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& ΑΕΙΦΟΡΟΥ ΑΝΑΠΤΥΞΗΣ

Methods of Sea Turtle Monitoring & Protection in Greece

Athens, September 2017

The content of this report on the methodology followed
upon issues of sea turtle protection and monitoring in Greece,
is a result of chronic research of the ARCHELON Society and its Scientific Committee
members, taking into consideration the international
Protocols and also the peculiarities of Greek ecosystems.

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Prologue

This report presents the methodology used in Greece for monitoring and protection of the sea turtles in the main reproduction habitats as well as in the marine area. Specifically, this report presents the main actions taken in Greece for monitoring and protection of the nesting populations of the loggerhead sea turtle *(Caretta caretta)*, which is the only species that breeds in the country, as well as the actions taken for monitoring and protection of all the three sea turtle species (*Caretta caretta, Chelonia mydas, Dermochelys coriacea)* found in the Greek marine area.

1. The methodology at a glance

1.1. Reproduction habitats

As Greece accumulates approximately 85% of the reproductive population of *Caretta caretta* in the territory of the European Union (in Mediterranean level the corresponding percentage is approx. 47%), monitoring of the conservation status of the species must be focused primarily on the main nesting habitats. These nesting habitats, with geographical distribution in the whole country, are monitored the last 34 years and include areas with populations in both upward and downward trends and with different pressures/ threats for the species. It is noted that, due to the slow sexual maturity of the species (minimum 14 years) and the large annual fluctuations of the nesting activity, it is necessary to monitor each nesting site during the whole nesting and hatching period for many consecutive years in order to make safe scientific conclusions for the conservation status of each population. Because of the long term monitoring of the Greek nesting sites, sufficient time series of data are available. Specifically the main nesting sites in Greece are:

- Laganas Bay at Zakynthos Island in the Ionian Sea.
- Kyparissia Bay at western Peloponnese (from river Alfeios to the north to Kyparissia town to the south).
- Kotychi lagoon at northwestern Peloponnese (from Kalogria to the north to Kotychi lagoon to the south).
- Romanos beach and surrounding beaches at southwestern Peloponnese (from Agia Sotira to the north to Voidokilia to the south).
- Koroni area and surrounding beaches of Messisnian Bay at southern Peloponnese.
- Lakonikos Bay at southern Peloponnese (beaches Mavrovouni, Valtaki, Selinitsa, Vathy and estuaries of Evrotas River, from Trinisa to the west to Kokkinia to the east).
- Rethymno Bay at Crete Island (from the town of Rethymno to estuaries of Geropotamos river).
- Chania Bay at Crete Island (from Kato Stalos to Kolybari).
- Messara Bay at Crete Island (from Komos to Kokkinos Pyrgos).

In addition, the annual monitoring of the species at the nesting sites ensures the simultaneous recording of the direct and indirect effects of the various threats/pressures on the nesting females, the nests and the hatchlings, affecting both the species and the reproduction habitat, both on land (nesting area) and at sea (inter-nesting area and mating area). The type and intensity of the pressures, as well as their effects, are coded appropriately and objectively assessed, so that the results are comparable over time. In that way the necessary management measures, aimed at achieving a Good Environmental Status of the species, are defined.

The systematic monitoring of the nesting habitats can provide important parameters for the long-term viability of the population, such as the number of breeding females and the number of hatchlings entering the population per year. The monitoring is

conducted daily during the nesting period (from about mid-May to mid-August) and the hatching period (from about mid-July to mid-October). The methodology follows internationally recognized standards, such as the recommended methodology by IUCN's Marine Turtle Specialist Group, and basically consists of the location, marking and monitoring of nests (throughout the incubation period) as well as the excavation of nest (after the emergence of hatchlings) to check the success of hatching.

The recommended parameters to be monitored at the nesting sites are:

- Number and distribution of nests.
- Number and distribution of hatched nests.
- Number and distribution of destroyed nests and for what reason.
- Number of eggs per nest.
- Hatching success of eggs (% of eggs).
- Emergence success of hatchlings (% of eggs).
- Surface of the beach suitable for nesting.
- Surface of the beach occupied, especially during night hours (by beach furniture, structures etc.).
- Pressures/ threats in the terrestrial and nearby marine area.

1.2. Marine area

Monitoring at sea presents considerable difficulties due to the complex ecology of sea turtles (wide dispersion, different habitats according to age, long migrations, etc.). However, since 1994 operates in Greece the Rescue Network, through which all data for sea turtles' strandings are recorded and collected. Through these data, areas with an increased presence of turtles are identified (possible wintering and foraging areas). These areas can be used as "index" areas to monitor the conservation status of the sea turtles in the marine environment. In the index areas systematic sampling (capture-mark- recapture of individuals) should be carried out to estimate the size of the population. At the same time, the effects of the threats/ pressures in the index areas should be monitored, mainly by strandings' recoding or (in cooperation with fishermen and relevant authorities) by accidental captures recording. The following marine areas in Greece can be considered as foraging areas:

- Amvrakikos Gulf
- Messologhi lagoon
- Lakonikos Bay

Moreover, recording of strandings and accidental captures should be carried out also in the nesting sites and the surrounding areas, during the entire reproductive period, where the presence of the loggerhead turtles is increased. Lastly, through the continuous operation of the Rescue Network, the sea turtle strandings throughout the Greek coasts are recorded.

2. Monitoring of the nesting activity

2.1. Organization of the monitoring

Surveys for nesting activity monitoring should be carried out daily early in the morning. It is important to start promptly each morning so that all turtle activity can be observed before it is obliterated by ignorant or deliberate actions by third parties. The urgency for starting early is most necessary on beaches with high level of tourist activity. Starting early also means that more turtle activity can be dealt with before oppressive daytime temperatures develop (see in 3).

During the survey is recommended that a minimum of two researchers should participate. One survey member should patrol just out of the wave zone so that even the shortest tracks from adult females can be observed. The other should walk about halfway up the beach to check at that level. Care should be taken to look around the beach so that no tracks etc. are missed. Additionally, attention should be given to existing nests so that events that may affect their normal incubation (e.g. inundation, predation etc.) are dealt with and recorded (see in 4).

2.2. Characterizing of the animal behaviour

A turtle leaves evidence of three behaviours that are not nests on the beach, namely a swim, a body pit or an abandoned egg chamber. These are all forms of attempts as they result from activities turtles go through before nesting. The attempts should be classified and recorded in order for activity for all tracks.

- A “body pit” is the spoor resulting from a stationary turtle using all four flippers to dig herself into the beach.
- An “abandoned egg chamber” is the spoor resulting from an attempt that progressed to the turtle using her hind flippers to start excavating an egg chamber but then quits the attempt and thus leaves behind evidence of digging an egg chamber. An abandoned egg chamber generally has the appearance of a steeply fronted cup of sand to the rear of a depression from which the turtle walked up out of. Individual flipper marks end abruptly before the abandoned egg chamber and rear flipper marks restart from in front of the cup.
- A “swim” is the spoor resulting from the turtle digging a body pit while slowly moving forward. A swim may be several metres long, individual hind or fore flipper marks are generally not well defined and often there is a pair of parallel ridges running along the sides of the swim where sand has been pushed. No specific hind flipper digging is evident. Swims may sometimes be mistaken as camouflages and vice versa. A swim may terminate in an abandoned egg chamber or body pit or even a nest and these variations should be specifically recorded.

Each track from adult females that is observed on the beach must be assessed and defined as either a nest or a non-nesting attempt (in this process is crucial to verify the direction of the track, as only the last attempt can be a nest). Initial assessment of each turtle track is solely based on visual identification and is sufficient only if no protection activities will be performed (as is the case for beaches of absolute protection, where no human presence is permitted or any beach which is monitored less than daily). If nest protection activities are to be carried out (see in 3), then this assessment needs to be physically confirmed by careful digging of the area where the clutch is suspected to be. This digging should be undertaken for all spoors assessed to be nesting camouflages and for spoors that are suspected to be camouflages. Swimming attempts, and sometimes body pits, can be mistaken for camouflages and hence (especially in areas with high rates of nest predation, tourism or for possible nests that would require relocation) spoors assessed to be swims or body pits should also be physically investigated for presence of eggs unless experienced team members are 100% sure that it is a non-nesting attempt. If no eggs are found, then measurements of the suspected nest location should still be recorded.

2.3. Physical localization of the clutch – step by step

- Make visual assessment of possible identifying characteristics within the suspected camouflage (e.g. remains of ridge formed during construction of the body pit and egg chamber).
- Place bamboo or other markers around the periphery of the suspected camouflage, spacing them so the extreme front, back and sides of the camouflage are marked. Place two more markers at the edges where the eggs

are suspected to be along the camouflage, and one piece pointing down the central line of the camouflage.

- Sweep aside the dry sand in a large area around the suspected clutch location. Removing dry sand makes probing the wet sand for eggs simpler and stops it from falling in amongst the eggs when they are located.
- When an area of wet sand has been cleared then, using a few fingers, it should be probed for soft sand. Soft sand indicates the clutch is beneath as the turtle does not compact the sand used to cover the eggs to the same extent as found naturally along the beach.
- Gently dig using the side of your hand (so as not to burst eggs with fingertips) to the top egg.
- Once the eggs have been located clear the covering sand to identify the centre of the clutch.
- Measure the depth from the normal beach surface level to the top egg.
- If the nest is to be relocated then follow the guidelines for relocation, otherwise if the nest is to be left in situ then continue with the final two points below.
- Replace wet sand over the eggs to the natural level and lightly press down to compress it slightly (as done by the nesting turtle). At this point a small stick should be held a safe distance over the centre of the clutch so that its precise location is known thus allowing correct placement of protection material.
- Replace the dry sand into the area cleared for clutch location so that it is level with the surrounding beach.

2.4. Measurements and deletion of the track

It is important for all monitored nests to accurate record the various depth measurements (i.e. the depth from the surface of the beach to the top of the uppermost egg in the egg mass and to the bottom of the egg chamber). For nests remaining *in situ* only depth to the top egg should be recorded. For nests to be relocated (*ex situ*), depths to the bottom of the egg chamber should also be recorded for both the original and relocated nest sites.

Nests should be measured to fixed points (minimum 2) so that their location may be re-determined later in the season. All nests should also have GPS measurements taken.

Nest distance to sea should be derived from a *fixed point* during calm seas for general reference and can be noted to bottom of still visible track and or back of beach for periods of high waves.

After the turtle emergence has been fully dealt with and appropriate measures taken if it is a nest, then the track should be erased so that it is not mistakenly included in the next day's survey.

2.5. Recording of meteorological data

During the monitoring of the nesting activity, also other kind of data should be recorded. In particular, the record of meteorological and environmental conditions data (i.e. cloud cover, rain, wind and waves) is required so that it is available for analysis with respect to various aspects of sea turtle ecology and nesting biology.

An electronic temperature logger should also be set up to record air temperature through the season at each nesting site at 1m above beach height, in a safe place at the back of the beach. Care should be taken to ensure the temperature logger is placed in the same place each season (so that the results are comparable over time).

3. Nest protection methods

When each nest is located, then the appropriate protection method should be followed. The choice of the protection method is done according to the existing pressures/ threats for the nests in each nesting habitat.

3.1. Protection of nests *in situ*

Cages or tripods should be used primarily on beaches where the main threat to nests is human disturbance. They should be placed centrally over the clutch. Each cage or tripod should be furnished with a nest sign to inform beach users of its purpose (photo 1). On the other hand, screens (bamboo or metal) are used on beaches where the main threat is mammalian predation of eggs and hatchlings. The screens should be placed centrally over the clutch to ensure maximum protection of the eggs and to avoid piercing of the eggs with any stakes used to anchor them. Each screen should be furnished with a nest sign to inform beach users of its purpose. These signs can be attached to vertical poles or tripods associated with the nest (photo 2).

Nests on beaches that are generally not affected by predation, intensive use by tourists or suffering from light pollution, should be left visually unmarked so that no undue attention is brought to the nest site. Nest-identifying stones should be buried in the sand at predetermined positions relative to the nest to facilitate re-identification at a later date.

3.2. Protection of nests *ex situ*

If a nest is characterized as "doomed" (i.e. has little or no chance of survival if left *in situ)*, it should be relocated (photo 3). It is noted that if the problem is related to human threats (i.e. hatchling disorientation due to light pollution, shading of nests by umbrellas etc.) the problem should be addressed and nest relocation should not be applied as a solution. Reasons acceptable for relocation include only severe inundation by the sea, flood drains and rivers or unsuitability of original nest (e.g. the nest is laid next to plants with known invasive root growth).

Nest relocations should be undertaken within 12h from egg-laying (best before 11am) and be completed within 1 hour. This is the safest time to move eggs as movement least affects the developing embryos. Relocations at other times are considered emergency relocations and extra precautions are required (see in 3.2.2.).
A minimum requirement for transportation of the eggs is a large clean plastic bucket or freezer box.

3.2.1. The relocation process - step by step

- Locate the eggs.
- Measure the depth of sand from natural beach level to the top egg.
- Sand should cleared away from the clutch to leave the eggs as clear as possible during removal, transportation and replacement (thus reducing shell scratching).
- One person should carefully (with minimum jarring and rotation) remove and count the eggs, in twos and threes, from the original chamber into the relocation container(s). Full attention should be given to obtaining an accurate egg count that will be used for clutch size calculations.
- The eggs need to be kept from heating during relocations. The dry sand from the place where the bucket will sit should be cleared away as it heats quickly during the day. The eggs should also be shaded from direct exposure to the rising sun.
- Once all the eggs are removed then the depth to the bottom of the chamber should be measured.

- A new chamber should be dug in an appropriate place, usually near the top of the beach or in a specified hatchery location (see in 3.2.3.), so that the depths and dimensions of the nest match the original as closely as possible. Egg chambers should never be made to more than 52cm if the original is recorded as being deeper, make the new egg chamber shallower. Also ensure the new location is completely free from the threats of the original nest – there is no point relocating a nest to another threatened site.
- Clutches should be relocated to suitable sites that facilitate the promptest reburial of eggs, but not within 1m of another nest (including hatchery sites).
- The eggs should be counted, in twos or threes, as they are carefully placed into the new chamber. They should not be packed into the new chamber but remain loosely stacked. If the clutch was divided, then the portions should be replaced to match the original order within the nest. The number of eggs relocated should equal the number of eggs exhumed minus those removed as they were broken.
- The depth to top egg in the new chamber should be measured.
- Wet sand should be placed over the clutch to natural beach levels, and then lightly press to compress it slightly (as done by the nesting turtle).
- If the nest is to have a cage or screen placed over it then the centre of the new nest site should temporarily be indicated by placing a stick over the clutch (taking care not to touch the eggs).
- Finally, dry sand should be pushed back over the new nest site so that it matches or is slightly higher than the general beach level.

3.2.2. Procedure for emergency relocations

Emergency relocations are those carried out at any time other than the first morning after clutch deposition such as necessitated by beach erosion etc (photo 4). Relocations carried out at times other than the first morning after deposition carry the risk of destroying healthy eggs, thus emergency relocations are only carried out when the clutch is *sure* to be destroyed if it remains *in situ*.

Extra precautions to be taken in these circumstances should include marking the top of the egg with a soft grease pencil and transferring the eggs to a *bucket or other inflexible container* to ensure that the eggs are not rotated either during transportation or during reburial. Sand should be placed in the bottom of the container to stop the eggs from rolling. Egg trays, as used for chicken eggs, are excellent for this purpose as they can be stacked with no compression or rotation of eggs.

3.2.3. Construction of beach Hatcheries

Beach hatcheries are areas of the nesting beach, where a specific amount of nests (no more than 30 nests) are relocated. Hatcheries may be used in areas with either human or predator impacts on sea turtle nests, however they should not be used as a primary location for relocated nests. Hatchery design is varied according to needs. Hatcheries should be constructed on regions of beach that are not prone to inundation, root invasion or any of the factors that require nests to be relocated. A hatchery should also not be situated where there is possibility of hatchling disorientation.

Hatcheries are now mainly used for Public Awareness purposes (as it is considered better not to clump the nests in one place) and hence should have a large clear sign placed next to them explaining that they are there to house relocated nests. Hatcheries should be orientated parallel to the sea with one to three rows of nest locations, up to 10 places long, thus a hatchery should contain no more than 30 nests places. Each nest place must be one square metre (100cm x 100cm) to distribute the nests far enough apart to not influence each other.

At sites with no predation problems then hatcheries need only nest location corner marker posts and outlining wire with possibly a "museum rope" around the outside. At sites with predation problems then hatcheries need to be wrapped and capped with chicken wire with some form of fencing placed in the sand around the periphery. A "museum rope" can be used in this situation too (photo 5).

3.3. Protection from light pollution

The incubation period is approx. 2 months after the clutch deposition (generally after the 45th day of incubation and spread over several subsequent days). The hatchlings emerge during night hours (so they are protected from natural predators and heat), in big groups. Each nest hatches for about five days. As the hatchlings are phototactic (i.e. they find the sea by following the brightest light), they may be disorientated by artificial lighting at the back of the beach. As a result, hatchling rescue may be required to combat disorientation at night. The recommended way is to shade the nests using boards / beach mats etc. in combination with a ridge-sided, sand trench that passes from behind the nest and extends to the water's edge (photo 6). Thus, the hatchlings are restricted to the beach that leads them into the sea, from where they should have little or no problem with correct orientation.

For areas with severe light pollution the method of "nest-shading" may be not effective enough. For these areas is suggested to use open-topped boxes to retain hatchlings for collection, transfer and release at intervals in nearby dark beach sections throughout the night (photo 7). These intervals should be no longer than one and a half hours and should continue through to at least 04:30 hrs. It should be noted that the practice of "nest-boxing" may have consequences in the later behavior of the hatchlings, since they do not immediately head for the sea after exiting the nest, but remain trapped for a while, inside the box. Thus, "nest-boxing" is only carried out when shading is sure not to be effective.

4. Monitoring of factors affecting nest incubation

As changes in environmental conditions or human or animal activity may affect nests during their incubation, during the surveys for nesting activity monitoring (see in 2) attention should also be given to existing nests and not only recording and dealing with the new emergencies. In particular, these changes can reduce the hatching success or cause problems for emerging hatchlings. Additionally, monitored nests should be specifically checked at certain times during their incubation for overlooked events that may have happened during the incubation. This could be scheduled on a two-weekly basis for all monitored nests irrespective of laying date ("Nest Check").

4.1. Inundation

An inundated nest is one that has been covered by sea water. The most common reason for nest inundation is from high waves caused by winds and adverse weather conditions. Other inundation events may occur from rainwater run-off from roads etc. This is not to be mistaken with normal rainfall covering the nests.

To classify whether a nest has been inundated is simple on projects where the nests are protected with screens and cages etc. The egg chamber should be in the middle of the protective item and so if water is seen to have passed over this place the nest is inundated. A simple quantification of how inundated a nest has been can be given by noting the distance waves have passed up the beach beyond the nest. A subdivision of inundation (washed nests) should be used for nests where only part of the nest area has been covered by the sea. At nesting sites where there is no visual nest marking, it is practically impossible to distinguish if a nest has suffered from inundation and hence

particular note should be made in reports etc. of periods with high waves including measurements of the extent of wave wash up the beach.

An inundated nest is not necessarily immediately destroyed, but is increasingly affected by duration of immersion and resulting sand compaction. Inundated nests often hatch, even with no apparent harm to the hatching success and at other times, nests can be completely destroyed. To improve the possibility of successful hatching, sand above and around the nest should be carefully dug into, by hand, and de-compacted. This process aids aeration and drying of the sand hence supplies the eggs with more air for respiration and speeds return to normal beach temperatures that are generally lowered during inundation.

4.2. Predation

A predated nest is one that has had eggs destroyed by a predator (evidence of digging at the nest will be seen with eggshells scattered around the area). Nests are classified as predated when they have been at least partially destroyed (photo 8). If no eggs are reached, then this is only a predation attempt. Predator activity at the nest during its hatching period cannot accurately be assessed as to whether hatchlings have been taken; furthermore, hatchlings can be taken on their journey to the sea. This therefore, is why evidence of egg destruction and disturbance must be the guide for classifying a nest as predated and not predation of hatchlings. Furthermore, it is concluded that if a nest has produced hatchlings without predation then we have succeeded in our goal. Therefore, any predation activity on the nest, recorded after hatching, is noted, but does not classify the nest as predated. The nest is however unusable for excavation clutch size estimation and hatching success (see in 5).

When predators have reached the clutch and eggs have been damaged, then all dirty sand and broken eggs (especially inside the nest chamber) should be cleared away. The hole should be refilled with the appropriate clean sand (dig a hole nearby the nest to get fresh moist sand). The damaged eggs should be collected in a plastic bag and disposed of in an allocated place (in order to avoid the spoils of a predated nest being identified as a new nest if it is subsequently predated at the new site). If a predated nest is to be protected with bamboo stakes, then the stakes should be pushed (and not hammered) into the sand to stop any vibrations damaging the eggs. If the top of the remaining eggs is low compared to natural nest depth then the sand can be replaced over the nest so as to leave a normal top egg depth i.e. the nest area is pitted when compared to the surrounding beach.

4.3. Human interference

Humankind seems to know no bounds in causing havoc and destruction through both malicious and ignorant actions. Most nest-tampering that is encountered is removal of nest protection items. Sometimes it involves digging in the sand around the nest and occasionally it may involve removal of eggs or hatchlings.

Just as the disturbing action may be varied, so too are the actions that can be taken to remedy it. Most actions will involve re-measuring nests to their original co-ordinates to identify their precise location. If eggs are disturbed, then the actions to repair a predated nest should be followed. If no eggs have been damaged, then any holes dug should be refilled to the normal beach level. Lastly, if necessary, the nest protection item should be replaced. In some ‘trouble spots’ it may be necessary to stage regular beach patrols so that nests may be under constant surveillance for a defined period.

5. Monitoring of hatching

As mentioned above (see in 1) the hatching period in Greece is approximately from about mid-July to mid-October. During this period systematic monitoring is required in

order to provide important parameters for the long-term viability of the population, such as the number of hatchlings entering the population per year.

5.1. Identification of hatching nests

A nest has hatched when at least one hatchling, or its track, are observed originating from it. The track(s) and/or hatchling(s) should emerge from a pit over the nest where the sand has collapsed into the egg chamber (photo 9). The surface sand over the nest should not be dug into to search for hatchlings in hatching nests, as this practice only encourages hatchlings to emerge during the morning when it is sunlight, heat and there are predators.

In order for incubation duration to be calculated, the 'first hatch' must be observed and the date clearly and accurately recorded. Recording 'first hatch' should involve leaving some identifying marker on the beach at the nest site, so that nests are not mistakenly recorded as hatching for the first time on more than one occasion.

Minimum data recorded should include: hatching date, nest code (if appropriate) and estimated number of emerged hatchlings (as they emerge in groups, see in 3.3.). Subdivision of hatchling counts into the following categories is suggested: to the sea, disorientated, lost and dead, and in combination.

Although hatchlings emerge predominantly during night hours (see in 3.3.), it is possible that hatchlings are encountered on the beach during daytime. On that occasion, the first step is to shade them from the sun. The sand in front of them should be smoothed to aid walking and to remove the hottest layer heated by the sun. Every effort should be made to let the turtle walk unaided to the sea.

5.2. Nest excavation

Nest excavation provides information on clutch size and hatching success. This in turn can provide insights into suitability of beach conditions or external factors that have affected emergence rates.

To have accurate and exhaustive data on hatching success means excavating every nest made on the beach (100% excavation rate). However only a sample of nests need to be excavated to provide sufficient data to allow statistical comparisons between beaches, sites and years. The important factor here is that the sample must be chosen at random from the category of nests under investigation. There should be no spatial or temporal bias to the nests chosen. A sample of 20% of each nest category[1] is sufficient for analysis. Additionally, all nests which were located by predation or hatching (i.e. the “Unmarked” nests) should be excavated to verify the existence of the clutch.

Most healthy hatchlings have left the nest by the 10th day of hatching and so excavations can be performed at this time. The reason for nest excavation is to show hatching success for nests that have incubated naturally, i.e. no deliberate manipulation since the first day of incubation (excluding clutch location and relocation activity). The reason for excavation is not to release live / trapped and weak hatchlings. Non-hatched nests should also be excavated, in keeping with the random sampling of nests. The timing of these should be selected to be approximately 10 days after the

1 Monitored and unmarked nests. A monitored nest is one that is visually marked on the morning after deposition and therefore is observed for every day of its incubation. These are subdivided into: In situ, relocated to hatchery, relocated to another beach site (that is not a hatchery). Unmarked nests are in situ nests that were not identified at time of laying but are found afterwards through predation or hatching events. The main criterion of an unmarked nest is that it was not monitored everyday through its incubation. These are subdivided into: undisturbed nests, inundated nests and predated nests.

standard (long) incubation period of the relevant area, but never before 70 days. For example, if most nests hatch before 65 days incubation then non-hatched nests can be excavated at 75 days incubation. Excavations are better made during the evenings so that live hatchlings reburied are more likely to emerge during the night and not later in the heat of the day.

It should be noted that during excavations is possible that live hatchlings are found. Most live hatchlings found during excavation are weak and/or sick and their chances for survival are negligible and reduced further if they make it to the sea during day. For that reason, live hatchlings at excavation should be reburied for natural nocturnal emergence of the healthier ones. During this process, it is absolutely essential that onlookers are given a full explanation of what is happening (to avoid misunderstanding and inappropriate actions).

5.2.1. The excavation process

During the excavation the use of rubber gloves is essential. The process of egg removal from the nest may cause eggshells to fragment and hence should be done with care. A single hole made down one side of the clutch allows groups of eggs gently to be teased loose from the eggs mass and causes little fragmentation. Eggs should not be pulled from the body of the clutch as this leads to most fragmentation. Once the eggs have been removed then nest depth (see in 2.4.) should be recorded from normal beach level to egg chamber bottom.

Excavated nest contents should be classified as:

- empty eggshells (hatched eggs)
- unhatched eggs with no visible embryos
- unhatched eggs containing dead embryos
- unhatched eggs containing live embryos
- pipped live hatchlings including their eggshell
- pipped dead hatchlings including their eggshell
- dead hatchlings
- live hatchlings

Nest contents should not be returned to the nest until the counting is complete. The contents should be arranged in lines on the beach in their appropriate categories and counted at the end of classification (photo 10).

Egg fragments should not be amalgamated into extra eggs; only shell fragments over 50% should be included in egg counts. All unhatched eggs must be opened to look for embryos. Live embryos found in the nest at excavation are usually abnormal and would almost certainly not hatch even if left undisturbed. Their extended incubation is indicative of the developmental problems they are having. It is of vital importance though, that activities and reasons for finding live embryos are explained to any tourists watching the excavation.

Nests containing maggots should be noted and care taken to look for unhatched eggs that have been predated by the larvae. Likewise, the presence of ghost crabs and eggs or hatchlings that have been killed by them should be noted. Bacterial infection of the eggs should also be noted, and can be described by the colour of the infection (pink, purple, green etc.).

Once all nest contents have been checked, classified and counted then they can be returned to the nest hole. The nest site should be filled to normal levels. Excavated nests should be marked in some particular way to show they are excavated known nests. This is mainly useful for areas that suffer from nest predation and a predated, excavated nest could be mistaken for a new nest.

6. Monitoring of threats

Apart from the events (i.e. inundation, predation and human interference) that may affect nests during their incubation (see in 4), also threats/pressures that may affect nesting females and hatchlings, as well as the nesting habitat on land (nesting area) and at sea (inter-nesting area and mating area) should be recorded. The type and intensity of the pressures, as well as their effects, should be coded appropriately and objectively assessed, so that the results are comparable over time. In particular, some of the main threats to be recorded on the nesting sites are the following:

6.1. Erosion

Coastal erosion is due to natural phenomena and human actions. The natural erosion of the sea waves is balanced because the sand dunes continuously victual the beach with sand. When people destroy the sand dunes (because of coastal building etc.), however, supplying the beach with sand stops and erosion is a real problem. Coastal erosion results in reduction of the available nesting zone and increases the possibility of nest inundation. Recording of coastal erosion over time requires monitoring of the beach profile periodically (e.g. take photos of certain parts of the beach annually with similar weather conditions).

6.2. Coastal development and big scale interventions

Coastal development directly affects the sensitive sand dune system behind the beach, resulting in degradation of the nesting habitat. Moreover, has as a result the increase of light pollution and human presence that disorient the hatchlings and prevent the adult females from nesting. Monitoring of the beach profile periodically allows the record of new buildings and constructions. Subsequently these data are compared with the nesting and hatching success.

6.3. Occupation of the beach by touristic facilities

In nesting sites with tourist development large parts of the beach is covered with beach furniture (sunbeds, umbrellas), water sports equipment or even illegal permanent constructions (e.g. platforms). As a result, the available for sea turtles nesting zone is very limited and the females return to the sea without laying eggs. The record of the existing beach equipment is suggested twice per nesting season (during the low touristic season and during the high touristic season).

6.4. Human presence

Human presence on the nesting beach during night hours may prevent the nesting females from laying eggs. Moreover, during the hatching season may result in either the trampling of hatchlings on the dark beach or their disorientation (if artificial lighting is used on the beach). For monitoring this phenomenon is suggested night patrols to be conducted, especially during the high touristic season. Also, during nesting activity monitoring (see in 2), the tracks of human presence (e.g. footprints next to or on spoors, fire traces) should be recorded on a daily basis.

6.5. Light and noise pollution

Touristic areas have light and noise pollution, which may prevent the nesting females from laying eggs or cause hatchling disorientation (the hatchlings lose their way to the sea and die either from exhaustion or from dehydration). The record of the existing light pollution is suggested twice per nesting season (during the low touristic season and during the high touristic season).

6.6. Vehicles on the beach

At the Greek nesting sites, the presence of vehicles and heavy vehicles (either for recreational reasons or for beach cleaning activities) is very common. The weight of the vehicles on the beach compresses the sand and makes it very tough, so the

nesting females cannot dig the egg chamber. In addition, the hatchlings are often trapped in the deep vehicle traces, not being able to find their way to the sea. Vehicle tracks should be recorded on a daily basis during nesting activity monitoring (see in 2).

6.7. Interaction with fisheries

The use of nets and longlines in the marine area of the nesting sites, where the presence of turtles is increased (mating and inter-nesting areas), create problems for both sea turtles and fishermen. Many turtles are hooked or trapped in nets (photo 11). The monitoring and collection of data regarding this threat is explained below (see in 8).

6.8. Speedboats

The use of high-speed boats is very common for recreational purposes. This practice poses serious risks for the adult turtles, which during the mating and inter-nesting season stay at the sea surface near the nesting beach to breath or rest. As the reflexes of the animals are very slow, the risk of lethal collision is very high. The monitoring and collection of data regarding this threat is explained below (see in 8).

7. Sampling in foraging areas

As mentioned, in order to monitor the conservation status of the sea turtles in the marine environment, areas with increased presence of sea turtles throughout the year (wintering and foraging areas) should be identified and studied. In this chapter is described the methodology followed in Greece and in particular in Amvrakikos Gulf (north-western Greece).

Amvrakikos Gulf is a semi-closed sea with significant presence of marine turtles, although there has not been a record of a nesting site within it. Since 2002 field work is conducted to research the turtle presence by locating, tagging and satellite tracking the population. Besides turtle monitoring at sea, the authorities and the local community are kept informed.

High densities of loggerhead marine turtles are present in the shallow waters in the northern part of Amvrakikos Gulf. Turtles are captured at this location, using the “rodeo” technique from a small inflatable dinghy (photo 12). Captured turtles are hauled on board for data collection and are generally released within 15 min of capture. GPS coordinates are recorded for turtle capture locations. Curved carapace length is measured to the nearest 0.5 cm with a fibreglass tape measure, and straight carapace length is measured using wooden or metal callipers. Tail lengths, from tail tip to inner part of the notch between the supracaudal scutes, are also recorded using a fibreglass tape measured to the nearest 0.5 cm. Turtles are externally tagged on two flippers using a combination of uniquely numbered Monel metal tags (National Band and Tag Company, Kentucky, USA). Photographs of each turtle’s flippers, head, carapace and any notable injuries etc. are taken to be used as an archive for photo ID that may assist in identifying turtles that have lost both their flipper tags, but are scarred – indicating they have previously been tagged – and to record incidences of change to body condition etc. Additionally, a small tissue sample is taken from one of the rear flippers of each turtle to build an archive of tissues that can be used in studies involving genetics and stable isotope analysis. Such studies can establish the source breeding grounds of turtles foraging in Amvrakikos Gulf and also determine characteristics of foraging patterns for resident animals.

8. Operation of the Rescue Network

Through the Rescue Network, turtle strandings (both dead and injured or sick) throughout the Greek coastline are recorded, including the areas with increased turtle presence (nesting sites and wintering or/and foraging grounds). The analysis of stranding data allows conclusions to be drown regarding the main threats/pressures of the sea turtles in the marine area and proposals to be submitted regarding management plans.

8.1. Handling process for strandings

When a stranded turtle is reported (dead or alive) it is important to record the date, the exact location and the contact details of the person providing the information. For each case, the local Coast Guard should be informed, as according to the Greek legislation is the competent authority to report any cases of dead turtles and in case of injured or sick animals to undertake and accomplish its transport to the Sea Turtle Rescue Center. If the distance and the circumstances allow it, the immediate transition to the site to attend the stranding is essential. Otherwise, the competent local authority handles the stranding by its own.

As it is not always clear in the report whether a stranded turtle is dead or alive, it is best to prepare for both. A stranding kit[2] should be taken along with a suitable transport crate and plenty of old towels in case the turtle requires transport for rehabilitation.

At first, the determination whether the animal is dead or alive is necessary. Generally, this should be clear (bloating, rotting etc) but if the turtle appears very fresh then a gently touch in the eye and the cloaca gives evidence through reflex. Then close examination of the animal findings and completing of the relevant sheet (i.e. Stranding Sheet) with all the data (see in 8.2) should take place. Taking pictures is also essential. In cases of live animals is suggested during the examination a gauze soaked in saline solution to be placed over the head (covering the eyes, but not the nose), as this has the effect of calming the turtle.

After the examination is over, if the animal is dead the arrangements for the interment by the competent authority (i.e. in Greece the Municipalities) should take place, while if the animal is injured the transport for rehabilitation should be organized. During transportation the turtle should be covered in a wet towel to help it keep it cool. Moreover, the transport crate should be well lined with old towels to ensure the turtle does not damage itself.

8.2. Stranding data recording

During the examination of a stranded sea turtle is necessary to record the species (*Caretta caretta, Chelonia mydas, Dermochelys coriacea)*, the sex, the carapace measurements (length and width), the location of the sighting, the condition of the

[2] The necessary equipment should contain: 1.5m measuring tape, disposable latex surgical gloves (numerous), Stranding Sheets, Ball-point pens, big scissors (to cut lines or rope in case of entanglement), a large knife, scalpel and single-use blades, labelled tubes for tissue samples, 95% alcohol, forceps, small plastic bags (to store the removed tags and/or fishing equipment or other items), a packet of sterilized gauzes, a bottle of saline, red spray paint (to mark an X on the dead turtle and avoid returning to same stranding), Betadine Scrub (for hygiene purposes for the people that deal with the stranding), a metal tag remover (ring poppers), a plastic tag remover (wire cutters), calipers, GPS unit and PIT Scanner.

animal and (if visible) the cause of injury or death (photo 13). In addition, in case of tagged animals, the code of the tag should be recorded (including their flipper location and then removed and stored). In particular, regarding the cause of injury or death:

- The head should be examined on all sides to identify possible impact injuries to the skull, injuries to the eyes (injuries on the top of head or in the eyes are usually inflicted on purpose following capture in fishing gears) and possible foreign objects in the mouth (fishing hooks or lines). Three photographs should be taken: one from each side and one from above the head. Any specific injuries should have additional close up photographs taken.
- Each flipper should be examined to identify possible entanglement injuries caused by nets, fishing lines or other objects. Clear photographs of each of the flippers, plus close ups of injuries, tags and tag scars should be taken.
- The carapace should be examined for any evidence of trauma from a boat or propeller strike or any other impact (e.g. from human action – hammer or equivalent). One full shot of the carapace from the top should be taken, along with close up of any injuries.
- The cloaca should be examined for any evidence of a consumed fishing line. A photograph of the rear end of the turtle should be taken from above, to include the tail. Any visible injuries should be photographed as well.
- The turtle should be turned upside down to examine the plastron to identify any injuries there (e.g. from predation from other animals such as monk seals).

All photographs of injuries should be taken with a tape measure in the shot to show clearly the extent of the injury. Any objects removed from the turtle (fishing lines/nets/hooks etc.) should also be described and photographed separately. Finally, a tissue sample (preserved in alcohol) should be taken from the turtle.

For every single stranded turtle, the Stranding sheet and the relevant photos should be archived.

8.3. Main threats/pressures in the marine area

The main threat/pressure in the marine area, which has been recorded, is the interaction with fisheries. Sea turtles are affected to a significant degree by entanglement in fishing gear. In addition, a number of studies have indicated that large numbers of sea turtles are caught as bycatch by some types of Mediterranean fisheries.

In Greece, fishing is not currently targeting the sea turtles; however, many of them are accidentally caught in various fishing gear. With the existing data, three types of fishing methods catch most of the turtles: longlines, bottom trawls and static nets. The capture of the sea turtles in the above three fishing gear has a significant mortality rate and therefore their impact on the populations is very serious. These effects appear to be greater as the size of turtles that die increases. Indeed, population models have shown that the loss of adult individuals have a large impact on the population. Therefore, fishing gear such as bottom trawls and static nets (although they catch fewer turtles than the longlines), have a more serious impact on the population because they mainly catch adult individuals, which have greater reproductive value.

The mortality of the turtles after their accidental capture in fishing gear can be divided in two categories "non-deliberate" and "deliberate" or “intentional” mortality, depending on the behavior of the fisherman.

Through the Stranding Network, the data of the turtle standings throughout Greece are recorded (including the cause of injury or death), in order for the main threats/pressures of the species in the marine area to be monitored (see in 8.2).

9. Protection of the important sea turtle sites

A successful procedure of monitoring and protecting sea turtles must be connected to specific management measures. These measures have to be conducted and implemented by institutional bodies, within a legal framework, both in main reproduction habitats and the marine area. The minimum protection measures applied on the important sea turtle sites are the following:

9.1. Protection measures at the nesting sites

- Placement of umbrellas at fixed points, vertically towards sea waves with distance between them equal to or greater than 3 meters.
- The sand between umbrellas and sunbeds is not to be covered by wooden paths.
- Reassurance of a 5-meter width free zone in the back of the beach in order for the sea turtles to be able to nest.
- The washing of sunbeds and the cleaning of beach equipment is to be done away from the beach.
- Transportation of the sunbeds and other beach equipment at sunset to a spot outside the sandy beach and reposition of them on the beach the next morning. Dragging the equipment along the sand is forbidden. In the case of umbrellas, because of their stable base, daily removal is not recommended. In order for shading to be avoided, the use of umbrellas that have the ability to close is recommended in case of nests made in the specific beach area.
- Cleaning of the beach during sea turtle reproduction period must be done manually. Beach cleaning vehicles can be used only before and after the reproduction period (1st May-31st October).
- Avoidance of light pollution and reassurance that there is no leakage from any private or public light sources in order to prevent the disorientation of the hatchlings.
- Beach-parties or music events are forbidden.
- Access and movement of vehicles is forbidden on the beaches.
- Reassurance that a sufficient number of chemical toilets is installed for the swimmers, far from the sea turtle nesting areas.

9.2. Protection measures in the marine area hot spots

In the marine areas, especially where the presence of turtles is increased (mating, inter-nesting and foraging areas), conduction of a Management plan is required for each marine hot spot, whereas protection measures are to be defined depending on the specific characteristics of each area. The minimum protection measures that must be considered are the following:

- Definition of specific speed limit of vessels and jet skis (at least in a one mile zone from the coast) between April and October.
- Definition of vessel capacity in each hot spot. All licenses of vessels must be issued according to the capacity which will be defined. The licenses must refer not only to the number of vessels in the marine area, but also to the technical requirements of the operating boats (such as size, noise level of the engine, propeller type etc).
- Definition of specific protection measures for the fisheries in each marine area (fishing zones, period of fishing, authorized catch etc.). Especially for sea turtles, specific guidelines have to be given to fishermen in order to reduce their mortality, such as:

    a. Trawlers: if sea turtles remain underwater for several hours, they may get into a coma and very possibly be drowned. Under these

conditions they must remain on the fishing vessel until they recover and then to return to sea.

b. Longlines: if sea turtles are entangled in longlines, they should not be carried on board with the line but they have to be released after cutting the line as close to the turtles' mouth as possible (special line cutter has to be used).
c. Static nets: if sea turtles are entangled in nets they have to be completely freed from the net and then released to sea.

Conclusions

In conclusion, continuous monitoring within scientific methodology is necessary for the conservation of sea turtle population. Nevertheless, due to the continuous recordings of increased threats in the main reproduction habitats as well as in the marine areas, monitoring and protection is inextricably linked to the institutionalization and implementation of management measures by government bodies for the major areas of the species, so as to achieve the Integrated Protection of the Sea Turtles on a long-term basis.

Photos

Photo 1: Protection of nest *in situ*

Photo 2: Protection of nest *in situ*

Photo 3: Nest relocation

Photo 4: Nest that needs emergency relocation

Photo 5: Beach hatcheries

Photo 6: Protection from light pollution/Nest shading

Photo 7: Protection from light pollution/Nest boxing

Photo 8: Predated nest

Photo 9: Hatching nest

Photo 10: Nest excavation

Photo 11: Entangled sea turtle in fishing nets

Photo 12: “Rodeo” technique in Amvrakikos gulf

Photo 13: Stranded sea turtle