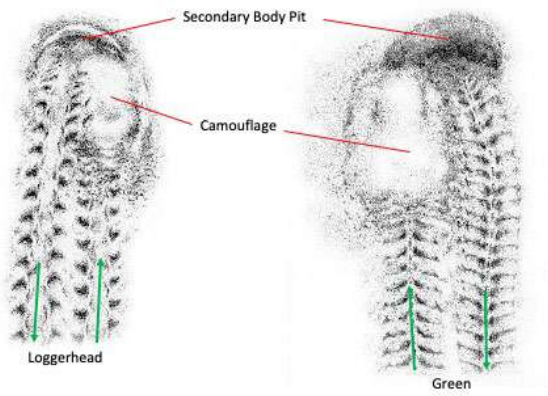
Protecting nests is one of the fundamental conservation management actions that can occur at an MPA and in order to protect a nest one needs to be able to identify it and locate the clutch. A turtle does not deposit a clutch every time it emerges from the sea, as external and internal factors may dissuade it from successfully nesting, hence it is important to be able to properly identify various types of nesting activity and in doing so save wasted time and effort searching for clutches that are not there.

Equipment

Only a notebook and pen are necessary. A GPS unit, 50m tape measure and camera are all useful.

Actions

- On encounter with a turtle track the observer systematically assesses it for species, the direction of travel the turtle took ('up' and 'down' track), any nesting activity and if suc-cessful clutch deposition occurred.
- First, the species of turtle is identified from the style of the track. Loggerhead turtles have an alternating, asymmetrical gate whereas green turtles have a symmetrical gate.
- Second, the up and down direction of the track is determined from the track's appearance. On steeper beaches the down tracks have lighter indentations in the sand as gravity helps the turtle slide down the beach and deeper indentations on the up track as the turtle needs to work harder to climb the beach.
- Third, nesting activity needs to be assessed. The turtle may make several attempts to nest on the one emergence. Determining the track direction prior to examining nesting attempts is useful as only the last nesting attempt on a track could hold the clutch of eggs – turtles do not do any digging after they have deposited their clutch. Features left in the sand, such as body pits, swims, abandoned egg chambers and camouflages indicate if a turtle was successful in its clutch deposition or not.



Examples of the typical appearance of tracks of loggerhead and green turtles showing characteristic patterns of successful clutch deposition (successful nesting). Further annotated examples of tracks with no attempts at nesting and variations in between are available from FFWCC (2016).

Once all aspects of recording the nesting event and related nest protection measures have been completed the track should be erased by scuffing the sand surface or otherwise marked so that it is not mistaken as a fresh track on a subsequent survey. Additional information on marine turtle nesting surveys is presented in Schroeder & Murphy (1999).

Ethics

No ethical issues are raised from visual inspection of a turtle track but tampering with a nest is likely to require permits and should only be undertaken by trained personnel or those undergoing training.

Data to record

Date, Species, nest or not (nest code if clutch present), GPS coordinates of nest, last nesting attempt or highest point of the track if no nesting attempt.

Management relevance

Confirming nesting activity triggers a suite of protocols related to nest monitoring and protection. These should already be in place in established nesting areas but will be novel measures in areas of one-off or sporadic nesting.

Reporting

Per species, typical reporting includes first and last date of nesting. Number of nests and non-nesting emergences (and derived nesting success, i.e. number of nests divided by the number of tracks times 100), nest densities (number of nests per km of beach) and a map of nest and track locations. Data on nest numbers and locations should be shared periodically, e.g. every 5 years, to central data repositories (such as SWoT; www.seaturtlestatus.org) or published to be accessible to other researchers in the region.

Collaboration potential

Regular and intensive track monitoring is labour intensive and can be carried out by NGO or University teams that report directly to the MPA management. Reactive measures in response to sporadic nesting reported by third parties can be carried out in-house or again be NGO/University teams in close coordination with the MPA authority.

References

- FFWCC (Florida Fish and Wildlife Conservation Commission) (2016) Marine turtle conservation handbook. https://myfwc.com/media/3133/fwc-mtconservationhandbook.pdf accessed on 1 April 2020.
- Schroeder B, Murphy S (1999) Population surveys (ground and aerial) on nesting beaches. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 45-55.

ANIMAL

Locating clutches

FACTSHEET 9

Standard ★★

ASSOCIATED PROTOCOLS

Nest (and track) identification by species [8], Relocating clutches [10], Nest protection against predation [11], Beach surveys (ground) [16], Beach survey (drone) [17].

MANPOWER

1-2

COST

€

FREQUENCY

On encounter with a nest.

A fresh green turtle nest © ALan Rees / ARCHELON

Reason

To confirm the visual inspection that a clutch has been deposited and facilitate clutch protection measures.

Context

Clutch deposition for an adult emergence can be confirmed through post-hatch excavation or through evidence of depredation, but to know for sure a clutch is present soon after deposition the eggs need to be located. Once clutch locations are established, management and conservation measures, such as caging and clutch relocation can be undertaken. If the nest is not under threat, then the general location of the clutch can be recorded by GPS and no further attempt to precisely locate the eggs is necessary. In these circumstances the nest can be safely staked-out or fenced-off with poles around the edge of the camouflage.

Equipment

1.5 m tape measure with cm graduations.

Actions

The characteristics of the nest site, including the incoming (up) and outgoing (down) tracks can be used to predict the location of the clutch. A loggerhead clutch is often located about 50cm down the midline of the camouflage. A green turtle clutch is generally just under a metre back from the end of the camouflage where it turns into the secondary body pit. Once a rough idea of the clutch location has been determined there are two main methods used to reveal its precise location.

"The first method involves slow and methodical localized digging (use small diameter test holes and dig with the hands only—no implements!) to confirm that eggs are present or absent. The second method involves the use of a small, narrow diameter probe stick which is gently inserted into the sand to test for the softened area of sand directly above the clutch. Extreme care must be exercised when probes are used so that eggs in the clutch are not punctured. Either technique should be used only by experienced, well trained, and properly permitted personnel. Care should always be taken to ensure that clutch "finding" techniques are not taught (either directly or by indirect observation) to persons who may illegally [take the eggs]." Schroeder and Murphy (1999).

Once the clutch is located the depth to the top egg from the sand surface can be measured.

Ethics

As clutch location involves altering, to some degree, the incubation condition of the eggs and is a first step to clutch relocation, it should only be carried out by trained and permitted personnel. The manager needs to assess if there are threats likely to impact the incubating clutch that warrant identifying its precise location soon after deposition or whether confirmation of clutch deposition can be made at time of hatching.

Data to record

If the clutch position is identified, through locating the eggs, its GPS location should be recorded and this is in preference to the potentially less accurate GPS location taken based on nest morphology (i.e. where clutch location is estimated from the appearance of the camouflage). Depth from the sand surface to the top of the uppermost egg is also often recorded. Note that GPS locations are accurate to only a few metres, and sites with high densities of nests should use additional methods to individually identify each nest to avoid confusing nests at a later date, e.g. at hatching.

Management relevance

Locating the clutch facilitates additional nest management actions and confirms the number of nests present in an area. Knowing the number of nests rather than the number of tracks is important as the proportion of turtle emergences that result in clutch deposition may vary over time and space and hence population size estimations based only on track counts can be excessively inaccurate.

Reporting

Average (mean, StdDev, range, sample size) depth to top egg can be reported per species over a nesting season, but otherwise clutch location simply contributes to the nesting data collected under the Nest and Track Identification protocol.

Collaboration potential

Regular and intensive clutch monitoring is labour intensive and can be carried out by NGO or University teams that regularly report back to the MPA management. Reactive measures in response to sporadic nesting reported by third parties can be carried out inhouse or again be NGO/University teams in close coordination with the MPA authority.

References

- Schroeder B, Murphy S (1999) Population surveys (ground and aerial) on nesting beaches. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 45-55.

Relocating / Translocating Clutches

ASSOCIATED PROTOCOLS

Nest (and track) identification by species [8], Locating clutches [9], Nest protection against predation [11], *Beach surveys (ground) [16], Beach survey (drone) [17].*

MANPOWER

1-2

COST

€

FREQUENCY

On encounter of a nest whose clutch needs moving to a safer place.

Green turtle eggs in a man-made egg chamber
© ALan Rees / ARCHELON

Reason

To move a clutch of eggs from a position of peril where it is unlikely to incubate successfully to a location where safer incubation is assured.

Context

Marine turtles deposit clutches at different locations in beaches of variable conditions and their nest site selection process is not understood to any great degree. In this scattered nesting approach, sometimes clutches are deposited in sub-optimal conditions (e.g. below the common high wave line) or places with high anthropogenic impacts such as light pollution and beach use. Clutches in these locations may not incubate safely through to hatching or the emerging hatchlings may be misorientated away from the sea. In these circumstances judicious use of clutch relocation can be used to mitigate the threats. It cannot be overemphasized that eggs should never be collected and reburied unless there is compelling evidence that significant losses will accrue which cannot be countered using non-manipulative strategies and that all relocations should be carried out by trained personnel. Moreover, in choosing this technique, managers must be willing to commit the resources requisite to ensure that eggs are properly collected either at deposition or at first light the following morning (before the heat of the day).

Equipment

Clean sturdy plastic bag/bucket, tape measure.

Actions

- Clutch relocation should ideally take place within six hours of nesting, to minimise movement induced injury to embryos (Boulon Jr, 1999), but if care is taken to minimise rotation and jarring of the eggs, the practice can be undertaken within 12 hrs of nesting and result in negligible impact on hatching success (Pers. Obs.).
- If the nest location is judged to be unsafe during night patrols and the turtle is encountered during the nesting process then the eggs can be collected as they are laid by either: 1) placing a clean plastic bag into the egg chamber to collect them as they drop, or 2) the eggs can be gently gathered or caught by hand as they drop and placed in a clean bag or bucket ready for placing in a new, artificially dug, egg chamber at a safer place. If a bag is placed in the egg chamber to collect the eggs the top should be clasped shut to exclude sand and it should be dug out from the beach as soon as egg laying is complete. Efforts should be made to minimise the amount of sand on the eggs as it can abrade the eggshells and reduce hatching success. Nest depth should be recorded to facilitate replication of original nest conditions in the new egg chamber (Boulon Jr, 1999).
- However, clutch location is more likely to occur on the morning after the nesting event happened. This means that jarring movements, rotation of the eggs and changes in temperature may all significantly reduce the success of the nest and care should be taken to minimise them. Once the clutch has been located *(see Clutch Location protocol factsheet n°9)* and the depth to the top egg recorded, eggs should be removed from the nest in ones or twos, with as little sand on them as practicable, and placed in a clean plastic bucket or bag, the number of eggs removed from the nest should be counted. For a definition of what is and is not an egg see Miller (1999). Once all the eggs have been removed, the nest depth from bottom of the egg chamber to the surface of the beach, should be measured and recorded. The bucket or bag containing the eggs should be shaded to avoid heating and moved gently and only as much as required to transport the eggs to the new nest site.
- The new nest site should be located as near to the original site as practical to reduce movement induced mortality, but should be away from potential threats such as under the highwave line or in an area of high human use and traffic and at least 1m away from any existing clutches incubating in the beach. It may be prudent to fence off an area of beach that can be used as a hatchery, so clutches can incubate in a defined area that can be closely monitored, but this process runs the risk of literally having all your eggs in one basket and if something happens to that area, catastrophic flooding, vehicles driving over the beach or unknown existing sand contamination etc. all the relocated nests can be destroyed.

- To begin the reburial process, dry surface sand is swept aside to prevent it from slipping into the excavation. Once the damp subsurface is exposed, a narrow shaft to the desired depth is excavated using one hand. The weight of the person excavating the nest should rest heavily on the other hand, and as far from the rim of the hole as possible. When proper nest depth has been confirmed using a tape measure or weighted line, the neck of the nest is widened, again using one hand, to the desired diameter. Finally, the egg chamber is widened at the bottom, so the finished nest resembles a flask or inverted light bulb. The GPS location of this new nest site should be taken.
- The eggs should be placed carefully, not dropped, in groups of 2-5 (a comfortable handful), taking care not to pack the eggs too tightly in the new chamber, and counted. Cover the new nest by replacing the damp, subsurface sand removed from the hole (do not place hot, dry surface sand on the eggs), firmly tamping it in place in layers of 8-12 cm. Once the hole is completely filled nest antipredation nest protection measures, cages or simple nest markings can be placed to indicate the location of the nest and aid reidentification at hatching.

Ethics

As indicated, incorrectly relocating clutches can have a devastating impact on their hatching success and hence recruitment of new turtles to the populations, thus this practice should only be carried out by trained personnel. Permits will be required to exhume and relocate the clutch.

Data to record

Nest depth and depth to top egg should be recorded at the original and new nest sites, along with the number of eggs exhumed and the number reburied. GPS locations of the original and new nest sites should be taken. Reason for relocation should be recorded to keep a log of threats that may be developing in a nesting area. Notes on any odd shaped eggs and reasons why the number of eggs buried may be different to the number exhumed should be kept.

Management relevance

When carried out properly this protocol will increase the number of hatchlings produced adding to the year's cohort of population recruits. Increasing recruitment/decreasing loss of hatchlings over the long-term will contribute to recruitment of adults to the nesting population.

Reporting

Average depths to top egg and bottom of the nest chamber (mean, StdDev, range, sample size) can be reported, but more important facts are: number of clutches relocated, reasons for relocation and average clutch size (number of eggs per clutch; mean, StdDev, range, sample size). Reporting the reasons for relocation highlight the threats to turtle nests in the area the reporting should include discussion on what is being done to minimise or manage those threats.

Collaboration potential

Regular and intensive clutch monitoring, including clutch relocation, is labour intensive and can be carried out by NGO or University teams that regularly report back to the MPA management. Reactive measures in response to sporadic nesting reported by third parties can be carried out in-house or again be NGO/University teams in close coordination with the MPA authority.

References

- Boulon Jr RH (1999) Reducing threats to eggs and hatchlings: in situ protection. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 169-174.
- Miller JD (1999) Determining clutch size and hatching success. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 124-129.
- Mortimer JA (1999) Reducing threats to eggs and hatchlings: hatcheries. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 175-178.

ANIMAL – THREAT/MANAGEMENT

Nest protection against predation

FACTSHEET 11

Standard

★★

ASSOCIATED PROTOCOLS

Nest (and track) identification by species [8], Clutch location [9], Relocating / translocating clutches [10], *Beach surveys (ground) [16],* Beach survey (drone) [17].

MANPOWER

1-2

COST

€€

FREQUENCY

On encounter with a nest that is likely to suffer from depredation.

Protected nest in National Marine Park of Zakynthos - Greece © Laurent Sourbès

Reason

To increase survivorship of clutches and hence recruitment to the population in a yearly cohort of hatchlings, where mammalian depredation of clutches is a proven problem.

Context

One of the most widespread threats to egg survivorship, other than flooding, is depredation generally by canids, such as feral dogs, foxes and jackals. These animals sense where the clutch is buried in the beach and dig until eggs are exposed. The predator may only depredate a few eggs or a complete clutch at first attack but will often return to a partially depredated nest over successive days to completely devour the clutch. Preventing the predators from digging into the sand to reach the eggs, using some form of screen or barrier, is a much used and effective way of combating this threat, therefore resulting in higher hatchling recruitment.

Equipment

Nest screens/cages. These can be made from plastic, metal or wood and cover approximately 1 square metre. The apertures between the mesh/bars of the screens should be 5-10cm to prevent digging into the sand by the predator but at the same time being large enough for the emerging hatchlings to escape through. *See Bolon Jr (1999) for further description of anti-predator equipment.*

Actions

- Antipredator measures should only be employed on nests where the precise location of the clutch has been identified *(see Clutch Location protocol factsheet n°9)*, this is to ensure the clutch is properly protected and any anchoring stakes used to hold the screen in place are kept well away from the incubating clutch. The protective screen or cage is placed centrally over the clutch. Flat screens should be placed 10cm under the sand surface to conceal them from predators (and curious beach users), whereas cages comprise a sub-surface component around the edges with a protruding section near the centre to increase the hindrance for predators attempting to reach the eggs.
- Screens and cages should be placed over the nests as soon as possible after clutch deposition and this activity should be scheduled as part of regular beach surveys where egg predation is known to occur. It is good practice to deploy informative nest signs on poles at nest sites to inform beach users that this is a protected marine turtle nest that should not be disturbed.

Ethics

Permits will be required to carry out nest protection as it involves tampering with the nest site and digging in the beach to discover the location of the clutch. The conservation manager needs to ensure that the protection measures are correctly placed to increase hatchling production and not impede it and that the mesh sizes are suitable to avoid restricting the hatchlings escape from the nest, which would make them more susceptible to predation at the sand surface.

Data to record

Each nest's record should include an indication if it was screened against predation.

Management relevance

This protocol will increase the number of hatchlings produced adding to the year's cohort of population recruits. Increasing recruitment/decreasing loss of hatchlings over the long-term will contribute to recruitment of adults to the nesting population. Managers should note when nest depredation emerges in an area where it previously did not occur and efforts to control the predators can be applied, such as predator removal/relocation, confinement of domestic animals and pest/predator eradication.

Reporting

The number of nests equipped with antipredator measures should be reported.

Collaboration potential

Regular and intensive clutch monitoring, including protection against predation, is labour intensive and can be carried out by NGO or University teams that regularly report back to the MPA management. Reactive measures in response to sporadic nesting reported by third parties can be carried out in-house or again be NGO/University teams in close coordination with the MPA authority.

References

- Boulon Jr RH (1999) Reducing threats to eggs and hatchlings: in situ protection. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 169-174.

HABITAT - ANIMAL

Identification of nest hatching

FACTSHEET 12

Standard ★

ASSOCIATED PROTOCOLS

Nest (and track) identification by species [8], Locating clutches [9], Relocating / translocating clutches [10], *Hatchling disorientation (recording and mitigation) [27], Post-hatch excavation of clutches [13], Beach surveys (ground) [16],* Beach survey (drone) [17].

MANPOWER

1-2

COST

-

FREQUENCY

Potential to observe a hatched nest on any beach survey from July until October.

Nest hatching in National Marine Park of Zakynthos - Greece © Laurent Sourbès

Reason

Determining nest hatching provides a timeframe for nest excavations *(see post-hatch excavation of clutches protocol factsheet n°13)* to take place and, in tandem with known laying dates, provides incubation duration data.

Context

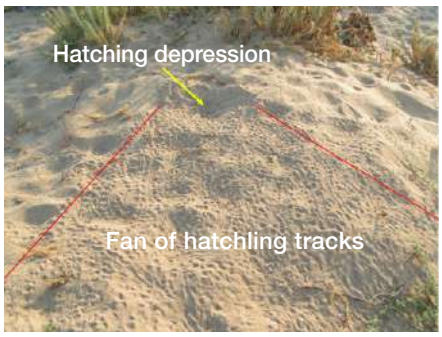
To ensure nest contents are as fresh as possible during post-hatch excavation (see post-hatch nest excavation protocol factsheet n°13) which offer insights into incubation conditions, threats and efficacy of nest management actions, it is good to know a precise hatching date, as this event is the trigger to excavate green turtle nests and trigger the count-down to excavate loggerhead nests. Identifying hatched nests on the day of hatching facilitates calculation of incubation durations, which can be used as a proxy for nest temperature and hence sex ratios of hatchlings produced by that nest. Monitoring hatchling sex ratio is of importance as the progress of climate change is likely to reduce the number of male turtles entering the year-cohort each summer.

Actions

A hatched marine turtle nest is typically identified from a group of 5cm wide hatchling tracks heading to the sea, fanning out from a single point that is often a 25cm wide shallow hatching depression in the sand. The depression is formed when sand from the neck of the nest sinks into the egg chamber as the empty shells take up less volume than unhatched eggs. Additional actions related to observation of nest hatching relate to noting the direction and spread of tracks from the hatching depression that are indicative of potential impacts of light pollution and are presented in the Hatchling disorientation (recording and mitigation) protocol.

Ethics

No ethical issues arise from this protocol as it involves the observation of imprints in the sand and no direct interaction with turtles or their nests.



Typical appearance of a newly hatched nest with the nest site (hatching depression) at the top of the image and the hatchling tracks fanning out away from that location towards the sea. Photo: ALan Rees/ ARCHELON

Data to record

Date of hatching and approximate number of hatchlings that emerged (individual numbers to 15 and more than that can be classified as “mass”).

Management relevance

Identifying hatching contributes to the calculation of incubation durations. Incubation durations are related to nest temperature and can used as a rough proxy for sex ratio estimations for the nest. These pivotal durations are estimated to be ~53 days for loggerheads (Mrosovsky et al. 2002) and ~56 days for green turtles (Broderick et al. 2000). Monitoring incubation durations will show if nest temperatures vary across the beach and within and between seasons highlighting potential impacts of climate change. These impacts may require mitigation such as pre-emptive nest shading to reduce over feminisation of the population or even avoid lethal nest temperatures.

Reporting

First hatching dates can be presented in a report in a number of ways. The first and last hatching date can be used to show duration of the hatching season, the number of nests first hatching per day or bin of days can be graphed to show the evolution of the hatching season and the Incubation durations of nests should be reported by using the difference between laying and hatching dates of individual nests.

Collaboration potential

Regular and intensive clutch monitoring, including observation of nest hatching, is labour intensive and can be carried out by NGO or University teams that regularly report back to the MPA management. Reactive measures in response to sporadic hatching reported by third parties can be carried out in-house or again be NGO/University teams in close coordination with the MPA authority.

References

- Broderick AC, Godley BJ, Reece S, Downie JR (2000) Incubation periods and sex ratios of green turtles: highly female biased hatchling production in the eastern Mediterranean. Marine Ecology Progress Series 202: 273-281
- Mrosovsky N, Kamel S, Rees AF, Margaritoulis D (2002) Pivotal temperature for loggerhead turtles (*Caretta caretta*) from Kyparissia Bay, Greece. Canadian Journal of Zoology 80: 2117-2124.

ANIMAL

Post-hatch excavation of clutches

FACTSHEET 13

Standard ★★

ASSOCIATED PROTOCOLS

Nest (and track) identification by species [8], Locating clutches [9], Relocating / translocating clutches [10], Beach surveys (ground) [16], Beach survey (drone) [17].

MANPOWER

1-2

COST

€

FREQUENCY

Suggested for every nest where the mother turtle is known and for all nests that have received some management actions (i.e. screening against predation and/or relocation) and at least 50% of other nests.

Nesting monitoring in Kuriat Island - Tunisia
© Notre Grand Bleu

Reason

To determine clutch sizes and assess hatching success and therefore the recruitment to the yearly cohort of hatchling production. Excavations can also identify threats impacting nest incubation and the effectiveness of management procedures.

Context

The MPA manager should know what levels of hatchling recruitment are being achieved within their area and what threats are reducing hatchling production. When likely threats to successful incubation are identified they can be mitigated and these mitigation measures themselves need to be shown as effective. In this context interpretation of data from post-hatch nest excavation can be invaluable to the manager to make informed decisions on conservation practices to be adopted.

Equipment

Medical gloves, 1.5m tape measure

Actions

- Suitable timing of nest excavation relating to days since first hatch was observed differs for Mediterranean loggerhead and green turtles. The deeper green turtle nests mostly hatch en masse during one night and can therefore reliably be excavated the morning that hatching is first observed. However, the shallower loggerhead nests may hatch over an extended period (Houghton and Hays 2001) and should be left for up to 7 days after first hatching, depending on the number of hatchlings recorded as emerging *(see Identification of nest hatching protocol factsheet n°12)*. All turtle nests should have hatched by 70 days of incubation, so any nest not reported as hatching can be excavated to inspect the contents after that interval.
- To excavate the nest, remove any nest screens or cages (it is useful to place a stick in the sand in the middle of the screen before removing the screen so that the location of the clutch remains clear). Sweep away dry sand from above the clutch and then gently dig down through the soft sand above the egg chamber until the eggs are reached. Be aware that you may encounter live or dead hatchlings any time during the excavation process and these need to be properly handled and recorded. Once the clutch has been revealed, wearing surgical gloves, the nest contents should be gently exhumed and sorted. The most authoritative description of categorising nest contents and determining hatching success is presented by Miller (1999).

Nest contents should be categorised as:

E = Emerged	Hatchlings leaving or departed from nest
S = Shells	Number of empty shells counted (>50% complete)
L = Live in nest	Live hatchlings left among shells (not those in neck of nest)
D = Dead in nest	Dead hatchlings that have left their shells
UD = Undeveloped	Unhatched eggs with no obvious embryo
UH = Unhatched	Unhatched eggs with obvious embryo (excluding UHT)
UHT = Unhatched term	Unhatched apparently full-term embryo in eggshell or pipped (with a small amount of external yolk material)
P = Depredated	Open, nearly complete shells containing egg residue

Note that egg fragments should NOT be amalgamated and counted as extra eggs, but instead only eggshells comprising more than 50% of a shell should be included in the count and also that live hatchlings just below the beach surface (not trapped by vegetation or debris) should be considered as successfully emerged and not included in the nest contents. Additionally, nests that have been depredated should not be used in calculation of clutch size based on post-hatch nest excavation.

- Clutch size (CS), which is the number of eggs within a nest, is determined using:

  CS = S+UD+UH+UHT+P

- Hatching success (HS%), which is the percentage of eggs that produced hatchlings, is determined using:

  HS% = (S/(S+UD+UH+UHT+P))*100

- Emergence success (ES%), which is the percentage of eggs that produced a hatchling that reached the beach surface, is determined using:

  ES% = ((S-(L+D))/(S+UD+UH+UHT+P))*100

Ethics

Permits will be required to undertake post-hatch nest excavations as it involves directly manipulating eggs and hatchlings of endangered species. The practice of excavating nests poses potential ethical issues as live hatchlings and embryos may be encountered. Indeed, the positive side of this action is the potential for trapped or struggling hatchlings to be freed from the nest and make it to the sea.

Data to record

For a nest excavation the existing nest code, laying and hatching dates should be recorded. After the nest contents have been sorted the number of eggs etc. in each category should be noted. Conditions inside the nest should also be recorded, such as root invasion, water in bottom of chamber, many stones in sand etc. The UH eggs can be subdivided according to embryo stage (see Miller et al. 2019) which can be used to date the stage of incubation that may have been impacted by threats such as flooding. Note, as per the above naming system, eggs that do not show clear signs of embryos should NOT be called infertile eggs, as it is practically impossible to determine fertility of an egg after it has incubated for at least 45 days in the beach, and studies dedicated to fertilisation rates show that it is usually very high (Phillott and Godfrey 2020).

Management relevance

With the purpose of nest management being increased hatchling production, post-hatch nest excavation can provide a wealth of information relevant for management. Roots and other objects found in the sand in and around the eggs can indicate poor suitability of the location for incubating nests and suggest mitigation measures such as management of the threat or clutch relocation from the affected area. Likewise, a waterlogged egg chamber will indicate the area is within the water table and not a good location to leave clutches. Furthermore, successive nests from one area may be found to have low hatching success for an unknown reason, which can be used to direct future seasons' relocation strategy.

Reporting

Annual summary data presented on post-hatch excavations should be include average clutch size (mean, Std Dev, range, sample size) of non-predated nests and averages (mean, Std Dev, range, sample size) for both hatching and emergence success. Data on threats that are likely to have impacted success of one or more nests should be listed and discussed to highlight the potential need to revise management actions for the following nesting season.

Collaboration potential

Regular and intensive clutch monitoring, including post-hatch nest excavation, is labour intensive and can be carried out by NGO or University teams that regularly report back to the MPA management. Reactive measures in response to sporadic hatching reported by third parties can be carried out in-house or again be NGO/University teams in close coordination with the MPA authority.

References

- Houghton JDR, Hays GC (2001) Asynchronous emergence by loggerhead turtle (*Caretta caretta*) hatchlings. Naturwissenschaften 88: 133-136.
- Miller JD (1999) Determining clutch size and hatching success. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 124-129.
- Miller JD, Mortimer JA, Limpus CJ (2017) A field key to the development stages of marine turtles (Cheloniidae) with notes on the development of *Dermochelys*. Chelonian Conservation and Biology 16(2): 222-122.
- Phillott AD, Godfrey MH (2020) Assessing the evidence of 'infertile' sea turtle eggs. Endangered Species Research 41: 329-338.

HABITAT

Beach suitability assessment for nesting

FACTSHEET 14

Standard ★

ASSOCIATED PROTOCOLS

(*Typical* / additional) Beach mapping (18], Beach surveys (ground) [16] Beach survey (drone) [17].

MANPOWER

1-2

COST

€

FREQUENCY

MPA-wide at onset and repeated every 5-10 years.

Nesting Beach in National Marine Park of Zakynthos - Greece © Laurent Sourbè

Reason

Marine turtles require certain conditions to be met in order to successfully nest and have their nests incubate and hatch properly. Knowing which stretches of coast are suitable or unsuitable for nesting can help target management actions.

Context

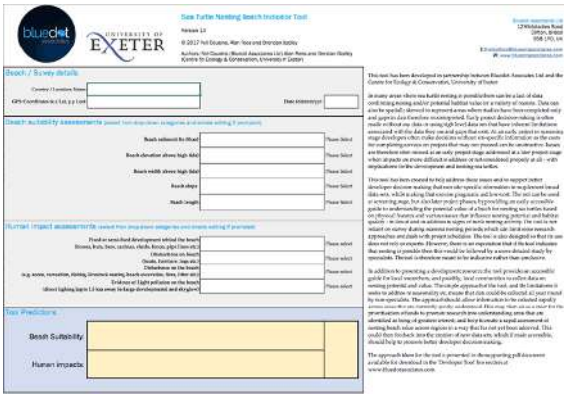
Beach patrolling for marine turtle nesting activity is time consuming and labour intensive. Being able to eliminate certain coastal stretches from within the MPA from being suitable nesting habitat can focus management and other actions, saving time and resources. Mediterranean beaches do not experience the high energy cyclical tides that manipulate coastlines of ocean-fronting nations. Seasonal variation in beach characteristics are likely to not vary considerably and therefore beaches can be assessed at any time of the year for general suitability as marine turtle nesting habitat.

Equipment

Sea Turtle Nesting Beach Indicator Tool (software)

Actions

- Nesting beaches are sandy stretches of coast from a few hundreds of metres to tens of kilometres. Their suitability for nesting is determined not only by the quality of the sand, but the amount of beach platform above the tide level and also how impacted they are by human activities such as development. The Sea Turtle Nesting Beach Indicator Tool (STNBIT; Cousins et al. 2017) is a useful simple-to-use tool that can rapidly assess and rank the value of beaches for their potential marine turtle nesting importance in areas where biological data are absent, to help managers assess their coastlines, and it can be downloaded from http://bluedotassociates.com/rapid-data/. It comprises a workbook that consists of two simple spreadsheets, the tool and the record form.
- The first way to use it is to print blank record forms and take these forms to the beach. The surveyor then completes their observations on the printed forms to take back to the office for input in the tool. The second way is the surveyor takes a device that can open MS Excel spreadsheets with them to the field and inputs their observations directly into the tool.
- Both methods result in the surveyor entering their observations into the tool which displays the beach's suitability using a combined colour code and star rating. Completion of the tool also populates the form including the suitability assessments, which can be printed on hardcopy or as PDF for archiving. Longer beaches (>1km) of variable topology should be divided into stretches of similar habitat and assessed using the STNBIT for each section.
- It should be noted that the tool deals with physical habitat features only and that it provides preliminary indicative rather than conclusive results on nesting potential, i.e. indications of poor suitability for certain beaches should not be used as categorical evidence there is no nesting.



The Sea Turtle Nesting Beach Indicator Tool's simple user interface.

Ethics

No ethical issues arise from enacting this protocol, but the manager needs to be aware of the simple indicative nature of the STNBIT to help prioritise efforts and not to use it as a definitive designation that cannot change over time.

Data to record

All parts of the STNBIT form should be completed. These include date of survey, GPS location and beach name and entries for the various assessment criteria.

Management relevance

Initial scoping surveys to determine a beach's suitability for marine turtle nesting will help focus management resources towards areas of likely nesting and document any existing threats that may impact an emerging turtle nesting site.

Reporting

All beaches should be surveyed as soon as possible to generate an inventory of possible marine turtle nesting areas and this overall MPA assessment should be recorded and reported. In basic format the report would comprise a summary page on how many potential nesting areas there are and total beach lengths etc. followed by a map showing the different regions of cost and their suitability and the individual STNBIT forms should be included as an annex.

Collaboration potential

Surveys can be carried out by MPA staff and/or associated personnel, or external collaborators under the guidance and coordination of the MPA management.

References

- Cousins N, Rees AF, Godley BJ (2017) A Sea Turtle Nesting Beach Indicator Tool to help identify areas with potential for sea turtle nesting. Marine Turtle Newsletter 153: 13.

HABITAT

Beach temperatures

FACTSHEET 15

Standard ★★

ASSOCIATED PROTOCOLS

Nest (and track) identification by species [8], Locating clutches [9], Relocating / Translocating clutches [10], Nest protection against predation [11], Identification of nest hatching [12], *Post-hatch excavation of clutches [13]*, Beach suitability assessment for nesting [14], *Beach surveys (ground) [16]*, Beach survey (drone) [17].

MANPOWER

1-2

COST

€€€

FREQUENCY

Annually (May-October)

Nesting monitoring in Kuriat Island - Tunisia © Notre Grand Bleu

Reason

Beach temperatures can be used as simple proxies for incubation temperatures which indicate the sex ratio of hatchlings being produced in an area.

Context

Marine turtle sex is determined by temperature during incubation. There is a pivotal temperature when the egg incubation temperature produces both sexes in equal numbers. Warmer temperatures produce females and cooler temperatures produces males and centrally there is a transitional range of temperatures where both sexes are produced (Mrosovsky & Pieau 1991). Fully determining hatchling sex ratio estimates and understanding optimal sex ratio production is complicated and poorly understood (see Godfrey and Mrosovsky (1999) and references therein), and there is concern that with global warming effects of climate change sex ratios may become increasingly if not entirely female skewed. Pivotal temperatures (the egg incubation temperature where both sexes are produced in equal numbers) has been estimated for Mediterranean loggerheads (Fuller et al. 2013; Mrosovsky et al. 2002) and green turtles (Kaska et al 1998; Broderick et al 2000). Knowledge of beach temperatures can provide a simple, rough indication of sex ratios highlighting important male producing locations or periods during a nesting season and when nest shading (to reduce incubation temperatures) may become important to reduce incubation temperatures below lethal thresholds (Katselidis et al. 2012).

Equipment

Waterproof calibrated temperature loggers (e.g. Tinytag Plus 2 - TGP-4017; www.geminidataloggers.com)

Actions

- Temperature loggers should be buried in the sand in May prior to or at commencement of the nesting season, with a temperature sampling interval of 30min - 1 hr. The loggers should be buried at least 40cm deep, i.e. midnest depth which should be around 40cm for loggerhead turtles and deeper for green turtles. They should be buried at a distance from the sea of a typical nest (>15m), bearing in mind that it may be difficult or impossible to retrieve loggers that have been covered during inundation events. There should be at least one logger per beach and ideally at least one logger every 2km of beach for longer beaches. GPS location of each logger should be taken.
- Smaller, short term (3-7 days), studies worth undertaking at each location are the variation of temperature with depth and/or distance from the sea. How temperature varies with depth can be determined by burying loggers in a stack at 60, 45, 30, 15 and 2cm depth with a sub-30-minute sampling frequency. This will show how daily variation and mean temperatures are affected by depth. For variation in temperature as a factor of distance from the sea, temperature loggers should be buried at mid nest depth every 5 metres from the sea to the back of the beach and should be replicated at 3 locations so that a temperature correction factor can be made and applied to nests based on the general beach temperature and the nest's distance from the sea.

Ethics

This protocol raises no ethical issues as it is focussed on obtaining environmental data and includes no interaction with marine turtles or their nests.

Data to record

Raw temperature data from seasonal beach temperature loggers should be processed to provide mean daily temperature. Each temperature profile should be associated with a location and GPS coordinate.

Management relevance

Beach temperatures can be used as proxies for nest temperatures and give a rough estimation of hatchling sex ratios. Extreme warm temperatures will initially excessively feminise hatchlings produced in the area – at the expense of male hatchling production, which may cause problems over time, or may reach lethal levels where eggs cannot successfully incubate through to hatching. Knowing beach temperatures therefore will inform a manager of the beach location's resilience to the impacts of climate change and the likely requirement for extreme nest management measures such as shading to reduce temperature.

Reporting

At minimum, the daily beach temperature profiles across the season per temperature logger should be presented in graphical form to show at a basic level how much time each beach or beach section experiences temperatures above and below the pivotal temperature, which can be assumed to be ~29°C. Sex ratio biases based on these observations can be discussed. At the next level, beach temperatures for the periods of the middle thirds of individual nest incubations (the thermosensitive period for sex determination) can be extracted to give more detail on skewing of sex ratios with more detailed discussion on spatial and temporal variation in likely sex ratios.

Collaboration potential

Deploying temperature loggers in nesting beaches should be within the capacity of the MPA authority, however the manager may want to share temperature logger and nest data with research scientists who can fully investigate likely sex ratios produced within the MPA and compare this seasonally with other locations if there is a lack of in-house expertise.

References

- Broderick AC, Godley BJ, Reece S, Downie JR (2000) Incubation periods and sex ratios of green turtles: highly female biased hatchling production in the eastern Mediterranean. Marine Ecology Progress Series 202: 273-281.
- Fuller WJ, Godley BJ, Hodgson DJ, Reece SE, Witt MJ, Broderick AC (2013) Importance of spatio-temporal data for predicting the effects of climate change on marine turtle sex ratios. Marine Ecology Progress Series 488: 267–274.
- Godfrey M, Mrosovsky N (1999) Estimating hatchling sex ratios. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 136-138.
- Kaska Y, Downie JR, Tippett R, Furness R (1998) Natural temperature regimes for loggerhead and green turtle nests in the eastern Mediterranean. Canadian Journal of Zoology 76: 723-729.
- Katselidis KA, Schofield G, Stamou G, Dimopoulos P, Pantis JD (2012) Females first? Past, present and future variability in offspring sex ratio at a temperate sea turtle breeding area. Animal Conservation 15: 508-518.
- Mrosovsky N, Pieau C (1991) Transitional range of temperature, pivotal temperatures and thermo sensitive stages for sex determination in reptiles. Amphibia-Reptilia 12: 169-179.
- Mrosovsky N, Kamel S, Rees AF, Margaritoulis D (2002) Pivotal temperature for loggerhead turtles (*Caretta caretta*) from Kyparissia Bay, Greece. Canadian Journal of Zoology 80: 2118-2124.

HABITAT – ANIMAL – THREAT/MANAGEMENT

Beach surveys (ground)

FACTSHEET 16

Standard ★

ASSOCIATED PROTOCOLS

Species ID [1], Measuring turtles [2], Sexing turtles [3], *Flipper tagging [5], PIT tagging [4], Photo ID [6],* Tissue sampling [7], *Nest (and track) identification by species [8], Locating clutches [9], Relocating / Translocating clutches 10], Nest protection against predation [11], Identification of nest hatching [12], Post-hatch excavation of clutches [13], Beach suitability assessment for nesting [14], Beach temperatures [15], Nest predation (repairing) [25], Nest inundation (repairing) [26], Hatchling disorientation (recording and mitigation) [27], Dealing with dead strandings [28], Dealing with live strandings [29],* Necropsy [31].

MANPOWER

1-3

COST

€-€€

FREQUENCY

Variable. From daily to seasonal or ad hoc occurrence

Nesting monitoring in Kuriat Island - Tunisia © Notre Grand Bleu

Reason

Beaches are critical habitats for breeding marine turtles where adult females come ashore to nest during a well-defined period and are the interface between the marine and terrestrial habitats where dead and injured turtles frequently strand.

Context

Ensuring successful nesting, clutch incubation and hatchling emergence are key components for a healthy nesting population of marine turtles, whilst collecting data on stranded turtles can reveal demographic details of this hard to access segment of the population in combination with lethal threats impacting the local population. Both nest and strand monitoring are best carried out with physical ground patrols to maximise their conservation and data gathering potential. It cannot be overstated that ground-based beach surveys are fundamental component of marine turtle monitoring and conservation.

Equipment

Equipment needs are dependent on the purpose of the beach monitoring and monitoring protocols being followed.

Actions

- When high density nesting is concentrated on short lengths of beach then nocturnal beach patrols can be adopted, covering at least 11pm to 3am, to encounter nesting turtles and build up an individual-based database of adult female turtles. For the months of June and July, patrols of 2-3 people should walk along the water's edge, at least hourly, until a turtle or 'up track' is encountered. A turtle should not be approached for data collection until it has completed egg-laying or is definitely returning to the sea.
- Morning track surveys should, ideally, be carried out daily at first light as: it reduces the chance for the track to be obscured by human or environmental actions, it permits the surveyor to undertake simplified nest relocation protocols when necessary to negate the potential impact of threats, such as flooding or trampling and the surveyor avoids working during the excessive heat of the Mediterranean daytime. Surveys should take place during the June to August breeding season, on important areas where nesting is concentrated and there are known threats that require mitigation for successful incubation of nests. The time frame can be expanded to include May and September/October to encounter early nesting events and all nest hatching. Infrequently nested or areas or those where there are negligible threats can be patrolled less frequently to record nesting activity. Sporadically nested areas should be investigated upon report of turtles on the beach at night or turtle tracks being observed.
- Foot patrols can cover 2-4km in an hour depending on conditions and number of turtle emergences encountered. ATVs can cover three to five times as much.
- Remote or infrequently visited areas of coast can be patrolled systematically every three months to record the presence and details of stranded turtles. Reports of stranded turtles are more likely to be reported by the public and associates from beaches and more visited stretches, which means reactive surveys in response to sightings can be sufficient.
- Further information on beach surveying and associated activities are available (FFWCC 2016, Schroeder & Murphy 1999)

Ethics

Patrolling the beach in itself raises no ethical issues, but associated protocols relating to interacting with turtles and nests raise ethical issues and require permits.

Data to record

Data to record depend on the purpose of the patrol, whether it is to encounter turtles, monitor nests or record strandings. Data recording requirements for the relevant protocols should be followed.

Management relevance

Ground surveys are the basic protocol which facilitate the implementation of many others. Without ground surveys the manager has limited opportunities to gather information and data to direct management actions and accurately assess conservation status or marine turtles in the MPA.

Reporting

Whatever the purpose, the survey rationale and scheduling should be reported with the data derived during the surveys. In this way it is simple to follow how the results relate to survey effort and understanding of the potential for missed events (nesters, nests and stranding) can be gained. Data should then be published or shared for regional interpretation of seasonal or annual results.

Collaboration potential

Depending on MPA capacity, more frequent and labour-intensive surveying can be carried out by associated NGOs and academic groups that regularly report the results back to the MPA management. Less frequent and ad hoc surveys can be carried out by trained MPA personnel.

References

- FFWCC (Florida Fish and Wildlife Conservation Commission) (2016) Marine turtle conservation handbook. https://myfwc.com/media/3133/fwc-mtconservationhandbook.pdf accessed on 1 April 2020.
- Schroeder B, Murphy S (1999) Population surveys (ground and aerial) on nesting beaches. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 45-55.

HABITAT, MANAGEMENT

Beach surveys (drone)

FACTSHEET 17

Standard ★★

ASSOCIATED PROTOCOLS

Nest (and track) identification by species [8], Locating clutches [9], Relocating / Translocating clutches [10], Nest protection against predation [11], *Identification of nest hatching [12],* Post-hatch excavation of clutches [13], *Beach suitability assessment for nesting 14], Nest predation (repairing) [25], Nest inundation (repairing) [26], Hatchling disorientation (recording and mitigation) [27], Beach mapping [18].*

MANPOWER

2-3

COST

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FREQUENCY

Can range from daily to seasonally, depending on purpose of survey and likelihood of encountering turtle activity.

Reason

Drone surveys can cover larger stretches of coast more quickly than ground patrols thus saving time patrolling areas with infrequent nesting activity and they can be used to create very detailed two- and three-dimensional maps of coastline that can be incorporated in GIS datasets used to monitor changes over time.

Context

The more frequent a beach is surveyed the less likely it is that events such as nesting and strandings will be missed. However, ground-based beach patrolling is time-consuming may be of marginal worth when the likelihood of encountering evidence of turtles is minimal. In these circumstances more rapid, wideranging surveys conducted from the air by drones can provide information back to the researcher on whether any turtle activity that requires ground truthing or further investigation is present. Additionally, drones can be used to create two- and three-dimensional georeferenced maps to sub 10cm accuracy, and these maps can be used to monitor environmental conditions and habitat change *(see Beach mapping protocol factsheet n°18)*. For general discussion on how drones can be used in marine turtle conservation see Rees et al. (2018).

Equipment

Drones (multirotor (E.g. Mavic, Phantom or Inspire; www.dji.com) or fixed wing (e.g. eBee; www.sensefly.com)). Multiple Terabyte hard drives for data storage.

Actions

Beach surveys to record nesting activity to be organised in such a way as the drone flies a stretch of beach using preconfigured route and signs of turtles are reviewed either real-time from the relayed view from the drone's camera or from the captured footage immediately after the drone returns. The location of any turtle activity can be obtained from the drone's data logs and the survey team can head to that location to carryout actions for whatever other protocols are required. National laws and restrictions should be obeyed, which may restrict the potential benefits of drones. For example, a Phantom 4 Pro drone can easily fly an out-and-back route totalling 8km, but laws in most European countries limited the distance the drone may be flown from the pilot to 500m.

Ethics

Images recorded from drones may contain people, which can raise ethical issues with their use. No imagery with identifiable people in should be published or shared. All other ethical issues relate to the associated protocols enacted alongside the drone survey and not from the survey itself.

Data to record

Date of survey should be recorded along with its purpose and findings. E.g. number of tracks/ nests and any stranded turtles. Video imagery from the nesting/stranding surveys can be kept in their entirety or as snapshots with relevant data. All imagery from mapping surveys needs to be kept for use in photogrammetry software.

Management relevance

Though providing less information that ground patrols drone surveys of the coast can rapidly provide data that may indicate the presence of threats impacting nesting or turtles at sea (by way of location and number of turtle strandings) and therefore trigger a specific management response.

Reporting

Survey dates, locations and survey results in terms of numbers of nests and stranded turtles should be reported together with any further details obtained from the nests or strandings. Reporting on mapping surveys should include areas covered and discussion on the results i.e. changes observed from one survey to the next. The reporting will be highly visual and can supply strong evidence to be used in conservation management and enforcement. Mapping data should be processed in GIS software to maximise its accuracy and utility.

Collaboration potential

Depending on MPA capacity, more frequent and labour-intensive surveying can be carried out by associated NGOs and academic groups that regularly report results back to the MPA management. For best responsiveness to evolving situations, less frequent and ad hoc surveys can be carried out by trained MPA personnel.

References

- Rees AF, Avens L, Ballorain K, Bevan E, et al. (2018) The potential of unmanned aerial systems for sea turtle research and conservation: a review and future directions. Endangered Species Research 35: 81-100.

Beach mapping

ASSOCIATED PROTOCOLS

Beach suitability assessment for nesting [14], Beach temperatures [15], Beach surveys (ground) [16], *Beach survey (drone) [17], Coastal development monitoring [22],* Light pollution monitoring and mitigation [23], Beach use monitoring and control [24].

MANPOWER

2-3

COST

€€€

FREQUENCY

Seasonal to annual surveys can be scheduled with additional ad hoc mapping actions carried out when required for time-sensitive data capture.

Reason

Marine turtle nesting habitats are relatively small, well defined and are critical to their lifecycle. Mapping this habitat aids in management and conservation.

Context

Changes to nesting beach habitats is often difficult to reverse, especially when brought about by deliberate anthropogenic interventions such as development, sand extraction or dune destruction and consequently having up-to-date irrefutable evidence of changes in beach conditions can help with enforcement issues and bring a timely end to the progress of degradation. Three dimensional maps can also be used in assessment of beach quality and resilience in the face of rising sea levels and more extreme weather patterns caused by climate change (Katselidis et al. 2014).

Equipment

Drones (multirotor (E.g. Mavic, Phantom or Inspire; www.dji.com) or fixed wing (e.g. eBee; www.sensefly.com)), ground control points and RTK GPS units (e.g. Reach RS+; emlid.com). Multiple Terabyte hard drives for data storage. Photogrammetry software (e.g. Pix4D / Agisoft Metashape) to construct the maps from still images.

Actions

- Ground control points (GCPs) are distributed around the area to be mapped with their locations precisely defined using RTK GPS data. The drone is then flown over the preselected area capturing still images using dedicated software. The still images and the GCP GPS coordinates are fed into photogrammetry software which then creates georeferenced orthomosaics (2D Maps) or 3D Digital models that can be used in GIS software for detailed analysis. See Varela et al. (2019) for an example of use of this technique.
- Note that historic data from online mapping services such as Google Earth, although at a much lower resolution than available from drones, can be used to complement contemporary drone acquired data and establish a longer timeline for environmental changes to the MPA coastline.

Ethics

Images recorded from drones may contain people, which can raise ethical issues with their use. No imagery with identifiable people in should be published or shared.

Data to record

Date of survey should be recorded along with its purpose and findings. All imagery from mapping surveys needs to be kept for use in photogrammetry software.

Management relevance

A repeated time series of nesting beach mapping can provide a wealth of information useful for management. Mapping can identify accretion and erosion events that affect the suitability of nesting sites. It can identify high use areas in terms of beach use by people and turtle nesting that can be used to update beach use criteria both within a season and between seasons. It can identify nearshore development that will impact nesting in terms of direct threats – beach lighting and associated obstacles on the beach, or indirect threats such as encouraging increased use of the beach.

Example of Google Earth view from 2007 (left) and recent (2019) equivalent view with high-resolution drone data (right). Drone image: ARCHELON

Reporting

Survey dates, locations and survey results in terms of areas covered should be presented and discussed. i.e. changes observed from one survey to the next. The reporting will be highly visual and can supply strong evidence to be used in conservation management and enforcement. Mapping data should be processed in GIS software to maximise its accuracy and utility.

Collaboration potential

Depending on MPA capacity, more frequent and labour-intensive surveying can be carried out by associated NGOs and academic groups that regularly report results back to the MPA management. Less frequent and ad hoc surveys can be carried out by trained MPA personnel who can more promptly respond to emerging situations.

References

- Katselidis KA, Schofield G, Stamou G, Dimopoulos P, Pantis JD (2014) Employing sea-level rise scenarios to strategically select sea turtle nesting habitat important for long-term management at a temperate breeding area. Journal of Experimental Marine Biology and Ecology 450: 47-54.
- Varela MR, Patrício AR, Anderson K, Broderick AC, DeBell L, Hawkes LA, Tilley D, Snape RTE, Westoby MJ, Godley BJ (2019) Assessing climate change associated sea-level rise impacts on sea turtle nesting beaches using drones, photogrammetry and a novel GPS system. Global Change Biology 25: 753-762.

Marine survey (plane)

ASSOCIATED PROTOCOLS

Species ID [1], Marine survey (drone) [20], Fisheries interactions (bycatch) [30], *Marine traffic management [32].*

MANPOWER

3-5

COST

€€€€€

FREQUENCY

Annually or less frequently, given costs, though initial seasonal surveys would be useful to identify temporal variation in turtle presence.

Reason

Marine turtles spend the vast majority of their lives at sea hence knowing their density and distribution at sea can help defined spatiotemporal conservation measures.

Context

By definition, marine parks mainly cover the marine realm, and this is where all marine turtles spend their lives, except for the short periods when adult females come ashore to nest every few years. Identifying temporal and spatial hotspots with high densities of turtles will help localise measures for turtle conservation, however, to maximise results for the financial and logistical obstacles that must be overcome, these turtle conservation measures should be assessed with a multi-taxon approach, incorporating marine mammal and sea bird species. In this manner the most cost-effective biodiversity preserving measures can be selected. Aerial surveys for marine megafauna have been established for decades but are seldom employed due to expense. Currently there are only two published records of aerial surveys enumerating the distribution of marine turtles in the Mediterranean (Gómez de Segura et al. 2006, Lauriano et al. 2011).

Equipment

Small piloted aircraft

Actions

In principal, aircraft are flown following a predefined route over a set area of sea and observers, looking from either side of the aircraft, record sightings of marine turtles. Henwood and Epperly (1999) report:

"Aircraft selection is important in planning an aerial survey. A single engine aircraft may be adequate for low budget operations in nearshore waters (within gliding distance of land). Larger twin-engine aircraft are recommended for offshore operations. Plexiglass bubbles on the sides or in the nose of the aircraft providing forward, aft, and downward trackline visibility are essential to meet the assumptions of line-transect theory. Aircraft should be equipped with a Global Positioning System (GPS) [logger] for continuous position recording. Flight altitude and airspeed should be constant within a study and depend upon primary objectives of the survey and variables such as species of turtle, size, sex, behavior, study area, and a number of other factors. For studies of sea turtles, altitudes should be about 150m (500ft) or less and airspeed should be 150 to 225km/hr."

Ethics

The main ethical consideration is justification of the expense to carry out aerial surveys in piloted aircraft when the financial resources may be more effectively employed undertaking other monitoring and conservation measures.

Data to record

Routes and timing of the aircraft transects should be recorded together with sea state, which affects observation likelihood. Time and location of turtle sightings, together with the distance of the turtle from the aircraft are also recorded to place the turtle sightings and statistically determine effective strip width for the survey.

Management relevance

Plane surveys generate data that will be useful at regional levels for population distribution and relative densities. They can confirm that offshore waters are important for marine turtles within the MPA hence clarifying the importance for management measures in the wider area.

Reporting

The two published studies (Gómez de Segura et al. 2006, Lauriano et al. 2011) have reported turtle densities and abundance, variation in seasonal presence and related these data with known threats such as bycatch.

Collaboration potential

Due to the expense of carrying out piloted aerial surveys, collaborative efforts can minimise MPA resource consumption. MPA participation in national and region-wide surveys can be effective ways to gather vital distribution data on marine turtles and other marine megafauna as exemplified by the ACCOBAMS Survey Initiative (ASI; https://accobams.org/main-activites/accobams-survey-initiative-2/accobams-survey-initiative/).

References

- Gómez de Segura A, Tomás J, Pedraza SN, Crespo EA, Raga JA (2006) Abundance and distribution of the endangered loggerhead turtle in Spanish Mediterranean waters and the conservation implications. Animal Conservation 9: 199-206.
- Henwood TA, Epperly SP (1999) Aerial surveys in foraging habitats. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 65-66.
- Lauriano G, Panigada S, Casale P, Pierantonio N, Donovan GP (2011) Aerial survey abundance estimates of the loggerhead sea turtle *Caretta caretta* in the Pelagos Sanctuary, northwestern Mediterranean Sea. Marine Ecology Progress Series 437: 291-302.

Marine survey (drone)

ASSOCIATED PROTOCOLS

Species ID [1], Marine survey (aircraft) [19], Fisheries interactions (bycatch) [30], *Marine traffic management [32].*

MANPOWER

2-5

COST

€€€ - €€€€€ Depending on incorporation of boats in survey schedule.

FREQUENCY

Ranging from weekly to monthly, seasonally or annually based on method used (hence cost) and presence data being sought.

Reason

Marine turtles spend the vast majority of their lives at sea hence knowing their density and distribution at sea can help defined spatio-temporal conservation measures.

Context

By definition, marine parks mainly cover the marine realm, and this is where all marine turtles spend their lives, except for the short periods when adult females come ashore to nest every few years. Identifying temporal and spatial hotspots with high densities of turtles will help localise measures for turtle conservation. Use of drones to monitor presence of marine turtles at sea is a relatively new practice, with no case studies published to date from the Mediterranean. See Rees et al. (2018) for further information on the use of drones in marine turtle conservation. Aerial surveys with aircraft *(see Marine survey (plane) protocol factsheet n°19)* can cover larger areas than drones, but drone surveys can acquire more detail on the individual turtles recorded during the survey (e.g. Schofield et al. 2017) and, depending on the techniques used, can be much less expensive.

Equipment

Drones (multirotor (E.g. Mavic, Phantom or Inspire; www.dji.com) or fixed wing (e.g. eBee; www.sensefly.com)). Multiple Terabyte hard drives for data storage. Boats can be used as bases for drones to be deployed at sea and cover more offshore areas – thus increasing costs considerably.

Actions

- Survey style will be restricted by legal limitations of distances drones may fly from their operators (typically 500m across Europe) or by battery life of the drone (typically ~20 mins for multirotor drones). Shore based surveys can be designed as a saw-tooth out-and-back pattern or a series of transects running at differing distances parallel to the shore. Offshore surveys, using a boat as a launch area, are best flown in a decreasing spiral of 1km square with the drone first flying around the perimeter then progressing inwards on each circuit, with the boat positioned in the centre of the square. It should be noted that boat based marine turtle surveys can be carried out without drones (see NAILSMA 2013 for methods) but these are more time consuming, and provide poorer data in terms of number of re-sighting observations (Dunstan et al. 2020)
- Data can be acquired as either maximum-resolution photographic stills (often up to 20MP on modern drones) or as 4K video from which 8.3MP snapshots can be extracted. Video or photographic data are reviewed at the end of the survey, ideally independently by two separate observers and records are compared and discussed until consensus is gained on all turtle observations.

Ethics

Images recorded from drones may contain people, which can raise ethical issues with their use. No imagery with identifiable people in should be published or shared.

Data to record

Date, location and time of surveys should be recorded together with sea state – though all this information can be taken from the recorded data. Locations of turtles together with species, size and sex (where determined) should be systematically recorded and incorporated into GIS software for analysis.

Management relevance

Marine surveys using drones can generate data on turtle distribution and abundance – highlighting high use areas requiring protection, and habitat types and condition, but also indicate the real time situation within the nearshore region – e.g. acquire data on presence of vessels in a no boating zone, evidence of anchorage damaging seagrass beds etc. Managers can promptly respond to any MPA non-compliance and instigate enforcement measures.

Reporting

Similar to piloted aerial surveys, turtle densities and abundance, variation in seasonal presence should be reported, but with the added resolution available from drones observations to species level should be reported where possible.

Collaboration potential

Depending on MPA capacity, more frequent and labour-intensive surveying can be carried out by associated NGOs and academic groups that regularly report results back to the MPA management. Less frequent and ad hoc surveys can be carried out by trained MPA personnel.

References

- Dunstan A, Robertson K, Fitzpatrick R, Pickford J, Meager J (2020) Use of unmanned aerial vehicles (UAVs) for mark-resight nesting population estimation of adult female green sea turtles at Raine Island. PLoS ONE 15(6): e0228524.
- NAILSMA (2013) Developing boat-based survey methods for dugong and marine turtles: Field trials at Montgomery Reef, Western Australia, August 2012. Micha Jackson, Rod Kennett, Frank Weisenberger, Peter Bayliss and the Dambimangari Rangers. NAILSMA Knowledge Series 021/2013. North Australian Indigenous Land and Sea Management Alliance Ltd Darwin. 27 p.
- Rees AF, Avens L, Ballorain K, Bevan E, et al. (2018) The potential of unmanned aerial systems for sea turtle research and conservation: a review and future directions. Endangered Species Research 35: 81-100.
- Schofield G, Katselidis KA, Lilley MKS, Reina RD, Hays GC (2017) Detecting elusive aspects of wildlife ecology using drones: new insights on the mating dynamics and operational sex ratios of sea turtles. Functional Ecology 31: 2310-2319.

ANIMAL

Marine turtle survey at-sea (turtle capture)

FACTSHEET 21

Standard

★★★

ASSOCIATED PROTOCOLS

Species ID [1], Measuring turtles [2], Sexing turtles [3], Flipper tagging [5], PIT tagging [4], Photo ID [6], Tissue sampling [7], Marine survey (drone) [20], Fisheries interactions (bycatch) [30], Marine traffic management [32], Pollution [33], Plastic ingestion [34], Deploying animal mounted data gathering and tracking equipment [36].

MANPOWER

2-6

COST

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FREQUENCY

In high-density foraging areas a minimum of yearly surveys lasting no shorter than one week. Ideally seasonal surveys four times per year each lasting one to two weeks. In important nesting areas surveys can be carried out in April/May when males are there to breed.

Reason

Obtaining turtles for study at sea opens up data acquisition from the less studied male and juvenile portions of the population.

Context

Most research and monitoring on individual turtles is carried out on adult females on beaches due to the relatively simple process of encountering them while they nest. However nesting females make up only a small amount of the population, and a capture-mark-recapture project involving non-breeding adult females and males and juveniles of both sexes allows better understanding of individual behaviour and also the opportunity to assess genetic stock compositions of the foraging population. An example of an on-going in water research project is carried out in Amvrakikos Gulf, Greece (see Rees et al. 2013, 2017). In-water turtle capture can also be used in breeding habitats to access the adult male segment of the population (e.g. Schofield et al. 2020).

Equipment

Small boat e.g. 4-5m dinghy. Fishing net (optional). See indicated fact sheets protocols for equipment required for each aspect of the survey work.

Actions

The survey team heads out to the survey location in the boat and once in location there are both active and passive methods for locating turtles (Ehrhart & Ogen 1999). The passive method is to set a net in shallow water from the seabed to the surface and wait for a turtle to become entangled in it. When a turtle becomes entangled it moves the net which should be obvious to the researchers, however, the net needs to be checked every 15 mins to avoid any issue with turtles that become entangled but are not noticed by the researchers. This method works better in areas with more extreme tidal waters than those of the Mediterranean. The first active method of capture is to drive the boat until a turtle is spotted, via its head coming up to breath or with it viewed still under water. In this case a net is progressively cast from the boat as the boat circles the turtle and in this way the turtle is ensnared and can be gathered in the net or by hand. The other active method of capture is using the boat to chase turtles in the water and a researcher jumps from the boat onto the turtle to catch it (Ehrhart & Ogen 1999). Once the turtle is caught it is carefully loaded onto the boat and various observations are recorded. Additionally, tissue samples can be taken and archived for future scientific analysis.

Ethics

As this protocol involves capture and handling live turtles, ethical approval will be required by national authorities. Managers need to ensure they eliminate chance of harm coming to the turtle that are caught in nets or pursued by the research vessel.

Data to record

A GPS coordinate of each capture location should be recorded. The turtle species should be identified, carapace and tail measurements taken, tags applied and/or read, and photographs taken. Written notes should be made of injuries and evidence of negative interactions with anthropogenic threats - impact trauma, entanglement and hooking etc. - to back up the photographic evidence. Note if tissue samples were taken.

Management relevance

Data derived from turtle captures may indicate local threats, such as fisheries interactions and boat strike etc. which informs management decisions on presence of fishing, marine vessels, travel speeds etc. Accumulated data on individual turtles reinforces the importance of marine habitats that require stricter management measures.

Reporting

A yearly report should include survey effort, number of turtles caught and total captures per species. Capture locations should be mapped per species. Size distribution of turtles that are present, and prevalence of anthropogenic impacts should also be reported. Recapture histories revealing residence times and possible associations with nesting areas (from records of 'alien' tags), should be included.

Collaboration potential

In-water capture-mark-recapture studies are very rare in the Mediterranean and none are carried out by local MPA staff, instead they are performed by NGO and academic groups, and this paradigm of operation is recommended to minimise disruption to MPA resources. These third parties should provide an annual report (as indicated above) to the MPA authority.

References

- Ehrhart LM & LH Ogren (1999) Studies in foraging habitats: Capturing and handling turtles. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 61-66.
- Rees AF, Margaritoulis D, Newman R, Riggall TE, Tsaros P, Zbinden JA, Godley BJ (2013) Ecology of loggerhead marine turtles *Caretta caretta* in a neritic foraging habitat: movements, sex ratios and growth rates. Marine Biology 160: 519-529.
- Rees AF, Carreras C, Broderick AC, Margaritoulis D, Stringell TB, Godley BJ (2017) Linking loggerhead locations: using multiple methods to determine the origin of sea turtles in feeding grounds. Marine Biology 164: 30.
- Schofield G, Klaassen M, Papafitsoros K, Lilley MKS, Katselidis KA, Hays GC (2020) Long-term photo-id and satellite tracking reveal sex-biased survival linked to movements in an endangered species. Ecology 101(7): e03027. Doi:10.1002/ecy.3027.

HABITAT - THREAT/MANAGEMENT

Coastal Development Monitoring

FACTSHEET 22

Standard ★

ASSOCIATED PROTOCOLS

Nest (and track) identification by species [8], Locating clutches [9], Relocating / Translocating clutches [10], Identification of nest hatching [12], Post-hatch excavation of clutches [13], *Beach suitability assessment for nesting [14],* Beach temperatures [15], *Beach surveys (ground) [16], Beach survey (drone) [17], Beach mapping [18], Light pollution monitoring and mitigation [23], Beach use monitoring and control [24],* Hatchling disorientation (recording and mitigation) [27].

MANPOWER

2-3

COST

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FREQUENCY

Seasonal to annual surveys can be scheduled with additional ad hoc mapping actions carried out when required for time-sensitive data capture.

Reason

Nesting beaches are geographically well-defined critical habitats for marine turtles controlling development that occurs near to them is essential for sustained environmental suitability and stability.

Context

Marine turtles require suitable nesting habitat to successfully incubate their nests and this habitat is a sandy beach with little or no anthropogenic impacts. Coastal development can harm the sustainability of nesting habitats in a variety of direct and indirect ways. Direct impacts include destruction of the beach platform, destruction of the dunes behind the beach which leads to reduced resilience of the beach to extreme weather events and light pollution that can deter turtle nesting and disorientate emerging hatchlings. Indirect impacts include increased beach use causing disturbances to nests and/or nesting turtles. Coastal development and other threats to nesting habitats are discussed in Witherington (1999).

Equipment

Minimum requirements would be a GPS unit and digital camera. Maximum requirements would be a drone (multirotor (E.g. Mavic, Phantom or Inspire; www.dji.com) or fixed wing (e.g. eBee; www.sensefly.com)) and multiple Terabyte hard drives for data storage.

Actions

The main outcome of this action is a GIS database of the state of the potential and actual nesting habitat with regard to anthropogenic development. In its simplest form developments are photographed with their GPS locations noted and this information is input into a GIS database. The most advanced form is completely aligned with the Beach mapping protocol in which two- or three-dimensional maps as created from drone imagery and they are incorporated into a GIS database where presence of development is categorised.

Ethics

Ethical issues arise in this protocol where imagery is recorded that may contain identifiable people. No imagery with identifiable people in should be published or shared.

Data to record

Date and location of observations to be recorded together with the camera or drone acquired imagery.

Management relevance

Monitoring coastal and near-coast development provides a reactive way to identify changes near the nesting environment that may impact nesting and hence require management and enforcement actions. An MPA manager should be aware of planned development within the MPA setting and armed with mapping and nesting data in order to robustly reject any inappropriate proposals for development.

Reporting

No regular reporting is especially required but may be useful if the action is funded by external partners. Reporting becomes important when changes occur to the development status of the area and evidence is required to support conservation and enforcement actions. Reports should show development changes at equivalent locations over time together with discussion on the foreseen and actual negative impacts the from the development.

Collaboration potential

Depending on MPA capacity, more frequent and labour-intensive surveying can be carried out by associated NGOs and academic groups that regularly report results back to the MPA management. Less frequent and ad hoc surveys can be carried out by trained MPA personnel. Collaborators should report any adverse development situations as soon as they are observed and not wait until the end of a reporting cycle.

References

- Witherington BE (1999) Reducing threats to nesting habitat. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 179-183.

Light pollution monitoring and mitigation

ASSOCIATED PROTOCOLS

Nest (and track) identification by species [8], Locating clutches [9], Relocating / Translocating clutches [10], Identification of nest hatching [12], Post-hatch excavation of clutches [13], *Beach suitability assessment for nesting [14]*, Beach temperatures [15], *Beach surveys (ground) [16], Beach survey (drone) [17], Beach mapping [18], Coastal development monitoring [22], Beach use monitoring and control [24]*, Hatchling disorientation (recording and mitigation) [27].

MANPOWER

2-3

COST

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FREQUENCY

Pre nesting season and pre hatching season surveys should be carried out to identify problematic lighting. Ad hoc surveys to take place at targeted locations where there is evidence of new light pollution impacts.

Reason

Light pollution can deter turtles from nesting in the illuminated area and disorientate emerging hatchlings thus reducing the effectiveness of the nesting habitat.

Context

Marine turtles prefer to nest on naturally dark beaches, as strong artificial illumination impacts their orientation and behaviour on the beach. Light pollution has an even more significant impact on hatchling turtles as they easily become disorientated or misoriented on the beach. This prolongs the time they are susceptible to terrestrial predation and entrapment and reduces their energy reserves required for the first days' swimming out to sea. Light pollution can take the form of light straying directly onto the beach from unobstructed sources or 'sky glow' caused by large amounts of lighting indirectly observed from atmospheric reflection.

Equipment

Equipment to accurately assess light pollution is hard to come by and generally the benefits of using it, over simple visual record, do not outweigh the effort and expense required in its acquisition and use. Consequently, no special equipment is required for this protocol.

Actions

Night time beach surveys, on foot, should be conducted so the observer can identify any problem light sources that will need remedial action to negate their impacts. The observer should walk the entire length of beach at the waterline.

There are a variety of options to mitigate against light pollution, such as removing, replacing or shading light sources and these are suitably dealt with in several texts, e.g. Witherington (1999) states:

> "There are many ways to alter light sources so that their effect on sea turtles is reduced (Witherington [et al. 2014]). Although permanent alterations are best, temporary alterations made during the nesting-hatching season can be sufficient to protect sea turtles. The most widely applicable solutions include the following:
>
> - 1. Turn lights off during the nesting-hatching season. This is the simplest, most effective, and least expensive solution, but it may not be accepted by property owners in cases where lighting is deemed essential for security or other reasons.
> - 2. Lower, shield, recess and/or redirect lights. These actions are effective to the extent that they reduce the amount of light reaching the beach. Dune vegetation, existing buildings, and opaque shields can be used to hide light sources from the beach. Fixtures that are designed to control light well and that are directed down and away from the beach are among the best types of lighting to use near sea turtle nesting beaches.
> - 3. Close curtains or blinds after dark and apply a dark tint or film to windows that face the beach. Light from the interior of buildings can also be reduced by moving lamps away from beach-side windows.
> - 4. Use light sources that sea turtles see poorly. Sources that emit very little short wavelength light (e.g., pure yellow and red sources) are less disruptive to nesting and hatchling sea turtles than are sources that emit a substantial amount of short- wavelength light (e.g., violet, blue, and green sources, or any source that appears whitish or golden). Low-pressure sodium vapor sources (not to be confused with high-pressure sodium vapor sources) are the purest yellow light sources and may be the best commercially available light sources for applications near nesting beaches. Yellow incandescent light bulbs, commonly called "bug lights," can be acceptable if used sparingly. Neither low-pressure sodium nor bug lights are completely harmless and they can affect some species more than others (Witherington et al. [2014]); therefore, they should be shielded or directed so that they are minimally visible from the beach."

The most recent authoritative and recommended text covering light pollution and its impacts on marine turtles and other wildlife is the National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds, Commonwealth of Australia 2020 available from https://www.environment.gov.au/biodiversity/publications/national-light-pollution-guidelines-wildlife.

Ethics

No ethical issues arise from this protocol.

Data to record

Any light source visible from the beach should be noted by describing its location, appearance, what type of lighting it is and methods by which it can be corrected (Witherington 1999).

Management relevance

Monitoring a nesting beach for light pollution prior to the nesting season and prior to the hatching season permits the manager to enact relevant light management and enforcement actions before problems with hatchling misorientation arise. Monitoring during the hatching season can prevent new and acute problems from affecting hatchlings. See table below for an extensive list of light management options.

Reporting

Similar to general development monitoring *(see Coastal development monitoring protocol factsheet n°22)* no regular reporting is especially required but may be useful if light pollution monitoring is funded by external partners. Reporting becomes important when changes occur to the illumination status of the area and evidence is required to support conservation and enforcement actions. Reports should show illumination changes at equivalent locations over time together with discussion on the foreseen and actual negative impacts the from the change.

Collaboration potential

It is recommended that MPA staff undertake the seasonal light surveys as they can quickly and authoritatively report problematic lights. Negative changes to night time illumination can be reported to the MPA by NGO or academic researchers that may be patrolling the beach to encounter nesting turtles, with enforcement actions then undertaken by the MPA authorities.

References

- Witherington BE (1999) Reducing threats to nesting habitat. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 179-183.
- Witherington BE, Martin RE, Trindell RN (2014) Understanding, assessing, and resolving light pollution problems on sea turtle nesting beaches, revised. Florida Fish and Wildlife Research Institute Technical Report TR-2. vii + 83 p.

Table (see next page) reproduced with minor modifications from: National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds, Commonwealth of Australia 2020 from https://www.environment.gov.au/biodiversity/publications/national-light-pollution-guidelines-wildlife

MANAGEMENT ACTION	DETAIL
Implement light management actions during the nesting and hatching season.	Peak nesting season for each stock can be found in the Recovery Plan for Marine Turtles in Australia.
Avoid direct light shining onto a nesting beach or out into the ocean adjacent to a nesting. beach.	Adult turtles nest in lower numbers at lit beaches.
Maintain a dune and/or vegetation screen between the nesting habitat and inland sources of light.	Hatchlings orient towards the ocean by crawling away from the tall, dark horizon provided by a dune line and/or vegetation. screen.
Maintain a dark zone between turtle nesting beach and industrial infrastructure	Avoid installing artificial light within 1.5 km of an industrial development.
Install light fixtures as close to the ground as practicable.	Any new lighting should be installed close to the ground and reduce the height of existing lights to the extent practicable to minimise light spill and light glow.
Use curfews to manage lighting.	Manage artificial lights using motion sensors and timers around nesting beaches after sunset.
Aim lights downwards and direct them away from nesting beaches.	Aim light onto the exact surface area requiring illumination. Use shielding on lights to prevent light spill into the atmosphere and outside the footprint of the target area.
Use flashing/intermittent lights instead of fixed beam.	For example, small red flashing lights can be used to identify an entrance or delineate a pathway.
Use motion sensors to turn on lights only when needed.	For example, motion sensors could be used for pedestrian areas near a nesting beach.
Prevent indoor lighting reaching beach.	Use fixed window screens or window tinting on fixed windows, skylights and balconies to contain light inside buildings.
Limit the number of beach access areas or construct beach access such that artificial light is not visible through the access point.	Beach access points often provide a break in dune or vegetation that protects the beach from artificial light. By limiting the number of access points or making the access path wind through the vegetation screen, light spill can be mitigated.
Work collectively with surrounding industry/private land holders to address the cumulative effect of artificial lights.	Problematic sky glow may not be caused by any one light owner/manager. By working with other industry/stakeholders to address light pollution, the effect of artificial light may be reduced more effectively.
Manage artificial light at sea, including on vessels, jetties, marinas and offshore infrastructure.	Hatchlings are attracted to, and trapped by, light spill in the water.
Reduce unnecessary lighting at sea.	Extinguish vessel deck lights to minimum required for human safety and when not necessary. Restrict lighting at night to navigation lights only. Use block-out blinds on windows.

Avoid lights containing short wavelength violet/ blue light.	Lights rich in blue light can include: metal halides, fluorescent, halogens, mercury vapour and most LEDs.
MANAGEMENT ACTION	**DETAIL**
Avoid high intensity light of any colour.	Keep light intensity as low as possible in the vicinity of nesting beaches. Hatchlings can see all wavelengths of light and will be attracted to long wavelength amber and red light as well as the highly visible white and blue light, especially if there is a large difference between the light intensity and the ambient dark beach environment.
Shield gas flares and locate inland and away from nesting beach.	Manage gas flare light emissions by: reducing gas flow rates to minimise light emissions; shielding the flame behind a containment structure; elevating glow from the shielded flare more than 30° above hatchling field of view; containing pilot flame for flare within shielding; and scheduling maintenance activity requiring flaring outside of turtle hatchling season.
Industrial/port or other facilities requiring intermittent night-time light for inspections should keep the site dark and only light specific areas when required.	Use amber/orange explosion proof LEDs with smart lighting controls and/or motions sensors. LEDs have no warmup or cool down limitations so can remain off until needed and provide instant light when required for routine nightly inspections or in the event of an emergency.
Industrial site/plant operators to use head torches.	Consider providing plant operators with white head torches (explosion proof torches are available) for situations where white light is needed to detect colour correctly or when there is an emergency evacuation.
Supplement facility perimeter security lighting with computer monitored infrared detection systems.	Perimeter lighting can be operated if night-time illumination is necessary, but remain off at other times.
No light source should be directly visible from the beach.	Any light that is directly visible to a person on a nesting beach will be visible to a nesting turtle or hatchling and should be modified to prevent it being seen.
Manage light from remote regional sources (up to 20km away).	Consider light sources up to 20km away from the nesting beach, assess the relative visibility and scale of the night sky illuminated by the light e.g. is a regional city illuminating large area of the horizon and what management actions can be taken locally to reduce the effect i.e. protect or improve dune systems or plant vegetation screening in the direction of the light.

Beach use monitoring and control

ASSOCIATED PROTOCOLS

Nest (and track) identification by species [8], Locating clutches [9], Relocating / Translocating clutches [10], Identification of nest hatching [12], Post-hatch excavation of clutches [13], *Beach suitability assessment for nesting [14],* Beach temperatures [15], *Beach surveys (ground) [16], Beach survey (drone) [17], Beach mapping [18], Coastal development monitoring [22]*, Light pollution monitoring and mitigation [23], Hatchling disorientation (recording and mitigation) [27].

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FREQUENCY

Pre-season checks should be carried out to ensure signage and beach access control measures are in place. Daily or weekly monitoring of beach use during the breeding season should be carried out to ensure management measures are being adhered to.

Protection measures in National Marine Park of Zakynthos - Greece © Boris Daniel

Protection measures in National Marine Park of Zakynthos - Greece © Boris Daniel

Reason

Inappropriate use of the beach can hinder nesting, destroy incubating clutches or hamper hatchlings from reaching the sea, hence some use management is required for nesting beaches.

Context

Beach use that is not conducive to successful marine turtle nesting through to hatchlings reaching the sea comes in various forms. Vehicles using the beach can crush clutches or hatchlings awaiting in the sand column to emerge, and the ruts made by their passage can prevent hatchlings from reaching the sea. Obstacles on the beach, ranging from piled fishing nets to deck chairs and boardwalks, can prevent nesting turtles from reaching a suitable spot to deposit their eggs or obstruct hatchlings from reaching the sea. Any activity on the beach at night-time, such as people taking a stroll or congregating around a fire, can deter turtles from nesting and increase the likelihood of hatchlings getting trampled. Beach access and beach use therefore needs to be controlled, at least during the summer breeding season.

Equipment

No specific equipment is required to monitor beach use, however signage can be used and control measures placed at beach access points to inform beach users and limit beach access.

Actions

Information boards and access control measures such as gates or chains should be put in place for the start of the breeding season and seasonal staff can be hired as rangers that are stationed at beach access points and/or patrol the beach to enforce management measures. Photographs should be taken of improper beach use or the results of improper beach use which can be used as evidence for enforcement and control. Further details on this and other threats to nesting beach habitat are described in Witherington (1999) and an example of evidence-based management at an important marine turtle rookery has been published by Katselidis et al. (2013). MedPAN has published a handbook for managers covering monitoring visitor use in MPAs (Le Berre et al. 2013) to which the MPA manager should refer.

Ethics

Aside from not sharing images in which people can be personally identified (unless the person is the subject of the issue), no ethical issues arise from the use of the protocol.

Data to record

Details of infractions of beach use management measures should be recorded by date and location. These may include the number of people present when there are restrictions, vehicular use of the beach or presence of beach furniture above permitted levels or placed in non-permitted manner.

Management relevance

Excessive and inappropriate beach use may impact successful nesting, incubation and hatching of turtle nests. Monitoring outside of the nesting season can ensure management measures are in place ready for the nesting season and monitoring during the nesting season can highlight MPA contraventions and reactive management adjustments, such as spread of banned beach furniture or vehicular use of the beach via a previously closed-off entrance.

Reporting

The MPA authority should keep a record of beach use measures and their effectiveness in order to justify their continuation or adaptation for improved results. Frequent reporting of these data by the MPA are not required, however if the monitoring is carried out by a third party, e.g. NGO or academic group, the third party should provide the MPA with a midseason and end of season report on beach use and contact the MPA immediately should any serious acute problems be identified.

Collaboration potential

Basic monitoring and management should be carried out by seasonal or permanent MPA staff however more intensive monitoring, combined with nest monitoring and protection measures can be carried out by third parties, such as NGOs or academic groups that regularly report back to the MPA management, including immediate contact with the MPA management if serious infractions are observed.

References

- Katselidis KA, Schofield G, Stamou G, Dimopoulos P, Pantis JD (2013) Evidence-based management to regulate the impact of tourism at a key marine turtle rookery on Zakynthos Island, Greece. Oryx 47(4): 584-594.
- Le Berre S, Peuziat I, Le Corre N, Brigand L (2013) Visitor use observation and monitoring in Mediterranean Marine Protected Areas. MedPAN North project. WWF-France and Parc National de Port-Cros. 58 p.
- Witherington BE (1999) Reducing threats to nesting habitat. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 179-183.

Protection measures in Dalyan-Mugla - Turkey © M.MABARI MedPAN

ANIMAL - THREAT/MANAGEMENT

Nest predation (repairing)

FACTSHEET 25

Standard

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ASSOCIATED PROTOCOLS

Nest (and track) identification by species [8], Locating clutches [9], Relocating / Translocating clutches [10], *Nest protection against predation [11],* Identification of nest hatching 12], Post-hatch excavation of clutches [13], *Beach surveys (ground) [16]*, Beach survey (drone) [17].

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FREQUENCY

On encounter with a depredated nest.

Nest monitoring in Kuriat Island - Tunisia
© Notre Grand Bleu

Reason

Clutches are often not fully devoured when first depredated, which means timely remedial action can result in the remaining eggs incubating safely through to hatching.

Context

Foxes and other canids often devour only part of a clutch during the first attack on a nest and then subsequently revisit the nest over following days to complete the predation. Additionally, even if the no further depredation occurs, any broken eggs in the nest are likely to spill over intact eggs and encourage infection that can kill them. Therefore, timely and effective nest repair after the first attack, can prevent additional loss of recruitment to the year's cohort of hatchlings.

Actions

If the nest had any protection measures in place, remove them so that you can access the nest site with no restrictions. Remove broken eggs and egg fragments from around the nest. Carefully dig, only using hands (no implements), into the debris in the egg chamber to remove soiled sand and broken eggs that remain near the clutch, and to identify if any intact eggs remain. If there are still intact eggs in the nest, they should be reburied to allow them to continue their incubation. Take some warm, moist sand from a nearby location on the beach and place it over the remaining eggs filling the pit created by the predator to near normal beach level, noting the position of the centre of the nest. It is not necessary to completely fill the hole as this will unduly increase the amount of sand the hatchlings will need to climb through to reach the beach surface. Once the clean sand has been placed over the remaining eggs, nest protection measures can be (re)placed to reduce the success of any subsequent predation attempts. At this time any anchoring stakes used to fix the protective screens in place should only be pushed into the sand and not hammered. This is to not cause any potentially damaging vibrations that may affect the remaining eggs.

Ethics

As live turtle eggs in an incubating nest are potentially being touched and the nest environment is being manipulated, permits will be required to complete this task. No ethical issues arise from the purpose of the task, which is to minimise loss of hatchlings that will contribute to the yearly cohort.

Data to record

The date, nest code, and number of eggs seen to be dug out by predators should be recorded along with if the nest has been completely depredated or not. If the predator species is known, this should be recorded too.

Management relevance

This protocol helps increase the number of hatchlings recruiting to the population in a year's cohort, which is a management goal.

Reporting

At the end of the season the number and percentage of nests on a beach that were depredated should be reported together with the number of nests that still managed to produce some hatchlings despite predation.

Collaboration potential

Repairing nests from predation should be carried out by the team that is most frequently on the beach carrying out nesting surveys.

Nest inundation (repairing)

ASSOCIATED PROTOCOLS

Locating clutches [9], Relocating / Translocating clutches [10], Nest protection against predation [11], Identification of nest hatching [12], Post-hatch excavation of clutches [13], *Beach suitability assessment for nesting [14]*, Beach temperatures [15], *Beach surveys (ground) [16]*, Beach survey (drone) [17], Beach mapping [18].

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FREQUENCY

On encounter with an inundated nest.

Reason

Inundation by sea water over marine turtle nests reduces oxygen availability to the incubating eggs and can kill them, therefore anything done to reduce the impact of an inundation event may decrease the reduction in hatching success for the nest.

Context

Incubating marine turtle eggs require gas transfer into and out of the eggs and egg chamber in order to survive. Complete inundation of a clutch from wave overwash can be catastrophic for the incubating eggs as it reduces the amount of gaseous transfer, infills the air spaces between eggs with washed in sand and the chemical composition of sea water can affect metabolism (Ackerman 1997). However, wave overwash often does not completely inundate a nest and only the surface layer of sand gets saturated. Especially in these cases remedial interventions can help with maintaining good hatching success from nests.

Actions

When an inundated nest is encountered, and the wave overwash events have ceased, the wet sand above the clutch should be dug and loosened by hand to decompact it, speed drying and facilitate gaseous exchange down to the clutch. In bad cases of wave overwash extra sand may be deposited over the clutch, creating an overly deep nest that will exacerbate problems of poor gas exchange and efforts necessary by emerged hatchling to climb through the sand column to reach the beach. In these cases, the additional layer of sand should be cleared away so that the clutch is within the normal range of depths.

Ethics

As for repairing a nest after depredation, live turtle eggs in an incubating nest are potentially being touched and the nest environment is being manipulated, permits will be required to complete this task. No ethical issues arise from the purpose of the task, which is to minimise loss of hatchlings that will contribute to the yearly cohort.

Data to record

The date, nest code and the extent of inundation should be recorded. The extent can be recorded with three factors. 1) The distance waves passed over the nest in the case of inundation from overwash, 2) the depth to which the sand was wetted, and 3) the amount of sand deposited or eroded from the nest site due to inundation activity.

Management relevance

This protocol helps increase the number of hatchlings recruiting to the population in a year's cohort, which is a management goal. Locations where inundations occur need to be recorded so that relocation guidelines for following seasons can be updated.

Reporting

At the end of the season the number and percentage of nests on a beach that were inundated should be reported together with the number of nests that still managed to produce some hatchlings despite inundation. Occurrence and distribution of nest inundations can be used to inform and adapt relocation guidelines, based on nest height above sea level or distance from sea, for the future year's conservation efforts.

Collaboration potential

Repairing nests from inundation should be carried out by the team that is most frequently on the beach carrying out nesting surveys.

References

- Ackerman RA (1997) The nest environment and embryonic development of sea turtles. In: Lutz PL & JA Musick (Eds.), The Biology of Sea Turtles, Vol 1. CRC Press, Washington DC, USA. Pp. 83-106.

Hatchling disorientation (recording and mitigation)

ASSOCIATED PROTOCOLS

Locating clutches [9], Relocating / Translocating clutches [10], Nest protection against predation [11], *Identification of nest hatching [12],* Post-hatch excavation of clutches [13], Beach suitability assessment for nesting [14], *Beach surveys (ground) [16]*, Beach survey (drone) [17], *Beach mapping [18*], *Coastal development monitoring [22], Light pollution monitoring and mitigation [23].*

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FREQUENCY

To prepare for or on encounter with hatchling disorientation.

Nest monitoring in Kuriat Island - Tunisia
© Notre Grand Bleu

Reason

Sometimes light management is insufficient to prevent hatchling disorientation and mitigation measures are needed to ensure the hatchlings can make it safely to the sea with minimal interference. At other times records of natural dispersal of hatchlings from the nest site can be useful to detect any undue influence of light pollution.

Context

At worst, light pollution keeps hatchling turtles from heading directly to the sea, thus increasing their chances of being depredated on the beach, getting lost so they never reach the sea or using up vital energy reserves as they wander aimlessly. There may be situations in the MPA where lighting management measures do not fully resolve the light pollution issue facing hatchling marine turtles. This can be the case in areas with sporadic nesting where light issues have not been fully assessed or resolved. In these cases, manipulations around the nest to shade a path for hatchlings to use or restricting hatchling movement, with boxes or cages, so they can be collected and safely released should be used. Under less extreme conditions hatchlings may become only marginally less orientated to the sea, but these indications imply that action should be taken to prevent any worsening of light pollution.

Equipment

Monitoring natural hatchling dispersal requires a 5m tape measure and a compass. Nest shades can be constructed from straw beach mats or other mostly opaque material supported by wooden stakes. Nest boxes can be made from any container with a 40cm diameter opening at the bottom, e.g. large washing bowl.

Setting up a nest shade around a nest that has been caged to prevent human disturbance (Left) and a boxed nest that has been screened to prevent predation (right) – some of the metal screen has been uncovered to show the set up. Note in both instances there is an informative sign placed at the nest to indicate this is a protected marine turtle nest.

Actions

- Assessing natural hatchling dispersal is carried out by measuring and marking an arc in the sand that encompasses all the hatchling tracks 5m from the nest site.
- Mitigating measures against problematic light pollution should be put in place from around 44 days of incubation to ensure no early hatching nests are missed. Nest shades are constructed so that a runway is placed around the nest site and extends to the water's edge thus restricting the hatchlings movement between the nest and the sea. This is useful when there is low-level light pollution and no manpower available for nocturnal patrols. Nest boxes are placed, at dusk, centrally over the nest site and weighed down with objects on top or sand built up around the edges. For example, an inverted washing bowl with

an access hole cut from the base, placed over the nest can be held in place with sand piled up over the rim and around the edges. These boxes need to be checked frequently through the night (at least hourly) to retrieve any emerged hatchlings so they can be taken, in a bucket or other suitable container, to a nearby dark area of beach. The boxes need to be removed at first light so that any day-emerging hatchlings are not trapped on the nest and killed by exposure to day-time temperatures. Boxing nests provides access to hatchlings that will not otherwise be encountered and advantage of this opportunity should be taken by carrying out additional research projects such as weighing and measuring a sample of the hatchlings and recording scute patterns to detect frequency of abnormalities.

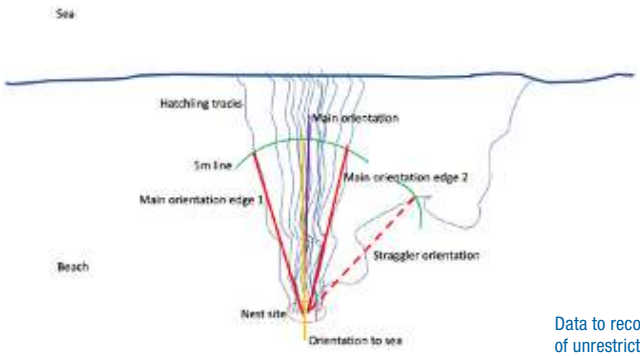
- During full moon nights the brightness of the moon often negates anthropogenic light pollution and nest shading or boxing can be halted for those nights. This moon effect should be tested before halting mitigation measures and note that the moon may not be visible throughout the night, so timing is important.

Ethics

Ethical issues come from boxing nests to temporarily retain hatchlings at the nest site before transporting them to another section of beach. This activity will need permits to carry out. Two ethical factors to consider are that 1) night patrolling will be constant to schedule so that no hatchlings are left on the beach for longer than necessary and 2) boxes used in areas of nest predation are sufficiently robust and covered to prevent predators from reaching the retained hatchlings.

Data to record

Data for unrestricted hatched nests are recorded as follows. Using a compass note the angle direct to the sea (count as 0), the angles at the edges of the spread of the main hatchling tracks (-degrees to the left of the direct path to the sea and +degrees to the right side of the direct path) and the main orientation of tracks if there is a defined area in the spread with most tracks. Also note the angles of any stragglers that are not included in the main spread of hatchling tracks.



Data to record as evidence of unrestricted hatchling dispersal.

For shaded nests the nest code and date of hatching should be recorded along with the estimated number of hatchlings that made it to the sea and the number of any hatchlings that did not make it to the sea as they escaped the shade or for some other reason. For boxed nests the nest code, timing of hatchling collection and number of hatchlings collected per visit should be recorded. As there will be no evidence on the beach that the nest has hatched the date of hatching needs to be shared with any teams carrying out morning patrols *(see Identification of nest hatching protocol factsheet n°12)*.

Management relevance

When elimination of light pollution has proven ineffective or an acute issue arises and there is not sufficient time to deal with the light source, this protocol helps increase the number of hatchlings recruiting to the population in a year's cohort, which is a management goal. Recording the spread and direction of hatchling tracks can indicate if light pollution is beginning to affect hatchlings in an area and that more effective management and control are likely to be required in the future as the tracks will be skewed to the direction of the light source.

Reporting

Reporting on natural hatchling dispersal should be carried out at the end of the breeding season. The beaches should be subdivided to highlight where potential problems are arising, and this information used to prepare for the following season. Reports on mitigation of disorientation should include the locations and number of nests where measures were taken, and an estimated number of hatchlings saved as a result of these measures. Again, the information provided should be used as evidence for the MPA to undertake further light control measures in these affected areas.

Collaboration potential

Basic monitoring, management and mitigation can be carried out by seasonal or permanent MPA staff however more intensive monitoring can be carried out by third parties, such as NGOs or academic groups that report back their findings to the MPA on a seasonal basis. But if any significant new lighting issues arise during the season (inferred from misorientation of hatchlings in an area where there was none) these should be reported immediately to the MPA authority.

Dealing with dead strandings

ASSOCIATED PROTOCOLS

Species ID [1], Measuring turtles [2], Sexing turtles [3], Flipper tagging [5], PIT tagging [4,] Photo ID [6], *Tissue sampling [7], Beach surveys (ground) [16], Beach survey (drone) [17]*, Dealing with live strandings [29], Fisheries interactions (bycatch) [30], Marine traffic management [32], Pollution [33], Plastic ingestion [34], Necropsy [31].

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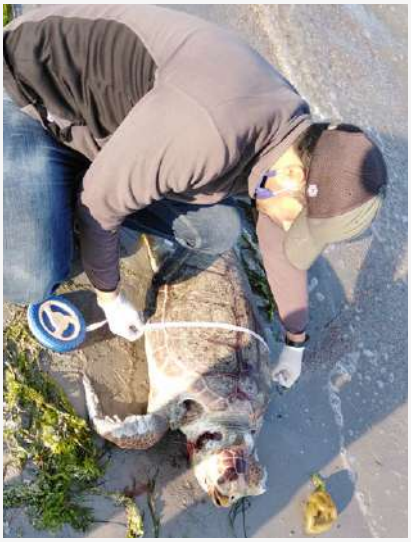
FREQUENCY

On encounter with a dead stranded turtle.



Stranded marine turtle in Kuriat Island - Tunisia
© Notre Grand Bleu

Reason

Turtles that die at sea often wash up or strand on the shore. Analysing data obtained from these animals can give an idea of which turtle life stages are present and what is affecting them.

Context

Marine turtles that become sick, injured, debilitated or die out at sea frequently are carried ashore and strand on the coastline. Recording data on the individual turtle and determining the cause of the stranding can help identify the demographic use of the MPA by the turtles and the threats at sea that are impacting these turtles. These threats may be boat strikes, entanglement, illness or deliberate injury etc. Understanding the threats will facilitate better targeted conservation and enforcement measures.

Equipment

The simplest field stranding kit should contain a camera, tape measure, forceps and scalpel blade, sample tubes filled with 70% (or stronger) ethanol and surgical gloves. A slightly more complex kit would include callipers for recording straight carapace measurements in addition to curved measurements taken using the tape measure and a PIT tag reader. More in depth investigations can be carried out on the stranded turtle if it is transported to a laboratory for necropsy *(see Necropsy protocol factsheet n°31)*.

Actions

The turtle carcase should be photographed to show species-characterising features and any obvious potential causes for the stranding (entanglement in fishing gear etc.). The flippers should be checked for external tags and PIT tags if a scanner is available. Carapace measurements should be recorded. If the carcase is fresh, small skin biopsies should be taken for genetic and other studies. For less fresh animals, deeper incisions to access and sample intact muscles in the shoulder region are advised. Further, in depth, protocols for determining the cause of death in marine turtles are available in Wolke (undated). Once all required data have been recorded the carcase should be disposed of in accordance with national guidelines. If the carcase is to be left in situ, it should be marked using spray paint to identify it as having already been reported and recorded as a stranding.

Ethics

Handling a dead turtle may pose health risks to the observer and should be considered during the interaction. Handling dead turtles will probably require permits, as they are endangered species, and should only be carried out by authorised and trained personnel.

Data to record

Date, location, turtle species, carapace size (curved and straight carapace lengths and widths), tail length, evidence of injury or entanglement or no obvious signs of cause of death. Decomposition state (fresh, partial, advanced, mummified; INDICIT 2018). Also, the number and type of coded tissue samples should be recorded.

Management relevance

An increase in strandings in time and space should raise alarm bells for MPA managers that conditions at sea are deteriorating. Processing each stranded turtle will help identify what has caused the death and hence identify the management need. For example, there may be a spate of strandings of turtles with head injuries near to a coastal port, which would suggest a local sea user is purposefully injuring and killing turtles and this would stimulate enforcement action in the area.

Reporting

A press release can be issued for a single stranding if it is unusual or has any significance, or if there is a spate of strandings occurring in a short interval at a single location. Otherwise an annual report (combining live and dead stranded turtles) should be produced summarising the kinds of turtles found, where they have been found and the prevalence of different threat that have caused the strandings. This report can then be used to direct MPA resources for improved conservation and enforcement measures, if indicated.

Collaboration potential

Stranding response can be carried out by trained MPA personnel or by third party NGO or academic groups. Each stranding dealt with by a third party should be promptly reported to the MPA authority in addition to featuring in a summary report submitted to the MPA by the third party. Data on each stranding should be shared with the national stranding network if one exists and a regional network when initiated.

References

- INDICIT Consortium (2018) Monitoring Marine Litter Impacts on Sea Turtles. Protocol for the collection of data on ingestion and entanglement in the loggerhead turtle (*Caretta caretta* Linnaeus, 1758). 22 p. https://indicit-europa.eu/protocols/
- Wolke RE (undated) Protocol for determining cause of death in sea turtles. NMFS Contract NA81-GA-C-0050.

Dealing with live strandings

ASSOCIATED PROTOCOLS

Species ID [1], Measuring turtles [2], Sexing turtles [3], Flipper tagging [5], PIT tagging [4], Photo ID [6], *Tissue sampling [7], Beach surveys (ground) [16], Beach survey (drone) [17]*, Dealing with dead strandings [28], Fisheries interactions (by-catch) [30], Marine traffic management [32], Pollution [33], Plastic ingestion [34].

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FREQUENCY

On encounter with a live stranded turtle.

Rehabilitation of a marine turtle © Notre Grand Bleu

Reason

Turtles that are injured or become debilitated at sea often wash up or strand on the shore. Analysing data obtained from these animals can give an idea of what turtles are present and what is affecting them.

Context

Marine turtles that become sick, injured or debilitated out at sea frequently are carried ashore and strand on the coastline. Recording data on the individual turtle and determining the cause of the stranding can help identify the demographic use of the MPA by the turtles and the threats at sea that are impacting these turtles. These threats may be boat strikes, entanglement, illness or deliberate injury etc. Understanding the threats will facilitate better targeted conservation and enforcement measures. As the turtle is alive at stranding there is a chance it can be rehabilitated if given the correct treatment or humanely euthanised if deemed unrecoverable, therefore, where possible, the live turtle should be transported to a rehabilitation or veterinary centre for assessment.

Equipment

As fresh-dead stranded turtles are often mistaken as alive it is useful to take a simple field stranding kit to the scene when a live turtle is reported *(see Dealing with dead strandings protocol factsheet n°28)*! A suitably sized box or container, towels and petroleum jelly, together with a bottle of water are needed to transport a live turtle.

Actions

Size measurements can be taken if there is any delay in transporting the stranded turtle. Ropes and lines that are found tightly constricting limbs, so that the limb itself appears swollen or necrotic, should NOT be removed on site. The transported turtle should be protected from any extremes of heat or cold. They need to be protected inside their transport container with towels, which can be wetted in hot conditions. Smaller turtles can be smeared with petroleum jelly except for their eyes and any open wounds. Transport to the assessment facility should be carried out promptly following reporting of the live stranded turtle. Further information on this topic is presented in FFWCC (2016).

Ethics

Permits should be held to handle and move live stranded turtles and the assessment facility should be permitted and have the required expertise in dealing with sick and injured marine turtles.

Data to record

Date, location, turtle species, carapace size (curved and straight carapace lengths and widths), tail length, evidence of injury or entanglement to be recorded in situ, however the size measurements and other observations can be taken at the assessment facility and not at the strand site if immediate transport is available.

Management relevance

An increase in strandings in time and space should raise alarm bells for MPA managers that conditions at sea are deteriorating. Processing each stranded turtle will help identify what has caused the animal to wash ashore and hence identify the management need. For example, there may be a spate of strandings of turtles with head injuries near to a coastal port, which would suggest a local sea user is purposefully injuring and killing turtles and this would stimulate enforcement action in the area.

Reporting

A press release can be issued for a single stranding if it is unusual or has any significance, or if there is a spate of strandings occurring in a short interval at a single location. Otherwise an annual report (combining live and dead stranded turtles) should be produced summarising the kinds of turtles found, where they have been found and the prevalence of different threat that have caused the strandings. This report can then be used to direct MPA resources for improved conservation and enforcement measures, if indicated.

Collaboration potential

Stranding response can be carried out by trained MPA personnel or by third party NGO or academic groups. Each stranding dealt with by a third party should be promptly reported to the MPA authority in addition to featuring in a summary report submitted to the MPA by the third party. Data on each stranding should be shared with the national stranding network if one exists and a regional network when initiated.

References

- FFWCC (Florida Fish and Wildlife Conservation Commission) (2016) Marine turtle conservation handbook. https://myfwc.com/media/3133/fwc-mtconservationhandbook.pdf accessed on 1 April 2020.

Marine turtle entangled in fishing-line in Turkey © DEKAMER Archives

Fisheries interactions (bycatch)

ASSOCIATED PROTOCOLS

Species ID [1], Measuring turtles [2], Sexing turtles [3], Flipper tagging [5], PIT tagging [4], Photo ID [6], Tissue sampling [7], Marine survey (plane) [19], Marine survey (drone) [20], Dealing with dead strandings [28], Dealing with live strandings [29], Marine traffic management [32], Pollution [33], Necropsy [31], Questionnaires [35].

MANPOWER

1+ (depending on methods chosen i.e. if onboard observers are used to monitor bycatch).

COST

€ - €€€€

FREQUENCY

A bycatch log should be kept at all times by all fishers operating in the marine park.

Rescuing a marine turtle with fishermen in Kuriat Island - Tunisia © Notre Grand Bleu

Reason

Fishery interaction is one of the main threats facing marine turtles. Monitoring the impacts of fishing permitted in the MPA can inform managers if adaptations to minimise impacts on turtles are required.

Context

Bycatch and other interactions with fisheries are of major concern for marine turtle conservation, as high direct mortality rates and unquantified delayed mortality occur from such events. The type of gear used and how it is used can affect the chances of turtle survival. E.g. reducing soak time in trawls gives any captured turtles a chance to survive as they may be able to breath hold and not drown. Monitoring fishing activity within the MPA with quantified bycatch levels will aid managers decision making if adaptations, such as spatial or temporal closures or changes in gear types are required to protect turtles.

Equipment

Minimum equipment comprises a GPS recorder, tape measure, camera. This can be supplemented with flipper and PIT tags and metal callipers if the fisher is trained and willing to tag turtles and take straight carapace measurements before releasing the turtle back to the sea.

Actions

- Self reporting fishing activity and bycatch incidents should be the minimum activity for fishers in the MPA. For larger vessels, on-board observers may be deployed to record fishing effort and bycatch. Live healthy bycaught turtles should be released back to the sea – ideally having been tagged. Live injured turtles can be brought ashore if facilities exist to aid their recuperation and dead turtles can be brought ashore for accurate biometric records, necropsy and tissue sampling.
- The following texts are useful resources covering various aspects of fisheries monitoring and handling bycaught turtles FAO Fisheries and Aquaculture Department (2009) FAO General Fisheries Commission for the Mediterranean (undated), Gerosa and Aureggi (2001), NMFS-SEFSC (2008) and Oravetz (1999).

Ethics

Bycatch of marine turtles is unintentional so if the fishing activity is permitted each bycatch event is an unfortunate incident where the fisher should not be held accountable. However, if the fishing activity is not permitted or the fisher causes deliberate harm to a bycaught turtle this should be firmly addressed. Given the unique interaction and experience of fishers in encountering marine turtles, it is useful for cooperative fishers to be trained and permitted to tag and measure bycaught turtles prior to release.

A loggerhead marine turtle rescued from an ingested hook in Turkey © DEKAMER Archives

Data to record

The date and location of fishing activity, together with gear used should be logged with soak time of the line or nets. Marine turtles and other megafauna bycatch should be photographed, and biometric data recorded along with condition of the turtle and outcome of the interaction.

Management relevance

Fisheries management within an MPA will ideally be prescribed so that no marine turtles are bycaught or if bycatch is a possibility, that the fishing methods and practices used by fishers result in minimum harm to the bycaught turtles. Revision of existing management measures is indicated if bycatch data is obtained that reveals turtles are being negatively impacted within the MPA.

Reporting

Fisheries activity and marine turtle bycatch interactions should be reported at least yearly and preferably quarterly. Overall number of bycaught turtles together with catch per unit effort and mortality rates should be determined for all gear types. Bycatch should be also broken down by species and location to understand which fishing activities are impacting the turtles the most in the MPA and if they are occurring at sustainable levels. Reporting by third parties needs to be shared with MPA authorities promptly and frequently and any unusual or illegal fishing activity should be reported immediately.

Collaboration potential

Managing self-reporting fisheries within the Marine Park should be carried out by MPA personnel or by a relevant dedicated fisheries management authority. If on-board observers are to be used, they too can be MPA staff or those from a fisheries authority or possibly sourced from an NGO or academic group.

References

- FAO Fisheries and Aquaculture Department (2009) Guidelines to reduce sea turtle mortality in fishing operations. FAO, Rome. 128p. http://www.fao.org/3/i0725e/i0725e.pdf
- FAO General Fisheries Commission for the Mediterranean (undated) UNEP MAP, SPA/RAC http://www.fao.org/3/i8951en/I8951EN.pdf
- Gerosa G, Aureggi M (2001) Sea turtle handling guidebook for fishermen. UNEP MAP, RAC/SPA (available in English, Spanish, Greek, Croatian, Turkish, Slovenian, Italian, Maltese and Arabic) and teaching book available in English and Spanish from https://www.rac-spa.org/publications
- NMFS-SEFSC (National Marine Fisheries Service Southeast Fisheries Science Center) (2008) Careful release protocols for sea turtle release with minimal injury. NOAA Tech. Memo. NMFS-SEFSC-580. 130p.
- Oravetz CA (1999) Reducing incidental catch in fisheries. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 189-196.

Necropsy

ASSOCIATED PROTOCOLS

Species ID [1], Measuring turtles [2], Sexing turtles [3], Flipper tagging [5], PIT tagging [4], Photo ID [6], *Tissue sampling [7],* Beach surveys (ground) [16], Beach survey (drone) [17], Dealing with dead strandings [28], Fisheries interactions (by-catch) [30], Marine traffic management [32], Pollution [33], Plastic ingestion [34].

MANPOWER

1-2

COST

€-€€

FREQUENCY

On encounter with a dead turtle.

Observation of a marine turtle in Kuriat Island - Tunisia
© Notre Grand Bleu

Reason

Necropsies can reveal a lot of information on the status of marine turtles in the MPA. In terms of their foraging ecology, susceptibility to pollution, and the various threats causing mortality.

Context

The unfortunate death of a turtle should not be wasted and as much scientific data should be obtained from it as possible. In addition to obtaining the basic species and size of turtles, necropsies permit additional data and sample gathering such as sexing turtles from direct observation of their gonads, tissue sampling for pollutant loads, stomach sampling for foraging ecology and marine debris ingestion studies as well as identifying health condition and possible causes of death.

Equipment

Equipment required varies according the precise purpose of the necropsy and what procedures will be carried out. Minimum equipment will be a tape measure, a large knife to open the turtle and scalpel, forceps and sample tubes filled with ethanol. A good example of a basic necropsy kit is given in Work (2000).

Actions

- Basic skin sampling should be performed for all dead turtles to provide tissues for genetic and other studies *(see Tissue sampling protocol factsheet n°7)*. Undertaking a necropsy requires a detailed guide for each aspect of the process and is too complicated to be suitably addressed within the text of this protocol outline. The reader is referred to the several guides available on marine turtle necropsy and anatomy (Wolke 1981, Work 2000, Wyneken 2001) for instructions.
- The completeness of a necropsy will partly depend on the decomposition state of the subject animal. All observations should be possible from fresh dead and recently dead specimens, whereas only gross observations of external characteristics (that may include possible cause of death) from carcasses in more advanced stages of decomposition.

Ethics

Necropsies should be undertaken by authorised and trained personnel to ensure correct procedures are followed and accurate data and descriptions are recorded. As turtles are already dead there are no ethical issues arising from handling the turtles, but permits will be required in general to handle these endangered species.

Data to record

Turtle species, size and cause of death (if determined) should be recorded together with all samples taken for future analysis. Refer to the necropsy guides (Wolke 1981, Work 2000) for details of other records to be kept.

Plastics extracted after necropsy © DEKAMER Archives

Management relevance

Necropsies determine the cause of death for individual turtles. Accumulating a dataset on necropsies of turtles from within the MPA setting can highlight to managers what is killing the turtles and hence mitigation and management measures to eliminate this threat can be inferred. Special attention should be given to emerging threats that cause an unusual number of deaths within a period of time.

Reporting

Annual summaries on the findings from necropsies: turtle demographics, causes of death etc. should be reported along with the sources of the turtles. These data should be combined with other stranding and bycatch data to provide a holistic view of the conservation status of marine turtles within the MPA. As the necropsies are derived from dealing with strandings, all data should be included in stranding reports that are shared with national and regional networks.

Collaboration potential

Necropsies can be carried out by trained MPA staff should appropriate facilities exist, but more commonly they should be carried out by designated veterinarians associated with the MPA or via NGO/academic collaborations. Third parties undertaking rescue and rehabilitation operations should have capabilities to complete suitable marine turtle necropsies.

References

- Wolke RE (1981) Sea turtle necropsy manual. NOAA Tech. Memo. NMFS-SEFC-24. 20p.
- Work T (2000) Sea turtle necropsy manual for biologists in remote refuges. US Geological Survey. NWHC-HFS 25pp. (Available in English www.tortuesmarinesguadeloupe.org/wp-content/uploads/2015/01/Manuel-de-n%C3%A9cropsie-de-tortues-marines-pour-biologistes-en-refuges-%C3%A9loign%C3%A9s-Thierry-M.-Work-DVM-..pdf).
- Wyneken J (2001) The anatomy of sea turtles. NOAA Tech. Memo. NMFS-SEFSC-470. 172p.

HABITAT - ANIMAL - THREAT/MANAGEMENT

Marine traffic management

FACTSHEET 32

Standard ★

ASSOCIATED PROTOCOLS

Marine survey (plane) [19], Marine survey (drone) [20], Dealing with dead strandings [28], Dealing with live strandings [29], Fisheries interactions (bycatch) [30], Necropsy [31], Pollution [33], Plastic ingestion [34].

MANPOWER

1+

COST

€€ - €€€€ Depending on management and enforcement decisions.

FREQUENCY

After initial designation, management measures should be reviewed every decade, to assess efficacy of existing rules, and updated to ensure effective conservation measures based on strong scientific data are in place.

Map of the National Marine Park of Zakynhtos - Greece
© Laurent Sourbès

Reason

Marine traffic, especially in shallow habitats with high densities of turtles, can negatively affect both the habitat quality and turtle safety. Thus, restrictions and monitoring should be in place to preserve good conservation status.

Context

Excessive marine traffic can affect habitat quality especially in shallow and enclosed habitats where pollution and/or anchorage can degrade water quality and benthos. Additionally, boats, especially travelling at speed in shallow areas with high densities of marine turtles, create an increased risk of impact trauma, from hulls or propellers striking turtles at or near the surface. Temporal, spatial and velocity restricting measures applied to marine traffic can help reduce its impact on marine turtles and potentially multiple other species in Marine Protected Areas.

Equipment

Equipment may include marker buoys to delimit marine areas where different restrictions apply, signage at local ports and docks to highlight boating restrictions within the MPA and lastly a boat used by staff for compliance monitoring and enforcement.

Actions

Marine areas should be mapped and zoned according to habitat type and turtle presence and use. Restrictions on permissible boat types, speed of travel and mooring are applied to each zone, with potential for season variations in restrictions depending on seasonality of turtle presence. Requirement for adaptations to boats (such as propeller guards) can also be imposed. Compliance monitoring and enforcement should take place regularly to ensure effective protection is being afforded the turtles in the MPA. The National Marine Park of Zakynthos (http://www.nmp-zak.org/en) is long-established to protect marine turtles in an area with high use by marine traffic. Zonation of this MPA can be used as an indicative guide to the establishment of zones in other locations. MedPAN has published a handbook for managers covering monitoring visitor use in MPAs (Le Berre et al. 2013) to which the MPA manager can also refer.

Ethics

The main ethical consideration is the affect that new restrictions may have on traditional use of the area and how they may negatively financially impact local stakeholders. Alternative options, compromises and compensation may need to be supplied to ensure buy-in and compliance with the new measures.

Data to record

The main data to record are the incidences of violations to the marine traffic regulations together with the number of boats permitted in the area. Individual boats or skippers should be noted to record repeat offences that can lead to education or enforcement measures. Records of any turtles killed or injured by non-obeyance of the marine traffic regulations should also be kept.

Management relevance

Effective marine traffic management will eliminate death and injury to turtles where there is overlap. If strandings and marine surveys indicate there are turtle deaths occurring in restricted areas, then zonation of management measures should be reviewed, and appropriate enforcement actions completed to ensure compliance with MPA laws.

Reporting

The number and type of regulation violations should be reported together with the number of turtles affected by non-compliance. The reporting can be carried out seasonally or annually.

Collaboration potential

Monitoring can be carried out by MPA staff or by NGO and academic field teams that may be carrying out other research and monitoring activities in the MPA. Any third-party monitoring teams need to be in close and frequent communication with the MPA authority, so that serious offences against regulations can be acted upon immediately.

References

- Le Berre S, Peuziat I, Le Corre N, Brigand L (2013) Visitor use observation and monitoring in Mediterranean Marine Protected Areas. MedPAN North project. WWF-France and Parc National de Port-Cros. 58 p.

Pollution

ASSOCIATED PROTOCOLS

Tissue sampling [7], Beach suitability assessment for nesting [14], Beach surveys (ground) [16], Beach survey (drone) [17], Beach mapping [18], Marine survey (plane) [19], Marine survey (drone) [20], Coastal development monitoring [22], *Light pollution monitoring and mitigation [23],* Beach use monitoring and control [24], *Hatchling disorientation (recording and mitigation) [27],* Dealing with dead strandings [28], Dealing with live strandings [29], *Necropsy [31], Plastic ingestion [34].*

MANPOWER

1-20+

COST

€ - €€€

FREQUENCY

Beach clean-ups to be done before the start of the nesting season (early May) and before the start of hatching season (early July). Marine clean ups arranged annually or when a specific need is identified, e.g. if a large ghost net is washed near shore. Toxicological monitoring can be carried out yearly on samples collected throughout the year. Noise pollution monitoring is not something that is likely to be completed.

Stranded baby marine turtle © Notre Grand Bleu

Reason

Pollution in any of its forms can impact marine turtle survival directly or indirectly through degrading their habitats and therefore requires control and monitoring.

Context

Aside from light pollution (covered in a separate protocol) pollution in marine turtle habitats can take many forms that may be direct and obviously impacting turtles and/or their environment or more cryptic and have impacts that develop over time. Pollution may be physical -such as plastics and other debris, chemical -such as organic compounds and heavy metals, and 'audible'/pressure such as noise from marine traffic. Several reviews deal with marine pollution's effects on turtles. Hutchinson and Simmonds (1991) discuss the numerous effects of a variety of pollutants on marine turtles. More recently Nelms & Duncan et al. (2016) cover turtles and plastic, Nelms et al. (2016) deal with the specific noise problem caused by seismic surveys, Duncan et al. (2017) report on the extensive problem of turtle entanglement in anthropogenic debris and Wallace et al. (2020) discuss oil spill and marine turtles.

Equipment

The most actionable pollution to monitor and remove is litter and debris left on nesting beaches and in shallow, coastal seas. Beach litter monitoring and removal requires no special equipment whereas removing debris and other items such as discarded nets from the sea requires operators in scuba gear and floatation devices for larger items. Quantification of other pollution such as chemical pollution will require laboratory analysis of tissues. Sound pollution can be inferred from the number of and style of vessels operating in-water in the area.

Actions

The use of large motorised beach cleaning equipment should be discouraged. Beach-cleans are better carried out by a group of people on foot collecting rubbish into refuse sacks. In-water removal or debris and ghost gear should be carried out by teams of experienced scuba divers that remain within the normal parameters of safe diving. Samples for toxicological (and other) studies should be taken from all dead fresh turtles obtained in the MPA *(see Necropsy protocol factsheet n°31)* and analyses that may be carried are reviewed in Carneiro da Silva and López-Barrera (2017).

Ethics

No ethical issues arise from beach cleans and in-water clean-ups. Handling dead turtles will require permits and appropriate personal protective equipment but leads to no ethical issues.

Data to record

There are several guides available on monitoring marine litter that can be used as basis for Mediterranean MPAs (Cheshire et al. 2009, Hanke et al. 2013, Galgani et al. 2019, Gesamp 2019). The most up to date one, that references the others and should be adopted is Galgani et al. (2019). Due to the broad nature of the different methods to be used and data recorded therein which exceed the scope of this brief protocol, the reader is directed to that document for further details (freely available from https://archimer.ifremer.fr/doc/00487/59840/).

Management relevance

The management implications of pollution are as diverse and the forms of pollution that exist. The most simply monitored and addressed comes in the form of macro-pollution such as abandoned nets and other anthropogenic waste that can trap and harm turtles. If such items are identified within the MPA, clean-up operations should be organised by the MPA management authority.

Reporting

Annual reporting of results from the various actions is suggested with data made available for inclusion in national and regional analysis of the marine pollution problem.

Collaboration potential

Pollution can be monitored by trained MPA staff, but extra capacity can be gained through the involvement in the public for clean-up activities or as citizen scientists reporting sightings and incidences of pollution. Furthermore, NGO or academic third parties, under agreement, can undertake the suggested monitoring and clean-up activities reporting back promptly to the MPA manager the results of their efforts.

References

- Carneiro da Silva C, López-Barrera EA (2017) Ecotoxicology of sea Turtles. In: Rguez-Baron JM, Lara-Uc M, Rodriguez RR (Eds.), Advances in Research Techniques for the Study of Sea Turtles. Nova Science Publishers Inc., New York. Pp. 27-52.
- Cheshire AC, Adler E, Barbière J, Cohen Y, Evans S, Jarayabhand S, Jeftic L, et al. (2009). UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter. UNEP Regional Seas Reports and Studies, No. 186; IOC Technical Series No. 83: xii + 120 p.
- Duncan EM, Botterell ZLR, Broderick AC, Galloway TS, Lindeque PK, Nuno A, Godley BJ (2017) A global review of marine turtle entanglement in anthropogenic debris: a baseline for further action. Endangered Species Research 34: 431-448.
- Galgani F, Deidun A, Liubartseva S, Gauci A, Doronzo B, Brandini C, Gerigny O (2019) Monitoring and assessment guidelines for marine litter in Mediterranean MPAs. Technical report of the Interreg/MED/AMARE project. 57 p.
- GESAMP (2019). Guidelines for the monitoring and assessment of plastic litter and microplastics in the ocean. Kershaw PJ, Turra A and Galgani F. (Eds.), (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP/ISA Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud. GESAMP No. 99. 130p.
- Hanke G, Galgani F, Werner S, Oosterbaan L, Nilsson P, Fleet D, Kinsey S, et al. (2013) Guidance on monitoring of marine litter in european seas. EUR – Scientific and Technical Research Reports, Publications Office of the European Union. 128p.
- Hutchinson J, Simmonds M (1991) A review of the effects of pollution on marine turtles. Greenpeace International Ecotoxicology Project. 20p.http://seaturtle.org/library/HutchinsonJ_1991_GreenpeaceTechReport.pdf
- Nelms SE, Piniak WED, Weir CR, Godley BJ (2016) Seismic surveys and marine turtles: an underestimated global threat. Biological Conservation 193: 49-65.
- Nelms SE, Duncan EM, Broderick AC, Galloway TS, Godfrey MH, Hamann M, Lindeque PK, Godley BJ (2016) Plastic and marine turtles: a review and call for research. ICES Journal Marine Science 73: 165-181.
- Wallace BP, Stacy BA, Cuevas E, Holyoake C, et al. (2020) Oil spills and sea turtles: documented effects and considerations for response and assessment efforts. Endangered Species Research 41:17-37.

Plastic ingestion

ASSOCIATED PROTOCOLS

Dealing with dead strandings [28], Dealing with live strandings [29], Fisheries interactions (bycatch) [30], *Necropsy [31], Pollution [33].*

MANPOWER

1-3

COST

€€

FREQUENCY

On encounter with a dead turtle or when a live turtle is held for rehabilitation.

Plastics extracted after necropsy © DEKAMER Archives

Reason

Prevalence of plastic in the environment is increasing, as is its impact on marine turtles. Understanding the level of the problem and the provenance of the plastic informs development of mitigation strategies.

Context

Plastic waste and debris is increasingly common in both terrestrial and marine environments, creating problems for a range of animal taxa that include marine turtles. Larger items of plastic can block or damage a turtle's intestinal tract causing immediate and serious problems. Degrading plastic leaches toxic chemicals, so ingestion of plastic particles can raise toxin loads in otherwise apparently healthy turtles. Quantifying the rates of plastic ingestion and the types of plastic ingested can highlight the seriousness of the issue and stimulate mitigation strategies to reduce their presence and impact. Specific protocols covering plastic ingestion and other impacts of marine litter have been compiled for the regionwide INDICIT project (https://indicit-europa.eu/) and MPA managers are advised to check out the project page for further information.

Equipment

Appendix 2 of the INDICIT protocol (INDICIT 2018) provides a detailed list of all possible materials required, based on the location the investigation is to take place (see below).

Actions

For dead turtles, gut contents are collected during necropsy *(see Necropsy protocol factsheet n°31 and INDICIT 2018)* and analysed for presence of plastics. For live turtles, faeces is collected and analysed for presence of plastics. Plastics are classified according to a predetermined set of categories.

Ethics

Handling live or dead turtles will require permits and additionally, handling of live turtles must be carried out in safe and humane manner ensuring the safety of both the investigator and the animal.

Data to record

Briefly the number, size, type and colour of plastic items per turtle need to be recorded alongside details of the turtle itself (size and species etc.). Further details are provided in the INDICIT (2018) protocols.

Management relevance

Evidence of increased plastic ingestion and determining the source of the plastic can strengthen management actions to reduce plastic pollution in the MPA. Additionally, data acquired from it contribute at a regional scale to increase lobbying pressure, reduce use of plastic and improve disposal methods.

Reporting

Annual reporting per MPA should be carried out but data should be shared centrally for national and regional analyses.

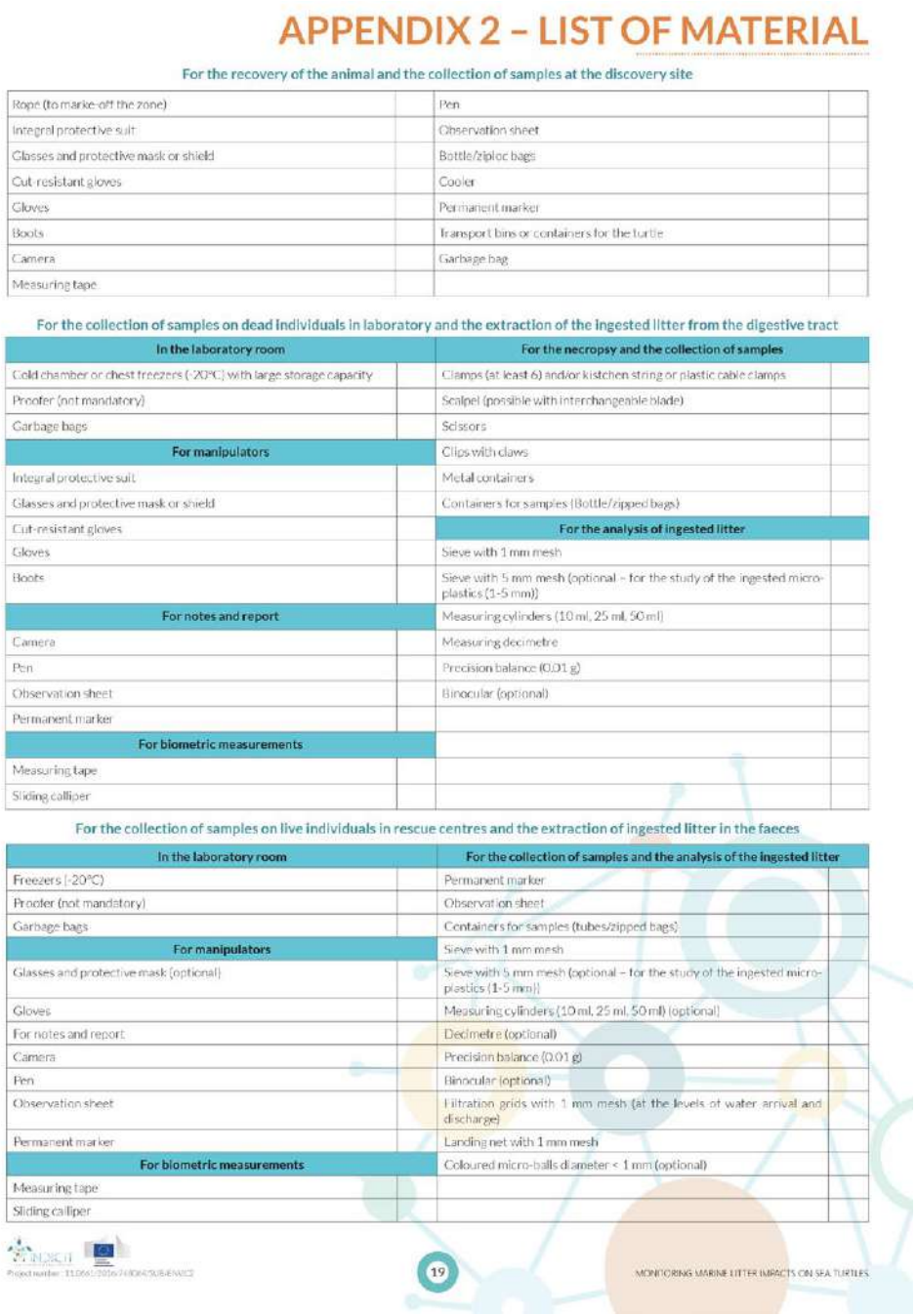
Collaboration potential

If the MPA has the capacity to process the dead turtles it encounters, including use of a preferred veterinarian, this protocol can be handled internally. However, collaboration with qualified NGO and academic third-party groups reduces demand on MPA resources and is recommended.

References

- INDICIT Consortium (2018) Monitoring marine litter impacts on sea turtles. Protocol for the collection of data on ingestion and entanglement in the loggerhead turtle (*Caretta caretta* Linnaeus, 1758). 22p. https://indicit-europa.eu/protocols/

Materials required for INDICIT ingested plastic investigations, reproduced from INDICIT (2018).



APPENDIX 2 – LIST OF MATERIAL

For the recovery of the animal and the collection of samples at the discovery site

Rope (to marke-off the zone)	Pen
Integral protective suit	Observation sheet
Glasses and protective mask or shield	Bottle/ziploc bags
Cut-resistant gloves	Cooler
Gloves	Permanent marker
Boots	Transport bins or containers for the turtle
Camera	Garbage bag
Measuring tape	

For the collection of samples on dead individuals in laboratory and the extraction of the ingested litter from the digestive tract

In the laboratory room	For the necropsy and the collection of samples
Cold chamber or chest freezers (-20°C) with large storage capacity	Clamps (at least 6) and/or kitchen string or plastic cable clamps
Proofer (not mandatory)	Scalpel (possible with interchangeable blade)
Garbage bags	Scissors
For manipulators	Clips with claws
Integral protective suit	Metal containers
Glasses and protective mask or shield	Containers for samples (Bottle/zipped bags)
Cut-resistant gloves	**For the analysis of ingested litter**
Gloves	Sieve with 1 mm mesh
Boots	Sieve with 5 mm mesh (optional – for the study of the ingested micro-plastics (1-5 mm))
For notes and report	Measuring cylinders (10 ml, 25 ml, 50 ml)
Camera	Measuring decimetre
Pen	Precision balance (0.01 g)
Observation sheet	Binocular (optional)
Permanent marker	
For biometric measurements	
Measuring tape	
Sliding calliper	

For the collection of samples on live individuals in rescue centres and the extraction of ingested litter in the faeces

In the laboratory room	For the collection of samples and the analysis of the ingested litter
Freezers (-20°C)	Permanent marker
Proofer (not mandatory)	Observation sheet
Garbage bags	Containers for samples (tubes/zipped bags)
For manipulators	Sieve with 1 mm mesh
Glasses and protective mask (optional)	Sieve with 5 mm mesh (optional – for the study of the ingested micro-plastics (1-5 mm))
Gloves	Measuring cylinders (10 ml, 25 ml, 50 ml) (optional)
For notes and report	Decimetre (optional)
Camera	Precision balance (0.01 g)
Pen	Binocular (optional)
Observation sheet	Filtration grids with 1 mm mesh (at the levels of water arrival and discharge)
Permanent marker	Landing net with 1 mm mesh
For biometric measurements	Coloured micro-balls diameter < 1 mm (optional)
Measuring tape	
Sliding calliper	

19

MONITORING MARINE LITTER IMPACTS ON SEA TURTLES

Questionnaires and Interviews

ASSOCIATED PROTOCOLS

Beach suitability assessment for nesting [14], Fisheries interactions (bycatch) [30].

MANPOWER

1-5

COST

€€

FREQUENCY

Data gathering at the onset of MPA activities to protect marine turtles should be used as a rapid and inexpensive way to obtain local ecological knowledge on the presence of marine turtles. Ideally information gathering should be undertaken before the start of a new action and following completion of an action, such as a public awareness campaign or campaign to sensitise fishers to conservation of marine turtles. In this way the efficacy of that action can be understood, and future actions can be guided. See Dimopoulos et al. (2008) on the use of a questionnaire to evaluate an education module for elementary school children as an example of this.

Reason

Understanding stakeholder perceptions of marine turtles, their conservation status, various threats impacting their survival and local ecological knowledge can be beneficial when designing conservation strategies and testing effectiveness of specific campaigns.

Context

Conservation actions would not be required if human interactions with species and habitats were never negative. Consequently, the understanding of perceptions of stakeholders, from beach users, coastal businesses and fishers to policy makers is important to design conservation strategies that will be accepted and generate long-term benefits to species and their habitats. Furthermore, interpretation of local ecological knowledge derived from questionnaires and interviews can be used as baseline data on which further actions are founded. Tambiah (1999) provides a strong rationale for the use of interviews and questionnaires on which this protocol is based.

Equipment

No specialist equipment required; however, a voice recorder can be used for face-to-face interviews.

Actions

Fundamentally, an appropriately worded questionnaire needs to be presented as a document or verbal survey to the previously selected target audience to gather written or spoken responses. See Tambiah (1999) for further details including questionnaire design and interview process etc.

Ethics

Responses from all interviews and questionnaires need to be anonymised so that the response cannot be attributed to a single individual or small group of individuals to prevent negative repercussions for those people and to encourage the subjects to provide truthful responses.

Data to record

Anonymised responses need to be accurately recorded and transcribed.

Management relevance

Knowledge is power. Results from questionnaires can point to areas where the MPA can improve buy-in from stakeholders and determine the best way forward for implementing new and novel management measures.

Reporting

Reporting on results from questionnaires and interviews carried out by MPA staff is not obligatory as the information gathered is to be used to inform internal MPA management actions. However, results collected by third parties, that should operate in collaboration with the MPA authority, should be reported to the MPA management in a timely manner together with any relevant inferences drawn for conservation and management outcomes.

Collaboration potential

Questionnaires taking place within the MPA and exploring topics related to the MPA should be carried out by MPA staff or under close collaboration with MPA staff. This is because the MPA managers should have the best idea on how a questionnaire or survey will be politically received by the target audience; if it is likely to generate illfeeling or mistrust that may outweigh the anticipated benefits derived from the investigation.

References

- Dimopoulos D, Paraskevopoulos S, Pantis JD (2008) The cognitive and attitudinal effects of a conservation educational module on elementary school students. The Journal of Environmental Education 39(3): 47-61.
- Tambiah C (1999) Interviews and market surveys. In: Eckert KL, KA Bjorndal, FA Abreu-Grobois & M Donnelly (Eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group, Publication No. 4, Gland. Pp. 156-161.

ANIMAL

Deploying animal mounted data gathering and tracking equipment

FACTSHEET 36

Standard

ASSOCIATED PROTOCOLS

Species ID [1], Measuring turtles [2], Sexing turtles [3], Flipper tagging [5], PIT tagging [4], Photo ID [6], Tissue sampling [7], Dealing with live strandings [29], Fisheries interactions (bycatch) [30].

MANPOWER

2-5

COST

€€€-€€€€€

FREQUENCY

To derive maximum benefit, devices should preferably be deployed when a specific research question has been identified and to a predefined schedule. However, funding limitations may mean that obtaining the required sample size is not immediately possible and in this case the researcher should ensure that all devices acquired and deployed over time provide comparable data.

Reason

Acquiring knowledge of marine turtle behaviour and movement is fundamental to gaining better knowledge of their biology and, through inference, their conservation.

Context

Flipper tagging has long been used with marine turtles to help link breeding with foraging and overwintering sites that may be separated by hundreds of kilometres of sea. These point observations provide useful data but do not indicate which routes the animals took to undertake that journey, and neither is it certain the distant point of capture away from the nesting area is the endpoint of the turtle's migration. Satellite tracking devices permit following turtles on these migrations and during their times of residence at breeding or foraging areas. Furthermore, some tracking and other dedicated data-logging devices can store depth and other movement information that generates a more complete understanding of a turtle's three-dimensional use of the marine habitat. All this data can be used in the decision-making process for setting up or updating of zones within MPAs or for establishing new MPAs. Hays and Hawkes (2018) review opportunities arising from use of marine turtle tracking.

Equipment

Data generating equipment appropriate to the research question being posed should be purchased in numbers that provide results suitable for population-level analysis and inferences. Examples of satellite tracking and data logging device manufacturers are Wildlife Computers (https://wildlifecomputers.com/), Lotek (https://www.lotek.com/) and Telonics (https://www.telonics.com/).

Actions

Turtles to be outfitted with data generating equipment need to be obtained from the nesting beach (restrained on the beach in a wooden or plastic container after nesting) or in-water through 'rodeo', freediving or net capture. The most common method of attaching a device is to attach it to a turtle's carapace that has been cleaned of epibionts etc. using a thermally appropriate two-part epoxy. Attachment methods vary, but directions are normally indicated by the equipment manufacturer. E.g. Wildlife Computers sell an attachment kit with an instruction manual to guide the researcher in effective attachment of its equipment.

Ethics

Data recording devices mounted on turtles can affect their behaviour and health if not carried out properly, so all devices used should be appropriate for the subject animal in terms of weight, hydrodynamic and other properties (Jones et al. 2011, 2013; Omeyer et al. 2019). Equipment cost should also be considered. Is it ethical for the not insubstantial amounts of money to be spent on data logging devices, when it could be spent on other direct conservation and management issues, such as enforcement?

Data to record

Data recorded should be fit for purpose and decided as part of the project's inception. For example, if only rough locations (ca. 1km error) are required to track a turtle's post-nesting migration there is little point in paying double the price for tracking devices that produce locations to tens of metres accuracy. Conversely, if tracking fine-scale movement in a restricted area is required, e.g. to know where turtles reside in a coastal tributary system, using a device with >1km accuracy will not suffice.

Management relevance

Data acquired from the attached devices can be used to improve understanding of turtles' spatial and temporal use of the marine park, which can inform management for topics such as marine zonation and temporal closures etc.

Reporting

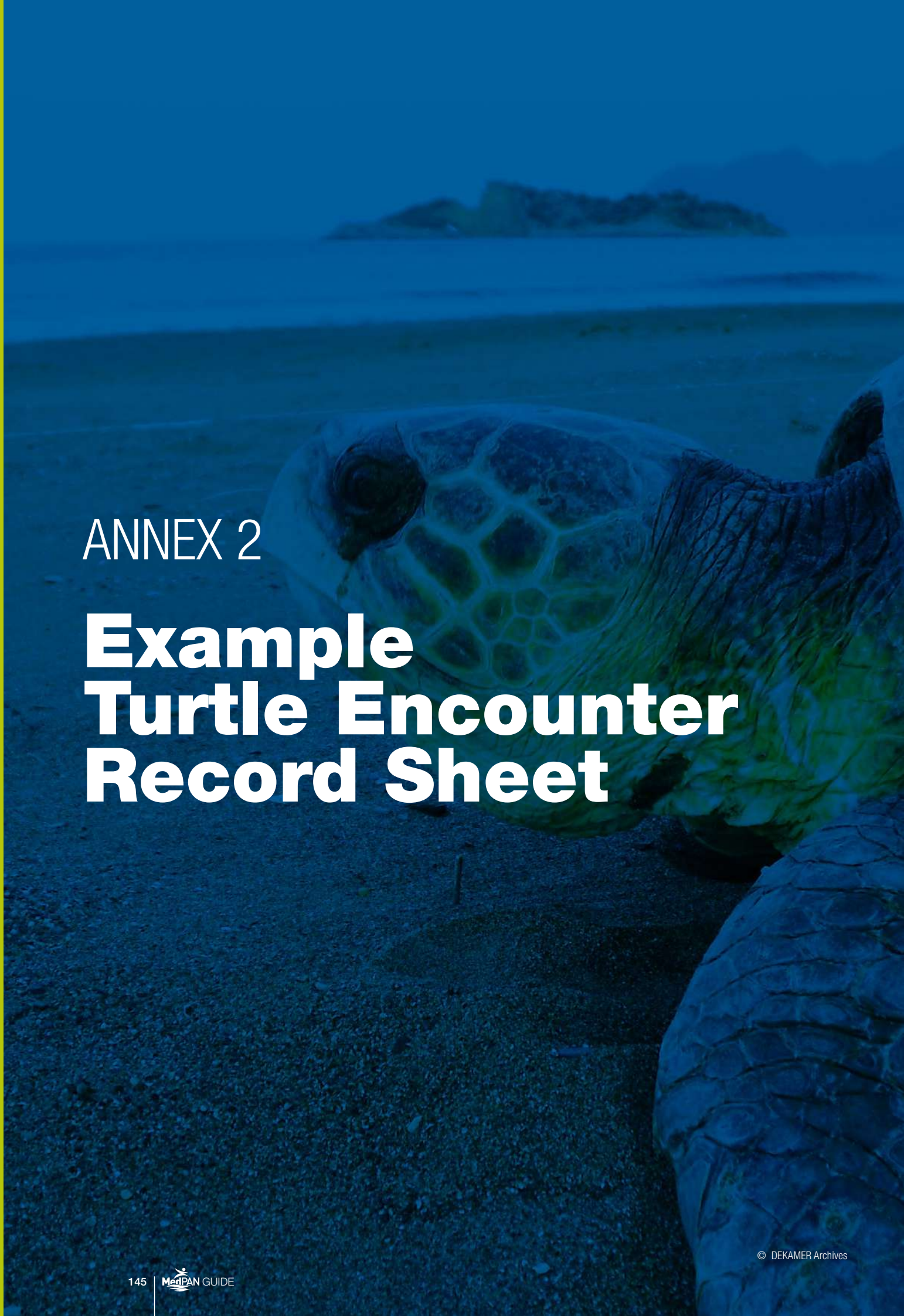
Tracking projects can act as useful awareness raising tools, reaching thousands or more people, when 'real-time' turtle routes are made available to the public on an informative web site. Summary reports on the findings from data-logging deployment projects should be published at the end of the project together with the inferences that can be drawn from the results. These results can also be published in scientific literature in isolation, if required, but should be made available to national and regional initiatives to maximise the benefits that can gained from each individual project. An example of this data sharing is the review by Stokes et al. (2015) highlighting migratory corridors and foraging hotspots for adult female green turtles from across the eastern Mediterranean.

Collaboration potential

Due to the high costs of acquiring the data logging devices and the specific analysis skills required to extract maximum value from results obtained, it is likely that this type of project is best carried out with academic partners. However, if suitable funding and expertise exists within the MPA staff, these projects can be carried out internally.

References

- Hays GC, Hawkes LA (2018) Satellite tracking sea turtles: Opportunities and challenges to address key questions. Frontiers in Marine Science 5: 432. doi: 10.3389/fmars.2018.00432
- Jones TT, Bostrom B, Carey M, Imlach B, Mikkelsen J, Ostafichuk P, Eckert S, Opay P, Swimmer Y, Seminoff JA, Jones DR (2011) Determining transmitter drag and best-practice attachment procedures for sea turtle biotelemetry. NOAA Tech Report 480. 61p.
- Jones TT, Van Houtan KS, Bostrom BL, Ostafichuk P, Mikkelsen J, Tezcan E, Carey M, Imlach B, Seminoff JA (2013) Calculating the ecological impacts of animal-borne instruments on aquatic organisms. Methods in Ecology and Evolution 4: 1178-1186.
- Omeyer LCM, Fuller WJ, Godley BJ, Snape RTE, Broderick AC (2019) The effect of biologging systems on reproduction, growth and survival of adult sea turtles. Movement Ecology 7; 2. doi: 10.1186/s40462-018-0145-1
- Stokes KL, Broderick AC, Canbolat AF, Candan O, Fuller WJ, Glen F, Levy Y, Rees AF, Rilov G, Snape RT, Stott I, Tchernov D, Godley BJ (2015) Migratory corridors and foraging hotspots: critical habitats identified for Mediterranean green turtles. Diversity and Distributions 21: 665-674.



ANNEX 2

Example Turtle Encounter Record Sheet

The following example sheet (from FFWC 2016) has fields for information on individual tagged turtles that can be encountered under a number of circumstances. It is acceptable to create separate sheets for turtles encountered in nesting beach and in-water tagging programmes if so desired.

COOPERATIVE MARINE TURTLE TAGGING PROGRAM (CMTTP)
TAGGING DATA FORM

SPECIES:_____	**DATE CAPTURED:**	DAY__	MO____	YR____	**DATE RELEASED:**	DAY____	MO____	YR____

TAG NUMBERS (LIST ALL NUMBERS AND LETTER PREFIXES; CIRCLE TAG NUMBERS ALREADY ON THE TURTLE [="OLD TAGS"]):

LEFT FRONT: _____	**RIGHT FRONT:**_____	**LEFT REAR:**_____	**RIGHT REAR:**_____

PIT TAG#:_____	**LOCATION OF PIT TAG:**_____

WAS TURTLE CARRYING TAGS WHEN ENCOUNTERED?:	YES	NO	IF YES, THEN CIRCLE CORRECT STATEMENT:

1. RECAPTURE OF SAME PROJECT TURTLE (EITHER WITHIN SEASON OR BETWEEN SEASONS)
2. RECAPTURE OF DIFFERENT PROJECT TURTLE (NOT A TAG YOUR GROUP APPLIED)

TAG RETURN ADDRESS:

ORGANIZATION TAGGING AND/OR RELEASING TURTLE (INCLUDE AREA CODE/PHONE NUMBER; AND EMAIL):

PROJECT TYPE (CIRCLE ONE):

[NESTING BEACH]	[TANGLE NET]	[POUND NET]	[HAND CATCH]	[STRANDING]	[OTHER, DESCRIBE]

IF NESTING BEACH: DID TURTLE NEST?	YES	NO	UNDETERMINED

FACILITY WHERE TURTLE WAS BEING HELD:

DESCRIBE CAPTURE LOCATION. BE SPECIFIC, INCLUDE COUNTY AND LAT/LONG IF AVAILABLE

DESCRIBE RELEASE LOCATION. BE SPECIFIC, INCLUDE COUNTY AND LAT/LONG IF AVAILABLE.

TURTLE MEASUREMENTS:

STRAIGHT CARAPACE LENGTH (SCL MINIMUM):	_____ CM	_____ INCHES
STRAIGHT CARAPACE LENGTH (SCL NOTCH-TIP):	_____ CM	_____ INCHES
STRAIGHT CARAPACE WIDTH (SCW):	_____ CM	_____ INCHES
CURVED CARAPACE LENGTH (CCL MINIMUM):	_____ CM	_____ INCHES
CURVED CARAPACE LENGTH (CCL NOTCH-TIP)	_____ CM	_____ INCHES
CURVED CARAPACE WIDTH (CCW):	_____ CM	_____ INCHES
WEIGHT:	_____ KG	_____ LBS

TURTLE WAS INSPECTED AND/OR SCANNED FOR:

TAG SCARS:	YES	NO	WHERE LOCATED?
PIT TAGS:	YES	NO	WHAT FREQUENCY?
MAGNETIC WIRES:	YES	NO	WHERE LOCATED?
LIVING TAGS:	YES	NO	WHERE LOCATED?

ADDITIONAL REMARKS OR DATA ON BACK OF FORM:	YES	NO

MAIL COMPLETED FORM TO:
ARCHIE CARR CENTER FOR SEA TURTLE RESEARCH, DEPARTMENT OF ZOOLOGY, PO BOX 118525
UNIVERSITY OF FLORIDA, GAINESVILLE, FL 32611 USA
and
SCDNR Marine Turtle Program, PO Box 12559, Charleston, SC 29422

FFWCC (Florida Fish and Wildlife Conservation Commission) (2016) Marine turtle conservation handbook. https://myfwc.com/media/3133/fwc-mtconservation-handbook.pdf accessed on 1 April 2020

MedPAN collection

The MedPAN collection is a series of tools and user-friendly guidebooks that can provide guidance and build capacity on key issues that managers of Marine Protected Areas (MPA) in the Mediterranean have to confront daily.

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