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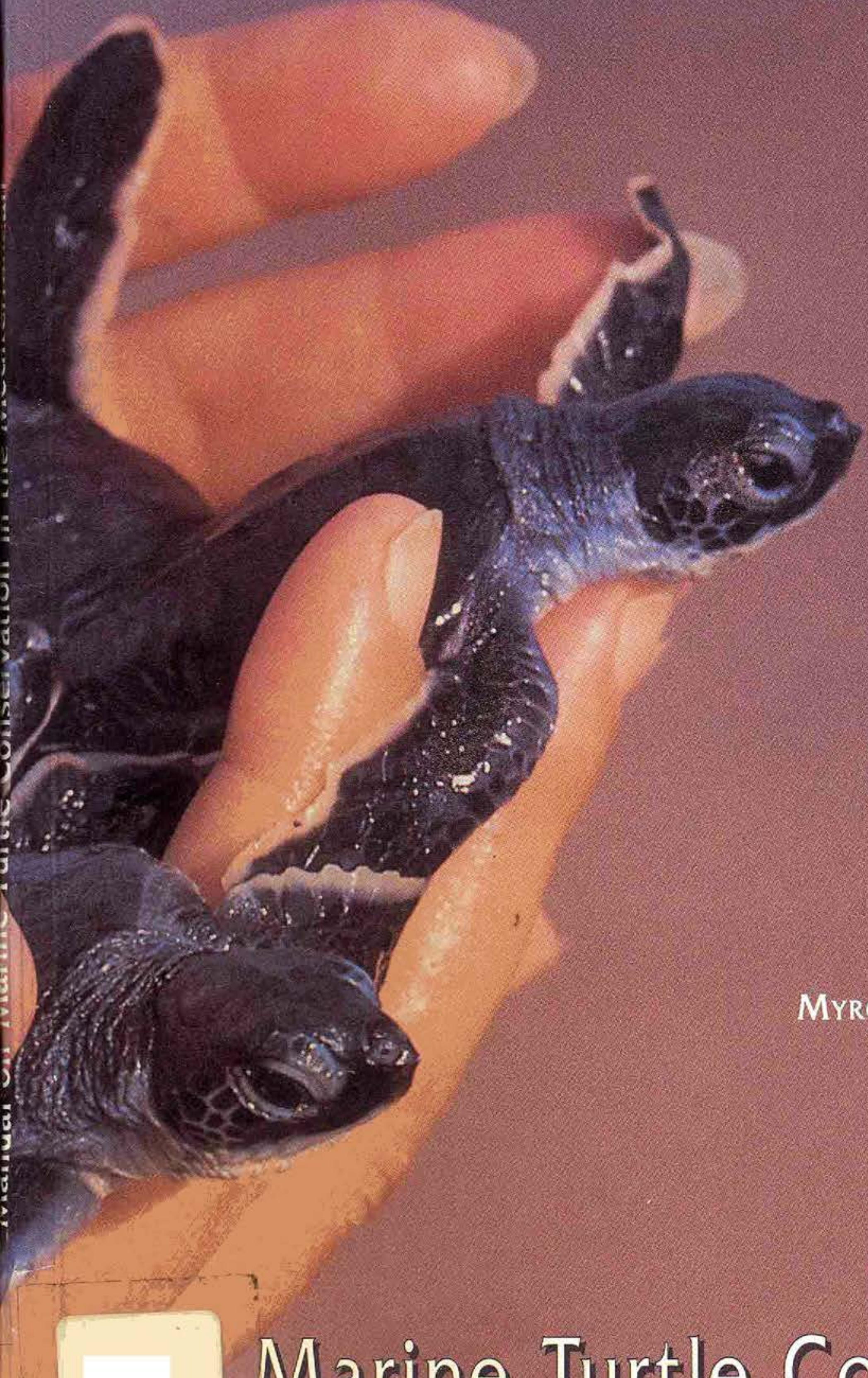

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Manual on Marine Turtle Conservation in the Mediterranean

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PREFACE

The present manual attempts to give practical information that may be useful, under Mediterranean conditions, for marine turtle conservation work. It was originally conceived as an aid for the training courses held by the Department of Fisheries of Cyprus, at the Lara Turtle Reserve, for UNEP/MAP sponsored trainees from Mediterranean countries and for volunteers and other scientists working on the Cyprus Turtle Conservation Project . This manual is still seen as a supplement to practical training in turtle conservation techniques.

The printing of this edition of the Manual was co-financed by the Mediterranean Action Plan (Specially Protected Areas) through the World Conservation Union (IUCN), within contract 9112-4/CWS/RAC-SPA, and by the Cyprus Wildlife Society. The first edition was prepared for the meeting of the National Focal Points for Specially Protected Areas of the Mediterranean Action Plan (Athens, October 1992). The present edition is a revised, illustrated and somewhat extended version of the 1992 edition.

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- The participants in the training courses and the volunteers that have worked with the authors on the Cyprus Turtle Conservation Project, for their interest and their many questions which have helped shape this manual. The authors hope that it will answer the needs of past and future trainees and volunteers and be of assistance to marine turtle conservation in the Mediterranean.

- Alain Jeudy de Grissac for his encouragement and support in the realization of this manual

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CONTENTS

I. INTRODUCTION

Three species of turtles are found in the Mediterranean. These are:

Caretta caretta - Loggerhead Turtle
Chelonia mydas - Green Turtle
Dermochelys coriacea - Leatherback Turtle.

Only the Loggerhead and Green turtles breed in the Mediterranean. There are no records of Leatherbacks breeding in the Mediterranean but their pelagic nature often leads them into this sea where they are occasionally caught on floating long-lines. Occasional records of other species also exist.

Past exploitation is undoubtedly responsible for the decimation of turtle stocks in the Mediterranean. Though some exploitation still takes place, this concerns mainly incidental catches. At present the other main threat to turtles comes from putting nesting beaches to recreational uses. Many such beaches have already been completely lost to the turtles.

Nowadays Loggerheads nest mainly in Greece, Turkey and Cyprus. They are also known to nest in Syria, Israel and Tunisia in very small numbers. Nesting in Libya and Egypt has been confirmed, though the number of turtles nesting there is still uncertain.

Green turtles nest in Cyprus and Turkey. Occasional nesting has also been reported in Israel. There are past records of Green turtles nesting in other areas of the Mediterranean.

The populations of both species are known to have been much larger in the past than they are now. The turtles now nesting in the Mediterranean are the remnants of these larger populations that have collapsed. Their ancestors colonised this sea about 10.000 years ago and the present turtles' genetic make up testifies to this and to the fact that these turtles form populations genetically distinct from their ancestral Atlantic populations (see chapter "About Turtles in the Mediterranean").

If turtles are to be effectively protected in the Mediterranean, conservation efforts need to concentrate on protecting them from man's activities, by reducing losses due to fishing and by safeguarding their remaining nesting and feeding habitats. They should also aim at increasing recruitment into the ailing population by protecting turtle eggs and hatchlings from predation and other dangers.

A strategy of intervention in conserving turtles is necessary, in certain areas at least, because of the low population levels in the Mediterranean and because of the disturbing trends in the destruction or degradation of their nesting habitats. Such intervention should be carefully thought out and applied only where appropriate, using techniques that are as close to nature as possible. Without a doubt the protection of mature female turtles and of their remaining nesting habitats merit top priority and nothing in this manual is intended to imply a different ranking of priorities (See chapter "Conserving Turtles - Perspectives and Priorities").

II. ABOUT TURTLES

Though it is not within the scope of this manual to summarise the biological data on turtles, some basic information is presented as this may be useful. A brief bibliography at the end of this manual gives the references to other documents which are recommended reading. References are given only where mandatory or useful.

Marine turtles are an ancient group of reptiles which, like the marine mammals, have "reversed" their evolution and have returned to the sea. This "reversal" is, however, incomplete, and although turtles have adapted well to life in the sea, (e.g., they are excellent swimmers and can stay underwater for long periods of time) their ties to their land-adapted ancestors are unmistakable. For example, they still have to breathe air, i.e., they have lungs, and they have to come up on land to lay their eggs.

There are eight species of marine turtles in the world (or seven if *Chelonia agassizi* is grouped as a subspecies of *Chelonia mydas*). These are:

Lepidochelys kempi	- Kemps Ridley
Lepidochelys olivacea	- Olive Ridley.
Eretmochelys impricata	- Hawksbill
Caretta caretta	- Loggerhead.
Chelonia mydas	- Green Turtle
Chelonia agassizi	- Black Turtle
Chelonia depressa	- Flatback
Dermochelys coriacea	- Leatherback.

Feeding

Adult and sub-adult Loggerheads are primarily carnivorous, feeding on benthic invertebrates such as crabs, sea urchins, molluscs and other hard-shelled animals, which they crush with their hard palate. They also feed on jellyfish. Hatchlings and juveniles (turtles during their epipelagic stage) feed on macro-planktonic animals.Green Turtle hatchlings and juveniles are primarily carnivorous during their epipelagic stage and feed on a diet similar to that of the Loggerhead hatchlings and juveniles, i.e., they feed mainly on macro-planktonic animals. After their epipelagic stage, which lasts about 2-4 years, Green turtles become herbivorous. In the Mediterranean, there is little information on their food and it is assumed that they feed mainly on sea-grasses such as *Cymodocea nodosa, Zostera spp., Posidonia oceanica, Halophila stipulacea*, algae etc. The gut content of three drowned Green Turtles, which had been feeding in Cyprus waters, was examined by the authors. It was found that all had been feeding exclusively on *Cymodocea nodosa*. One turtle was 50 cm in length (curved carapace length - CCL) and weighed 15.5 kg while the other two were about 30 cm long turtles weighing about 3 kg. The *Cymodocea* was chopped in 2-3 cm pieces in the case of the larger turtle and 1-2 cm in the smaller ones. Hatchlings and juvenile Green and Loggerhead turtles, during their epipelagic development stage, are attracted to light-coloured or white objects as food. As a result they may also ingest plastic beads, polythene sheets, plastic bags etc., mistaking them for jellyfish.

Behaviour at sea

Turtles are solitary and do not form any concentrations except in the mating season in which they congregate in specific areas. In the Mediterranean, migrations (to and from the feeding grounds) probably occur, but migration routes etc. are still largely unknown. There is some evidence of Loggerhead turtles migrating to the Gulf of Gabes in Tunisia, i.e., to their feeding grounds, from the nesting beaches in Zakynthos in Greece (1). Young Green and Loggerhead turtles go through an epipelagic development stage which lasts several years (probably 2-4) before becoming benthic foragers.

Hearing

Turtles have no inner ear structure and to all intents and purposes they are deaf. They can, however, detect vibrations of certain low frequencies, probably through the skull and carapace. They are apparently sensitive to stimuli in the range of 0.25 to 0.50 kc/s (2). This sensitivity to a low frequency spectrum of sounds may be relevant in the turtle locating and selecting an appropriate spot on which to emerge on the nesting beach as such sounds may be generated by wave action.

Chemo-sensory behaviour

Little is known about chemo-sensory behaviour in turtles (3), although orientation to certain chemicals introduced in the nest has been experimentally demonstrated on hatchlings (4 and 5). There is also strong indirect evidence of chemo-sensory behaviour when turtles locate their nesting-beaches. In Cyprus, the densest nesting activity of Loggerhead turtles is on a stretch of beach of about 100 metres. The sand on this beach has a high sulphur and iron content from past (i.e., centuries old) mining operations in the area. It is presumed that this acts as a chemo-sensory "compass point" which helps turtles locate the beach. (This high content in sulphur etc. does, however, causes some other problems to the incubating eggs).

Vision

Not much is known about vision in adult turtles though this is obviously an important sense at sea and on land. Hatchlings need their sight to locate the sea (6). Turtle hatchlings are apparently more sensitive to the shorter wavelengths of the light spectrum (i.e., blue colour). This fact however, may be related to the intensity of the light perceived by the turtle and not to colour (7-10). Their sensitivity to the very long wavelengths has still to be ascertained and may have conservation implications, e.g., in the use of infrared lights, for monitoring nesting activity on beaches. (Such lights are already in use by the authors with no apparent reactions from the nesting turtles.)

Longevity

It is not known how long turtles live. Without any human interference the Loggerhead Turtle life-span is estimated at more than 60 years (11).

Maturity

The age at which turtles mature apparently varies from place to place, presumably as a result of growth-rate, which depends primarily on temperature and food availability. Estimates of age at sexual maturity for Loggerheads vary from seven to over 30 years. More recent estimates put sexual maturity in the 13-30 years bracket for wild Loggerhead turtles.

Published estimates put sexual maturity in Green turtles at anywhere between 9-58 years (12) and between 27-33 years for Atlantic Green turtles (13). However, some of the information available is misleading, especially that relating to early maturity, since it is obtained partly from captive turtles and captive turtles evidently grow and mature more quickly than wild turtles.

In the Mediterranean, Loggerheads start nesting when they are about 60 cm long, measured as curved carapace length (CCL - see page 37). When they start nesting, these females are smaller than Loggerheads in other areas of the world. The age at which they reach this size is uncertain.

Green turtles in the Mediterranean start nesting when they are about 70 cm long (CCL) (Cyprus data). The age at which they reach this size is not known.

Fecundity

It has been estimated that Loggerhead turtles can continue being reproductively active for at least 32 years. This is the period they have been estimated to survive fishing (shrimping) operations in Georgia (USA) (14). This period is dependant on the intensity of fishing and the fishing gear used (and the resulting rate of turtle mortality from such fishing operations) and has not been calculated for Mediterranean turtles. Without human interference they are likely to continue being reproductively active for a longer period. From sparse observations by the authors there is some evidence that though older turtles continue nesting their eggs are often malformed, with double or multiple eggs, and with reduced viability. This may, however, be the result of other factors and needs further investigation.

Mating

Mating takes place in shallow waters, usually within 1 km of the shore, often in areas not adjacent to the nesting beaches, but a few kilometres away. In Cyprus, mating starts in late April, when turtles congregate offshore prior to mating.

There is evidence that turtles are polyandrous, i.e., that they mate with several males which are said to vigorously compete for the female. Copulation is infrequent after the start of the nesting-season. Fertilization is internal. The male clings onto the female with all four flippers, the large claws on the front flippers firmly holding on to the female's carapace. Copulation lasts several hours and mating pairs can often be seen on the surface of the sea. In Green turtles the carapace of the older females is deeply and permanently scarred in the marginals, where the claws of the male clasp the female.**(Photo 7)**

Nesting season

In the Mediterranean, Loggerheads usually start nesting at the end of May and continue laying until the end of August. Some turtles continue nesting into early September. Green turtles start about two weeks later. Variations in the nesting season, due to weather conditions, have been observed in both species. Nesting and the nesting process is discussed in detail in later chapters.

Intraseasonal nesting

In other areas of the world, Loggerheads are known to lay from 1-6 times and Green turtles from 3-6 times in the same nesting season. In Cyprus, Green turtles have been observed to nest 3-5 times. The observers, however, probably missed some nesting by the same turtles and the number of clutches laid in one season is, therefore, probably somewhat higher, judging from the length of the nesting season and the records of the nesting dates of tagged turtles. It is probable that 4-5 clutches of eggs are laid in a season, in some years at least. Loggerheads have been noted to nest 1-3 times in the Mediterranean (15) although more observations are needed to confirm this. On Lara beaches indications are that they nest at least four times in the season. There are also indications that the number of clutches laid in a season may vary depending on factors such as weather conditions (extended winter or early summer) though it is still not certain that the total number of eggs laid in a season varies as a result. There are indications that the number of eggs per clutch may vary to compensate for such eventualities.

Turtles, and more particularly Green turtles, will usually nest on the same beach, and often on the same part of a beach, in a season. Nesting by the same Green Turtle on different (but nearby) beaches or on a different and distant part of a long beach, during the same season, is probably the result of disturbance caused by humans or predators. Loggerheads are said to be somewhat less specific, though much remains to be learnt on their habits. One Loggerhead turtle tagged on Lara beach (west coast) was observed to nest on a beach 20 Km away during the same nesting season. More intensive tagging and especially follow-up programmes (beach surveillance in the breeding season) will help in getting better information.

Natal homing

Tagging has shown that female turtles faithfully return to the same beaches in successive nesting seasons. These beaches are their natal beaches, i.e., the beaches on which they incubated and hatched. Recent research involving mitochondrial DNA fingerprinting in turtles has shown that environmental cues, i.e., imprinting behaviour, are responsible for their choice of a nesting-beach (16, 33). Similar imprinting on their feeding grounds may take place (17). The environmental cues responsible for imprinting on natal beaches are still the subject of many hypotheses and research. The earth's magnetic field and variations in it, wave direction and chemicals in the sand and adjacent water are some of the factors that are being researched into as possible cues in imprinting and "map reading" in turtles. There is evidence that all the above cues are to some degree at least involved in such imprinting. This imprinting has significant conservation implications as it results in demographically distinct populations. The implications are that each rookery, obviously, has to be protected separately and that replenishment of decimated populations and recolonisation from protected populations is extremely slow.

Nesting cycles

Turtles do not nest every year. It is generally accepted that they nest in longer cycles. These vary from two to eight years or even longer. Green turtles in Cyprus have been noted to nest on predominantly 2-year and 3-year cycles, though 4-year and 5-year cycles or even longer have been recorded. However, many turtles are never seen again. The implications and reasons for this are of great interest. Some no doubt perish. Insufficient beach surveillance and tag losses may confuse the situation. The longer cycles observed (4-8 years) may be real or they may be the result of such insufficient surveillance. It may be that turtles nest in a wider area (i.e., nesting on beaches not under surveillance), though on present evidence this is unlikely. Nesting periodicity for the same turtle may change, i.e., a turtle nesting in 1987 may nest in 1989 and then in 1992. Such variations probably reflect changes in food availability and in the amount of food (fat) stored by the turtle. Such changes in periodicity have been noted in the Cyprus turtle population.

Commensals and ectoparasites

The commonest species of commencals and ectoparasites encountered on Loggerhead turtles in the Mediterranean belong to the *Cirrepedia (Chelonibia testudinaria, Balanus sp., Lepas anatifera* and *Conchoderma virgatum* etc.). The crab *Planes minutus,* found living in the cloaca of Loggerheads, is fairly common. Many Loggerheads also have algae growing on them. Several other species of commensals and parasites have been identified on Mediterranean Loggerhead turtles (11). Commensals and ectoparasites on *Chelonia mydas* are apparently fewer, in the Mediterranean at least, and the authors have only noticed *Chelonibia testudinaria* on a few turtles.**(photos 18&19)**

III. ABOUT TURTLES IN THE MEDITERRANEAN

Origins

Although turtle evolution goes back to about 200 million years, the present colonization of the Mediterranean is much more recent. In Tethyan times turtles probably colonised the Mediterranean several times from the Atlantic, during inter-glacial periods, and in previous eras from both the Indian and Atlantic oceans.

The current population probably colonised the Mediterranean after the regression of the last ice-age which started about 40.000 years ago. It is most likely that this colonisation took place in the last 10.000 years, when the area warmed up enough to sustain nesting on the shores of the Mediterranean. Recent mitochondria DNA fingerprinting of Green turtles from Cyprus (19) confirms that these turtles have been a separate (and isolated) population from the Atlantic stock for at least 10.000 years.

Recent studies on Loggerhead turtles show that the female nesting population in the Mediterranean (Greece, Tunisia and Cyprus) is genetically isolated from the Atlantic nesting female population (20, 21). The latter study also showed that Loggerhead turtles of Atlantic origin are found in the West Mediterranean basin where they are caught on long-lines in large numbers. They are caught as sub-adults. It is concluded that natal homing is so strong as to make them return to the Atlantic (probably to the East Florida beaches), from which they originated, without leaving any impact on the Mediterranean turtle gene pool.

Nesting in the Mediterranean

Green turtles

Mediterranean Green turtles nest only on the eastern shores of the Mediterranean, on a few beaches in Cyprus (22) and on a few beaches at the eastern end of the Turkish Coast (23). Occasional nesting has recently been reported on the coast of Israel (24). There is no nesting in Greece and the rest of the Levant Coast while the status of any nesting in Egypt and Libya, if such nesting takes place at all, is unknown, but likely to be sparse. There is no nesting of Green turtles in Tunisia and further west.

It is unlikely that any historical data will be reliable enough to distinguish with any certainty between Loggerhead and Green turtles and determine with any reliability the previous extent of Green Turtle nesting in other areas. Nonetheless, statistical data, including data from FAO, show relatively large catches of turtles (without mentioning species). For example, turtle catches of 75 tons are recorded in Turkey in 1965 (25). This is equal to about 1,000 turtles. Other reports of catches of turtles in Turkey estimate that in Mersin alone about 15.000 turtles were landed in the period between 1952 and 1965 (26). The same source mentions catches of 10.000 turtles in the Ceyhan/Seyhan river estuaries in 1965 alone. In all cases only Green turtles were mentioned as having been caught. Records for Cyprus concern the export of turtles to Europe in the 1920's via Alexandria but the quantities could not be ascertained. Turtles from Palestine and Syria were also exported to the UK via Alexandria (27). It has been estimated that about 30.000 turtles (90% of them are mentioned as being Green turtles) were caught in the two decades preceding the second world war, from the coast of Palestine alone (26). Following the end of the war catching of turtles continued in this area but at a much lower level, until about 1972 when it was practically brought to a halt. Nesting has practically stopped since then on the Levant Coast.

"Historical" records, of the species concerned in particular, are of course somewhat suspect though there is little doubt that a fishery for turtles existed in Palestine and the Eastern coast of Turkey at least. It is likely that both species of turtles were being caught, both on the beaches during nesting and, judging from the "fishing seasons" mentioned, i.e., April to June, mainly during the mating season. Presumably the Green Turtle would have been targeted by preference.

Loggerhead turtles

Currently Loggerheads are known to nest in Greece, Turkey and Cyprus. They are also known to nest in very small numbers in Syria, Israel and Tunisia. It has also been ascertained that they also nest on the Egyptian and Libyan coasts, although the intensity of nesting, on the Egyptian coast at least, is apparently low.

The largest single nesting site known in the Mediterranean for Loggerheads is in Zakynthos. Loggerheads also nest on several other beaches in Greece, mainly in Cephalonia, the Peloponese and Crete. They also nest on several beaches on the southern Turkish coast, from Dalyan, in the west, to Samandagi, in the east (28).

Population size and dynamics

Many estimates of the numbers of turtles currently nesting in the Mediterranean are based on the number of nests counted on the beaches. As not all turtle tracks lead to nests (see chapter on "Nesting") the number of nests is sometimes estimated as a percentage of the turtle emergences (i.e., turtle tracks) counted. This percentage needs to be verified as, for many reasons, it can vary significantly from beach to beach. To calculate the number of female turtles nesting, the number of successful nests (as estimated) is divided by the number of clutches these turtles are thought to lay in a season. The number of clutches laid in a season still needs to be verified. The number of clutches laid by a turtle can also vary from season to season. Obviously, these again can lead to significant variations in the estimates. Until more information is collected on the number of clutches laid in a season, population estimates based on such calculations inevitably have to be treated with some caution.

Nesting activity can also vary from year to year. In Green turtles in particular, there are large fluctuations in nesting activity (i.e., number of turtles nesting) from year to year, sometimes of orders of magnitude and any estimates of density of nesting or of number of nesting females or of population size, based on one year's data (or even two years' data) may be misleading. Estimates have been made on even shorter period surveys.

From the information that is currently available any estimates of population can obviously only give figures relating to orders of magnitude and not to true estimates of populations.

The number of Green turtles nesting on the west coast of Cyprus is tentatively estimated at about 100 (70 have already been tagged). Several new (untagged) turtles are found each year. This shows that it is possible that the population may be larger and that (a) turtles are nesting more infrequently (on average) than was thought until now - which tallies with the information available to the authors and with the Lara data or (b) they nest over a wider area - which does not tally with the information available to the authors (the question of tag losses is discussed elsewhere in this manual). The sizes of such new (untagged) turtles is such as to discount the possibility of them being new recruits.

It is assumed that the Green Turtle population nesting in Cyprus does not exceed 200 turtles, the north and east coast beaches included.

On the basis of 1988 data, the Green Turtle population nesting in Turkey was estimated at about 300-350 females p.a. (28). More recent information (29) suggests that there has been a very significant decline in the Green turtles nesting there. Whether this is a real decline, or not, is debatable as both estimates are based on observations made in one year (or shorter) surveys and, as already mentioned, annual fluctuations on the number of females nesting are likely to disguise any trends. The estimate of 300-350 females nesting per year (for Turkey) was based on the assumption that the average number of clutches laid by a turtle in a year is 2.5.

On the basis of the available information, and keeping in mind the various assumptions made, it is tentatively suggested that the population level of female Green turtles nesting in the Mediterranean is in the range of 500 to 1000. More data and intensive multi-year multi-year surveys are urgently needed.

The number of males is unknown but this is assumed to be less important than data relating to females.

The size of the Loggerhead population is evidently somewhat larger. The number of females nesting each year in Greece (calculated again from the number of nests) is probably about 300-800 for Zakynthos, probably about 1000 for the whole of Greece and probably another 500 - 1000 for Turkey. Assuming nesting usually takes place every two years, this would put the total female nesting population at about 2000 - 4000, say 5000 if all the remaining nesting areas (Cyprus, Libya, Egypt) are taken into consideration. Nesting in 3 or 4-year cycles or longer will change this estimate.

Relatively recent (1988) catches of turtles in Tunisia and elsewhere (excluding the Balearics and Spain and the Italian and Maltese long-line fisheries) were in the range of 6000-8000 animals per year (30).

On the mainland Spain and the Balearic sea at least 20,000 Loggerhead turtles are captured by the Spanish swordfish floating long-line fishery alone each year. Of these at least 20%, i.e., 4,000 turtles have been estimated to die. The turtles caught are sub-adult, mainly in the range of 45-55 cm (CCL) (18). A similar number is probably caught by the Italian and Maltese swordfish long-line fisheries.

From recent genetic information on these turtles (21) it is now clear that the great majority of these turtles are entrants into the Mediterranean from the Atlantic though no doubt some turtles of Mediterranean origin are also caught. Fishing in the Mediterranean is, therefore, having an impact not only on the Mediterranean population of turtles but also on the Atlantic population.

Sex ratios in turtle populations in the Mediterranean are unknown, but it is tempting to speculate that since the Mediterranean is on the northern limit of the turtles' distribution, the male to female ratios may be high. This is of course sheer speculation as the pivotal temperature for sex determination in Mediterranean turtles is not known and as such pivotal temperatures vary somewhat between other areas that have been studied.

The size composition of the turtle populations in the Mediterranean is also largely unknown. The sizes of nesting females, though not an indication of the size composition of the population as a whole, show, nonetheless, that the Mediterranean populations have a larger number of small mature females than practically any other population elsewhere in the world. This may be the result of several factors, such as the considerable variations between populations in growth-rates and size at sexual maturity.

The rates of recent, i.e., since 1980, decline in the Mediterranean nesting populations are still unclear as the information available is still not adequate. On the basis of 17 years of data on Green and Loggerhead (but especially Green) turtles nesting in Cyprus, it is obvious that there are very wide fluctuations in the numbers of females nesting from year to year (this tallies with information from other areas) (31). No overall decline has been noticed during this period in the turtles nesting on the beaches of the west coast (Lara-Toxeftra). Nonetheless, in the last 15 - 18 years, several beaches have been lost to recreational uses in other parts of the island and presumably the turtles that used to nest on those beaches have been lost to the nesting population.

IV. IDENTIFICATION OF TURTLES

This chapter deals primarily with the identification of Loggerhead and Green turtles and the differences between them.

Adults

Loggerhead

Loggerheads are smaller than Green turtles and in the Mediterranean, they do not usually exceed 90 cm (curved carapace length). The carapace is somewhat flat, elongated, tapering towards the rear, orange-brown to dark brown. Its surface, though generally smooth, is not shiny and may be flaky. The throat and the soft parts of the flippers are whitish-yellow or orange-yellow. The plastron is whitish-yellow to pale orange. There are five costal shields (scutes), the front one being smaller than the rest. The plastron has three inframarginal shields. The head is very large, compared to that of the Green Turtle and it has a powerful jaw. The flippers have two claws.**(Photo 1)**

Green Turtle

These are often larger and heavier animals reaching 110 cm or so in length, measured as curved carapace length (CCL), with a domed, oval and often smooth and shiny carapace which is generally dark olive green to black. There are four costal shields (scutes) of about equal size which are often mottled with brown or copper in radiating patterns. The throat and soft parts of the neck and the flippers are white, occasionally off-white or yellowish. The plastron is white or off-white. The plastron has four inframarginal shields. The flippers have a single claw. **(Photo 2)**

Hatchlings

Loggerhead

Both the carapace and the plastron are brownish - black, as is the rest of the body, with the marginals sometimes paler, from ochre to brownish-black. The extremities and the plastron are also occasionally ochre-brown. The carapace is rough with the costal and especially the median shields keeled **(Photo 7).** The average length (straight length) of the carapace of the hatchlings is about 41 mm and, on average they weigh 16 gm

(Cyprus data). There are marked variations in the size of hatchlings from different nests (originating from different females). Hatchlings from the same nest are very similar in size. The average size of hatchlings apparently varies very little between rookeries in the Mediterranean.

Green Turtle

The carapace is black with a narrow white margin. The underside of the hatchlings is white. The shields on the carapace are smooth (not keeled). The hatchlings are usually larger than Loggerhead hatchlings, averaging 47 mm in carapace length measured as Straight Carapace Length (SCL) and 21 gm in weight (Cyprus data). **(Photos 9 & 10)**

Measuring hatchlings and eggs

Eggs and hatchlings should be measured with calipers fitted with a micrometre, i.e., measuring straight carapace length (SCL) in the case of hatchlings. **(Photo 11)**

Juveniles and sub-adults

Loggerhead

The carapace starts turning orange-brown and the median plates remain keeled until the turtles are a few years old. The keels disappear before maturity. Within a few months the black plastron turns light brown to yellow-ochre. **(Photos 12 & 13)**

Green Turtle

Green Turtle juveniles often retain their hatchling colours, i.e., a smooth black carapace with a white or off-white plastron and throat etc. However, after the first year or so the shields on the carapace often go lighter in colour, turning light-brown with off-centre radiating patterns of copper-brown and black. **(Photos 14 & 15)**

Sexual dimorphism

In both species, male and female hatchlings, as well as juveniles and sub-adults are similar in external features. Before sexual maturity, the males of both species grow a much longer and fatter tail than the female. The tail in males extends well past the posterior end of the carapace by 30 cm or more. This is the main way of identifying the sexes. **(Photos 3 & 4)** There are also secondary characteristics such as the male's larger curved claws and its shorter plastron. The females also have a more domed carapace. Basing identifications on these secondary features is however more difficult.

Deviations

It should be noted that the above characteristics of the two species are subject to individual variations. The most common variation in the eastern Mediterranean population of the Green Turtle is the number of costal and central shields. There may be 5 - 7 costal shields and up to 8 central ones and their shape may be irregular. This seems to be a genetically controlled feature and it is apparent from the hatchling stage. In some nests many hatchlings exhibit this feature. Occasionally adult Green turtles have been found with a smooth carapace with no shields showing. **(Photos 16 & 17)**

The identification should, therefore, not be based solely on the shield count but should also take other characteristics into consideration. Albino hatchlings are very rare and usually do not survive, even in captivity.

Other species

No other species are known to nest in the Mediterranean. Leatherbacks are occasionally caught on floating long-lines. This is a much larger animal reaching 2 metres in carapace length with a soft, skin-covered carapace which has no shields but seven longitudinal ridges. **(Photo 4)**. In the Eastern Mediterranean the only other species to reach a comparable size to a young Green or Loggerhead turtle is the freshwater species *Trionyx triunguis* which can easily be identified by its limbs which have five claws and lack the flipper-like shape of the marine turtles. It occasionally strays into the sea. **(Photo 5)**

V. NESTING - NEST AND TRACK IDENTIFICATION

Track identification

The Loggerheads, being smaller and lighter animals can "walk" on land with their flippers moving alternately, i.e., front-left and rear-right at the same time, followed by front-right and rear-left.

Green turtles are generally larger animals and lift their heavy bodies up on both front flippers, pushing forwards with all four flippers at the same time.

Because of their different way of "walking" on land, the tracks that the two species leave on their nesting-beaches are different. Loggerheads leave tracks where the deep impressions of the front flippers are alternate, while Green turtles leave parallel impressions. The "footprints" of the Green Turtle are also closer together as shorter "steps" are taken by the turtle. **(Photos 20 & 21)**

Checking for turtle tracks should be done early in the morning, if night surveillance is not possible. The wind will cover turtle tracks with sand very quickly on some beaches, making their location impossible later in the day. Tides and waves will also make it more difficult to distinguish between old and fresh tracks. Human footprints and car tracks may also confuse the issue on some beaches.

Keep in mind that not all tracks lead to a nest, and many "false crawls" can be made, on some beaches in particular, before a turtle makes her nest. **(Photo 22)**

Nests and nesting

Typically, both the Loggerhead and the Green Turtle make an arc-shaped nest as the turtle faces away from the sea when she lays her eggs and then gradually turns towards the sea as she covers up the nest. However, this is not always the case, particularly when the turtle has made many attempts to find a suitable spot to lay. The shape of the nest also varies due to a number of other factors, such as the nature of the beach (slope, grain size) and the habits (idiosyncrasies) of individual turtles.

Both species start digging with the front flippers in powerful strokes throwing sand out behind them.

Loggerhead nests are shallow as Loggerheads do not dig much of a body-hole but simply make a small depression in the sand. Then the turtle digs the egg-chamber, with her rear flippers, her body sloping down towards the tail and her head and carapace usually well above beach-level. The depth of the chamber varies and depends on several factors, such as the size (age) of the turtle, the location of the nest on the beach, the distance from the sea and the nature of the beach (grain size) etc. The top layer of eggs is usually 20-35 cm below the surface of the sand while the bottom of the egg-chamber is about 35-55 cm deep. The diameter of the chamber is about 13-18 cm on top widening by about 5 cm lower down. Usually the whole nest, including the cover-up operation, is relatively narrow and may reach about 2.5 - 4 metres in length, though this again varies according to the nature of the beach, the size of the turtle, etc. **(Photos 23 & 24)**

Green Turtle nests are deeper, as Green turtles dig a sizable body-hole before digging the egg-chamber. Consequently the nest is wide and deep and the eggs are deposited deeper than those of the Loggerhead. The top layer of eggs in this case is usually about 45-60 cm below the surface of the sand, while the bottom of the egg-chamber may be 60-85 cm deep. The diameter of the egg-chamber is about 18-23 cm on top, widening by about 5 cm lower down. Here again the nature of the beach (grain-size etc.) affect the depth at which the eggs are deposited. The complete nests (including the cover-up operation) are often also longer than the nests of the Loggerhead turtles, reaching 5-10 m in length. Green turtles often leave a sizable depression at the end of the nest, i.e., the end at which the turtle left the nest for the sea. The head and carapace are usually below the surface of the beach during laying. **(Photos 27 & 28)** In both species the point of entry to the nest can be distinguished from the point of departure from it, because the tracks at the point of entry are covered up by the sand thrown up by the turtle in digging the nest and in covering the egg-chamber.

Invariably the egg-chamber in both species is dug in the moist sand. The turtle digs her egg-chamber carefully with her rear flippers used alternately. As already mentioned the dimensions of the chamber vary somewhat with the species, the size of the individual female and the nature of the beach. They also vary with the size of the clutch of eggs to be laid. Double chambers, i.e., one for each rear flipper, have occasionally been recorded in young inexperienced turtles.

The turtle deposits her eggs in the chamber and takes care that while she is laying no sand falls onto the eggs. While she is laying, she guards the chamber with both rear flippers, to prevent sand from falling onto the eggs. Green turtles keep their rear flippers close together, cupping the chamber, while Loggerheads tend to keep them apart on either side of the chamber. Egg laying takes only a few minutes, the eggs being dropped usually two or three at a time.

After the eggs are deposited in the chamber the turtle uses her rear flippers again to cover the eggs with wet sand, forming a kind of lid to the chamber, making sure that sand does not fall between the eggs. The mucus which covers the eggs when they are being laid helps to stop the sand from dropping between the eggs. The sand sticks to the mucus and helps form the lid to the chamber. The egg chamber covering process is quite complex and the dexterity shown by the turtle in the use of her rear flippers in both digging and covering up the chamber is surprising. The turtle after covering the eggs then covers and camouflages the chamber by throwing back large quantities of sand with her front flippers. As she does this, she moves forward in stages. The Green Turtle moves forward as the level of the sand where she is digging reaches the level of the body pit. As she comes to the end of her digging, the body pit gets a little shallower, although Green turtles always leave a sizable depression at the point of departure from the nest.

Loggerheads dig less deeply to cover up their nest and the turtle throws more or less surface sand behind her. Loggerhead nesting is quick and may finish in about one hour. Green turtles take much longer because of the kind of nest they dig and may take 2-3 hours to finish - and sometimes more. Green turtles usually nest higher up on the beach than Loggerheads and will usually only lay on high profile beaches. Green turtles usually nest on surf-swept beaches, which often have such high profiles. They often select the part of the beach which has the highest profile. **(Photos 25, 26, 30, 31 & 32)**

Nesting periodicity and nesting season

Nesting usually takes place every 14 days (half a lunar cycle), but variations are frequent and turtles may lay in periods varying from 10-18 days. Loggerheads start laying at the end of May or at the beginning of June and usually finish laying by the end of August. Occasional nesting in early September has been noted. Green turtles usually start about two weeks later and finish by the end of August, though sparse nesting has again been noted even in early September.

The beginning of the nesting season may be affected by weather conditions and it may vary widely from year to year. Prolonged winter conditions can delay nesting; for example, in Cyprus, in the summer of 1992 the nesting season was delayed by about 2-3 weeks.

Time of nesting

Nesting almost invariably takes place at night. Daylight nesting was witnessed only four times (in Loggerheads) in 15 years of observation in Cyprus. It took place about one hour before sunset or at dawn.

Usually nesting starts after 10 p.m.. During certain periods of the moon the actual nesting time is influenced by the time of rising or setting of the moon. Turtles usually come up on the beach just before the moon rises, when the moon is "young" or just after it sets, when the moon is "old". Therefore, during certain periods, nesting-time can be predicted to a degree. However, turtles will nest during the full moon or when there is no moon at all. During the full moon they often come up when the moon is at its highest, (i.e., about midnight), perhaps to avoid throwing long shadows (made by a low, full moon) which are all too noticeable by predators. In other parts of the world, where there are large tides, tidal cycles have been mentioned as an influence on nesting time, the turtles reportedly coming up on the beach at high tide (32).

It is unusual for nesting in Green turtles to start after 3 a.m. unless the turtle has been disturbed or has repeatedly been unsuccessful in finding a suitable nesting spot.

It is still uncertain if the beginning of the nesting season is related to lunar and tidal cycles.

Eggs and clutch size

The eggs are white, spherical and leathery, i.e., they are soft-shelled. Loggerheads lay 85 eggs per clutch, on average, while the Green Turtle lays 120 eggs per clutch, on average (figures refer to Cyprus data). Loggerhead clutch sizes in Greece and Turkey are reported to be about 90-100 eggs. In Cyprus, Green turtles have been noted to lay up to 215 eggs and Loggerheads up to 165 eggs. At the beginning and at the end of the season, the size of the clutch may be very small (20 -30 eggs) or very large. There is some evidence that at the beginning of the nesting season this may be connected to the timing of the commencement of the nesting season. Delayed nesting (as occurred in Cyprus in 1992 due to weather conditions) may result in very large egg-clutches at the beginning of the season.

Loggerhead eggs average 38.4 mm in diameter and 30 gm in weight while Green Turtle eggs average 41.5 mm and 38 gm respectively (Cyprus data). This means that a large clutch of large eggs may weigh 7 kgs or more. These data may vary considerably from turtle to turtle. Small, non-spherical, yolkless or deformed eggs are found regularly in small numbers.

Freshly-laid eggs have a "translucent", soft shell and are not dented. The eggshell of the fertilised egg starts turning white (opaque) on top, over the embryo. The white patch grows and its size is often a good indicator of the age of the egg during the first few days. When the egg is 1-2 days old, a white spot appears on the uppermost part of the egg, over the embryo, where the extra-embryonic membranes attach it to the shell. In about five to seven days, half the egg has turned white. In about ten to twelve days, the whole egg is white. Infertile eggs remain translucent.

Denting of the eggs often occurs, even in undisturbed nests and is the result of water losses due to evaporation. The nature of the beach (particle size etc.) is usually a factor in denting, as is the depth of the egg-chamber. Usually it is the top eggs that get dented, especially in shallow Loggerhead nests. Such denting is apparently normal and usually it has little effect on the hatchability of the eggs. **(Photos 33-36)**

Incubation

Incubation takes about seven weeks but may vary from 44-60 days or more. This is discussed in more detail in the chapter on "Incubation temperature and sex determination" while hatching is discussed in the chapter on "Hatching and releasing of hatchlings".

A few days before hatching, the eggshell starts flaking and it becomes somewhat brittle. This is the result of calcium uptake by the embryo. The hatchling breaks through the shell with a protuberance on its snout; this is lost soon after hatching. **(Photo 37)**

Beach Surveys

Though most nesting beaches on the northern shores of the Mediterranean are largely known, there are extensive areas on the southern shores that need to be checked to identify nesting beaches. The intensity of nesting activity on these beaches also needs to be assessed. The most cost-effective way of identifying nesting beaches on extensive coastlines is by aerial survey. The best way to carry an aerial survey is to use helicopters, although this is more expensive than using small planes. Helicopters can fly at low speed and are more versatile in such work. Surveys should be done from a height of about 80-100 m. Turtle tracks, especially fresh ones, are easily detectable early in the morning when the low sun enhances the shadows. Flights should aim at finishing by about 8 a.m., as observations made after that may be misleading. Once-off surveys during July, when nesting activity is at its highest, will give a first inventory of nesting beaches and some indication of relative nesting intensity. Regular flights, i.e., several times a week are necessary if more information is to be collected on the actual intensity of nesting etc. Such surveys are inevitably more elaborate. Turtle tracks don't always lead to nests and on some beaches very few do. Results of aerial surveys, therefore, need to be verified on the ground. Keeping in mind the very significant fluctuations in nesting activity from year to year, the results of such surveys (or indeed of any surveys) need to be qualified. Multi-year surveys are necessary to work out average nesting activity on any beach.

VI. PREDATION

Predation by animals on turtles and turtle eggs and hatchlings has become an important problem since the turtles have become endangered. Increasing recruitment of new entrants into the populations can be achieved by reducing the incidence of predation. Turtles face different predators during their life cycle:

Predation on adult and sub-adult turtles

The main "predator" on adult turtles is undoubtedly man. The main cause of the turtles' decimation in the Mediterranean is that in the past they were captured in large numbers on their nesting beaches and during the mating season. Currently their capture is limited as turtles are protected in many, but still not all, countries of the region.

Incidental catches of turtles in trawl nets, bottom-set nets (trammel nets), drift nets and floating long-lines for swordfish are having a serious impact on turtle stocks. Several thousand turtles are killed each year (see chapters on "Fisheries and Turtles" and "About turtles in the Mediterranean").

Sharks are the only other predators on adult turtles. The impact of predation by sharks is, however, not considered significant on adult turtles. It is likely that it is more significant on younger turtles though little information is available on this. Occasionally turtles with missing flippers or parts of flippers are encountered on nesting beaches. Bites on the carapace are even less frequent. **(Photo 38 & 39)**

Predation on eggs and hatchlings

In areas where there is no human interference, predation on turtle eggs and hatchlings is usually the main factor limiting the number of hatchlings that reach the sea. The main predator in many countries in the Mediterranean is the fox. The level of predation depends on a number of factors such as the number of predators, the proximity to habitation and the nature of the beach (which to some degree determines the depth of the nests-and the accessibility of the eggs). Shallow nests are more easily detected by animals with a keen sense of smell. On some beaches in Cyprus more than 80% of the nests are destroyed by foxes, which eat the eggs and hatchlings. The main danger periods are soon after laying, when smells are fresh, and, more frequently, when the hatchlings emerge from the nest. Nests, however, can be dug up at any time during incubation. Foxes can easily find nests which are hatching when the first batch of hatchlings emerges, carrying with it the very characteristic smell of a newly-hatched nest. The fox will eat or kill most of the emerging hatchlings and will dig up the nest and usually eat most of the rest; otherwise it will kill and bury nearby the hatchlings it cannot immediately eat. Foxes frequently patrol nesting beaches during the nesting and hatching season and will follow the tracks of hatchlings back to the nest. Even a single experienced fox can devastate an area. Foxes are territorial and one fox can be expected to cover at least 1 km of beach each. The importance of predation on turtle populations can be demonstrated by the example of Zakynthos which has no foxes and which has the most important single Loggerhead nesting population in the Mediterranean. Other predators on eggs and hatchlings include feral dogs, jackals and other mammals. The spectrum of land predators obviously varies with the country and its fauna.

As the hatchlings usually emerge at night, only nocturnal animals will normally be a danger to them. Ghost crabs (*Ocypode cursor*) usually take a small percentage of the hatchlings. Ghost crabs do not live on all beaches but only on those which have the right grain size and structure for them to make their burrows. They can catch hatchlings both on the beach and in the surf zone. Occasionally ghost crabs will burrow into a nest causing damage to the eggs. Crows and other diurnal birds are only attracted to nests which have already been disturbed by foxes or other animals. **(Photos 40-43)**

Hatchlings at sea are also subject to predation by large pelagic fish such as *Coryphaena hippurus* but little information is available on such predation and on any predation by sea-birds in the Mediterranean.

VII. TURTLE CONSERVATION - PERSPECTIVES AND PRIORITIES.

As already mentioned in the Introduction, conserving adult female turtles and their nesting habitats merits top priority in any conservation strategy. In the wild, a mature female will lay over many years, probably producing about 500 eggs per nesting season for several seasons. This means that in her lifetime she could lay many thousands of eggs. Most eggs and hatchlings will perish on the beaches as a result of predation and inundation by the sea. The numbers that reach the sea will be small, often estimated at less than 10%. Many young turtles will survive to a certain age but will perish before sexual maturity or soon afterwards. Many will die when they descent on their foraging grounds, when they are about 2 -4 years old, with little experience of fishing nets. For these reasons, it is obvious that mature female turtles merit top priority in any conservation programme, both on their nesting beaches and on their feeding grounds.

Mature female turtles cannot reproduce without nesting beaches - this much is obvious. What is not so obvious is the fact that these females and female Green turtles in particular, will not nest on any beach - they will only nest on their natal beaches, i.e., on the beaches where they were laid as eggs and on which they incubated and hatched. So the existence of suitable beaches and the existence of mature female turtles in the Mediterranean does not mean that nesting will take place. The mature females need to be able to return to the *specific* beaches on which they originated so they can lay their eggs. This also implies that the Mediterranean stock of turtles is not a single stock but that each rookery has its own stock of turtles, i.e., that each rookery is demographically distinct and independent. Therefore, conserving turtles in one rookery will not save turtles from another rookery. If a rookery is to survive, it needs to be protected individually and separately (19, 33).

The colonisation rate of new beaches by turtles is dependent on "imperfections" in natal homing, i.e., on infidelity to a nesting beach. Such "mistakes", however, have been shown to be very rare, as evidenced by the very slow recolonisation rates of rookeries extirpated centuries ago (16, 19, 33).

In the Mediterranean, both Green and Loggerhead populations are endangered and they have obviously suffered a dramatic decline during this century. Therefore, in addition to the complete protection of the turtles and their nesting beaches management measures aimed at increasing recruitment of new entrants into these populations should be envisaged in plans aimed at the recovery of turtle stocks.

In order of priority the recommended management measures for the protection of eggs and hatchlings are:

(a) Protection of eggs and hatchlings on nesting beaches by declaring these beaches protected areas and thus controlling or avoiding human interference.

(b) Protection of eggs by intervention where simple protection, as recommended under (a) above, is not sufficient and where there are heavy losses of eggs and hatchlings or where the hatching rate is reduced by heavy predation, human interference, inundation by the sea or likely physical damage to the eggs or hatchlings. In this case the recommended measures are (in order of priority):

(i) Protection of eggs *in situ*. The simplest and most effective way to do this is by protecting nests with a cage. (See chapter on "Conservation Techniques"). Protecting nests *in situ* implies *interalia* that the hatchlings originating from a particular beach will imprint on that particular beach and this will safeguard the continuation of nesting on that beach. This in turn implies knowledge that that particular beach will be "safe" for the hatchlings to return to in a few decades, when they become adults, i.e., that the beach is or will be a protected beach.

(ii) Transplantation (relocation) of eggs to a hatchery - preferably a nearby hatchery. This hatchery should use methods as close to nature as possible (i.e., replanting eggs in the sand on the beach). A hatchery is necessary only if the protection of eggs *in situ* is not possible or is insufficient to adequately protect eggs and hatchlings. Inevitably some nests are doomed by being laid either too near the waterline or on beaches on which they have little chance to survive. It is recommended to use hatcheries only for doomed nests. The risk of inundation by the sea varies from beach to beach and the situation in each case should be carefully studied. On some beaches the risk is negligible even though turtles sometimes lay their eggs near the waterline. On other beaches the risk is larger and even moderate summer storms can destroy a large percentage of the nests. Hatchlings from hatcheries should be released as soon as they emerge. (See chapter on "Conservation Techniques")

Removal of hatchlings to safer habitats is sometimes needed e.g., in cases of occasional nests hatching on tourist beaches with many lights in the hinterland or in cases of oil spills. In such cases hatchlings should be released as soon as possible on a "safe" beach, i.e., a beach with no lights or oil and as near as possible to the beach of origin. They should be released at night on the beach and left to walk down the beach by themselves. These are precautions to safeguard as much as possible likely imprinting mechanisms.

Head-starting (this means rearing hatchlings to a certain size or age and releasing them) should not be considered as a management option. Though it has some merits which need to be investigated, it has still to be proven as a management measure. Retention of hatchlings for such work should involve only a small percentage (<3%) of the hatchlings (see chapter on "Head-starting").

It should be kept in mind that the IUCN/SSC Marine Turtle Specialist Group has drafted *A Global Strategy for the Conservation of Marine Turtles* and *The Marine Turtle Action Plan,* both of which will be available soon. Both are essential reading for anyone working on the conservation of marine turtles.

VIII. FISHERIES AND TURTLES

Impact of fishing - relevant legislation.

Fishing activities invariably result in turtle catches. Nowadays these are mainly incidental catches which, however, are collectively damaging to turtle populations. Past exploitation of turtles (by catching them on their nesting beaches and during fishing operations) is the main reason for their decimation. Current fishing activities and the resulting incidental catches keep populations at low levels or even reduce them further. Adopting and enforcing legislation concerning the landing, sale and possession of turtles, turtle meat or turtle products is necessary and will help to a degree in curbing the killing of turtles. It will not do much to reduce incidental catches, nor will it reduce mortality of turtles accidentally caught on floating long-lines.

Turtles in the Mediterranean are caught mainly in drift-nets, on surface long-lines, bottom-set trammel nets and by trawlers. The turtles are often caught alive. Trawler hauls are often short and turtles caught in the nets don't often drown, as is evidenced by catches of turtles by trawlers in the Nile Delta area, in Libya and occasionally in Cyprus and no doubt elsewhere. Although "Turtle Exclusion Devices" (TEDs) appear to work in other seas (mainly on shrimp nets), their effectiveness on the Mediterranean trawl nets needs to be verified. The feasibility and the means of their introduction in certain areas also need to be assessed, even if they prove effective on Mediterranean trawl nets. Basically, TED's are devices incorporating a trapdoor, which are installed towards the rear part of the trawl net, just before the cod-end. The trapdoor opens when a heavy object, e.g., a turtle, presses against it. The turtle is then released from the net.

Bottom-set nets, in some cases at least, also result in catches of live turtles as the period the nets are left on the seabed is often short, due to practical considerations. Such nets are usually left on the bottom only for a few hours to avoid the spoiling of fish or to reduce the chance of predators getting at the fish. The period over which the nets can remain on the seabed can be regulated by law to safeguard resources. Turtles and especially Loggerheads will locate nets left down for any undue length of time and will systematically raid such nets for fish, damaging the nets in the process. This makes turtles unpopular with fishermen, who will often kill them to protect their nets. Legislation restricting the period during which nets may remain on the sea -bed does not only protect fishery resources but it also saves turtles from getting caught in nets.

Prohibiting the setting of nets in shallow waters, in particular near nesting beaches during the nesting season, will also reduce incidental catches and diminish conflicts with fishermen. Banning trawling in shallow waters (less than 50 metres) will have a very beneficial effect not only on turtles but on the coastal ecosystem as a whole. (The radical reduction of trawling on the continental shelf in most areas of the Mediterranean is a **must** in any fishery policy aiming at the rational use of marine resources. Turtle conservation is only one of the reasons for such a policy). Legislation to this end has already been introduced in many Mediterranean countries, including Cyprus, where it provides for:

(a) The period of the day during which nets can remain on the seabed.

(b) The prohibition of using bottom-set nets in shallow waters (10 m) from June to October (both months included).

(c) The banning of trawling in waters shallower than 55 metres, mainly for the protection of young fish and *Posidonia* meadows. (The enforcement of this provision is, however, posing problems). Trawling is also completely and effectively banned from the 1st June to the 7th November.

(d) A limitation to the number and power of trawlers.

A distance limit in addition to the depth limit could, in some cases, make law enforcement easier.

Floating long-lines used for catching swordfish also often catch turtles (see chapter "About Turtles in the Mediterranean"). The large hooks often cause injuries to the mouth and throat of turtles. In some cases, with some care, the hooks can be removed without any serious long-term effects. Should a turtle swallow such a hook, it will probably not be possible (under field conditions) to remove it. More than 20% of the Loggerhead turtles caught this way will die of their injuries subsequent to their capture, though they are released alive (even if with the hook inside) (18).

The control of fishing operations through fishing seasons and closed areas/seasons may help in this case. This implies knowledge of turtle behaviour and migrations. This is particularly important in the western and central Mediterranean where incidental catches of turtles on surface long-lines are very significant.

The banning of large-scale drift-nets in the Mediterranean will no doubt help in protecting turtles. Moves to this end are already underway (U.N. General Assembly Decision 49/436 and U.N. Resolution 46/215 are relevant). The need for all Mediterranean states to enforce this ban cannot but be underlined in this manual.

The intensity of fishing (and the rate of incidental catches) has a bearing on the longevity (and average size) of turtles in the Mediterranean and on their very survival.

Dealing with apparently drowned turtles

Turtles caught in nets may be brought up in a comatose condition. They do not move and appear dead. Some of them may be revived if kept out of the water for some time. They should be kept cool on their "belly" with the head down and the tail end much higher than the head (at about 45°) This helps to drain any water in the lungs. Holding the turtle with its head down, i.e., in a vertical position, as soon as the turtle is brought up on deck, will drain much water from its lungs. Such comatose turtles should be kept out of the water for about one day to give them a chance to come to and to get rid of water from their lungs. If they are put back into the sea in a comatose state, they will die.

Artificial resuscitation, by repeatedly pushing on the plastron with the turtle on its carapace with the head lower than the tail, may also work in clearing the lungs. Try this for a short time and then turn the turtle and place it as described above. Some of the turtles will come out of such a comatose state.

Trauma - propeller and other injuries

Turtles are occasionally found with injuries caused by boats and propellers, or by fishermen. Some of the injuries are superficial and the turtles are best left to themselves to heal. With more severe injuries, such as damage to the skull, it may be necessary to keep the turtle and to attempt treatment. It is beyond the scope of this manual to provide information on such a specialized subject. If it is too ambitious to set up a "rescue centre" it may be worthwhile to encourage a local vet (or doctor) to specialise in the treatment of these turtles. Such help has proved invaluable, especially since facilities for turtle recuperation (sea cages - spare bathrooms (!)) were available.

IX. CONSERVATION TECHNIQUES

Observing and tagging turtles

Although observing, tagging and measuring turtles are not strictly speaking conservation techniques, they are included in this chapter as they provide valuable information for conservation purposes and projects. Tagging turtles can provide information on populations, nesting frequency, migrations, behaviour etc. Any tagging programme will inevitably require a follow-up. The monitoring of beaches over many years, in particular during the nesting season, is necessary if the programme is to yield useful results. Tag losses should be expected and it is not certain whether scars left by lost tags are in all cases permanent. Caution should therefore be employed in the interpretation of results from tagging programmes. Double tagging, as recommended in this manual, can provide information on tag losses. If tags or information on such tags is expected to be returned by people other than those who are undertaking the tagging and the beach monitoring, the tags should be marked clearly on one side with an address. Rewards for returned tags are a debatable issue. In spite of any shortcoming, tagging is a useful technique in providing information for turtle conservation work especially in the Mediterranean where little is known about turtles and turtle populations. **However, tagging should not become an end in itself as obviously no amount of tagging will conserve turtles. All it can do is provide information on which to base conservation work.** Therefore, any tagging programme, its follow-up and the interpretation of the results, should have clear aims and be well-planned.

Spotting and approaching nesting turtles

If turtles are disturbed before they start nesting they will be frightened easily and will quickly return to the sea. Movements on the beach will also easily disturb turtles enough to disrupt nesting during the early stages and turtles will often go back to the sea or, at best, look for another place to nest. The more advanced the digging, the less likely the turtle is to be disturbed, especially if the digging of the egg-chamber has started. If the actual laying has started, the turtle will not usually stop laying but may, if unduly disturbed, finish laying and cover the chamber and the eggs more quickly. **Green turtles are more easily frightened than Loggerheads**.

It is preferable to walk on the beaches either singly or in twos communicating with the main group (if there is one) through portable VHF units (walkie-talkies). Tagging-guns and an adequate number of tags (in quadruplicate) should be carried by anyone checking the beach. It is best to wear a large waist wallet in which a tape measure, a pen and a notebook are also carried. **(Photo 44)**. A small adjustable narrow-beam torch is indispensable. It should preferably have a red filter (a Mini Mac-light or similar torch is well suited for this kind of work). Large torches are not recommended but may be used if one narrows the beam with the fingers. Holding the torch near the ground enhances the shadows so that tracks can easily be spotted at a distance. When looking for nesting females, it is recommended to walk along the beaches carefully, preferably without using a torch. Torches should be used only when necessary. On many beaches it is possible to see well enough to spot turtle tracks with starlight alone. Torch-beams should not be waved about on the beach or out to sea. **It is recommended to follow the surf-line while looking for tracks. Emerging turtles leave tracks that start from the surf-swept strip of that night.** Tracks from previous nights do not usually start from this strip but higher up, as tides and waves usually cover up the lower tracks. They may also be overlaid with footprints. It is good practice to draw a line in the sand across old tracks at 3-4 metres from the waterline to help identify new tracks. A single fresh track means that the turtle is on the beach, two tracks may mean that the turtle has left the beach, or that there are two turtles on the beach and so on. The novice may find it difficult to assess the direction of the movement of the turtle from its tracks.

If the turtle is disturbed and goes back to the sea, it will probably return to the beach one hour or so later, probably at another place on the same beach or on a neighbouring beach. Otherwise she may return the next night.

Image intensifiers (night-sights) can be very useful to scan and monitor the beaches from a safe place without disturbing the turtles at the wrong moment. However, such devices can be expensive and are not always easily available to the public (check local legislation). Cheaper models are becoming available for a variety of purposes (hunting, yachting etc.). These do not usually require any source of supplementary light and will work very well with a little moonlight. By starlight alone, they are only useful for short distances in spotting turtle tracks. Their effectiveness can be improved dramatically by the use of a narrow-beam torch with a red or infra red filter. Though the beam may not be visible to the naked eye, its effect through an image intensifier is spectacular. A small torch with a red filter can be effective to over 200 m. Some of the intensifiers have built-in infrared light sources for map-reading etc. These built-in sources are, however, of little use for scanning beaches, they are weak and they are situated at the same level as the image intensifier. Holding the torch at a low level will enhance shadows and highlight tracks etc. **(Photo 45)**

Once a turtle has been located, it is recommended to watch her for some time to ascertain at what stage of the nesting process she is at. Following the tracks to find the turtle will not necessarily position you behind her and care should be taken to find out in which direction the turtle is looking. Approach her carefully from behind. Keep in mind that Green turtles may not be visible above the level of the sand. Loggerheads usually are. To avoid disturbing the turtles, it is safer to crawl on all fours. Clothes which do not provide a visual contrast with the beach should be worn on night patrols. White or black clothes should be avoided as they can more easily be detected by the nesting turtles which are on the lookout for any moving objects. Remember that irrespective of any precautions you may take you may be highly visible to a turtle looking up from sand level, if you are silhouetted against the sky. **(Photos 46 & 47)**

Tagging and measuring turtles

Tagging should be undertaken just after the turtle has finished laying and has covered the eggs. At this stage she is not using her front flippers and tagging can easily and safely be undertaken. Turtles which are found obviously returning to the sea should be checked for tags, and tagged if necessary. Tagging at this stage is much more difficult. **Double tagging is strongly recommended** (i.e., one tag on each flipper) **with the same number**. The authors have found that plastic Jumbo Tags are reliable, practical to use and easy to read. (These are ear-tags for large mammals manufactured by Dalton Supplies Ltd., in the UK. Similar tags from other manufacturers probably exist). The authors have found these tags, still in place, a decade after tagging. They showed signs of wear but they were in all cases readable. Worn tags can easily be replaced with new ones. Occasionally broken tags will be found. Some researchers prefer alloy tags and several kinds are available. These are closed-end tags that firmly clench the turtle's flipper. The authors have observed that though such tags last very well they tend to constrict the flipper as it grows and they have discontinued their use. Moreover, these tags are not easy to read by torchlight at night due to the reflection of the torch beam and the small lettering. Tags should be attached to the soft, thin part of the fore-flipper.. Other researchers prefer to tag at the proximal end of the flipper. It should be expected that some tags will be wasted during tagging and spares with the same number should be available. Tags are put into place by special plier-like applicators. A strong hole-puncher or chisel, though not essential, will help in making a hole before inserting the tag. The tag should be put into place with the number uppermost. This will help in later observations. **(Photos 48, 49)**. At this stage, i.e., during tagging, the carapace length and width of the turtle can be measured.

Though there is still no agreed standard method of measuring turtles, experience has shown that it is more practical to measure turtles with a tape (metal or cloth), measuring "curved carapace length" (CCL) rather than to measure "straight carapace length" (SCL) with cumbersome instruments (calipers etc.) which may, as a consequence, result in fewer counts. **The method used should be clearly stated in any records or publications. (Photos 50 & 51)**

During tagging, the following should be recorded:

Species, tag number, carapace length and width and any other identifying marks. These should be entered with all the other information (location etc.) either in a notebook or directly on the Log Sheets (Annex). The same holds for already tagged turtles which are observed to nest.

Good photographs with details of the carapace and the tag number showing could be invaluable. Photographs should be taken preferably soon after the turtle has finished laying. Photographs should **not** be taken before the turtle has started laying. **It should also be ascertained that there are no other nesting females in the vicinity at the time of taking photographs.**

Whilst being tagged the turtle may wince, as she is obviously in pain. Loggerheads may snap. **During tagging it is strongly recommended to:**

- **Keep out of reach of the turtle's head and beak**. The beak is very strong and accidents can happen.

-**When tagging, kneel behind the fore-flipper whilst an assistant(s) holds the flipper.** A single person can tag the left flipper relatively easily by standing out of reach of the turtle's flipper and by holding the tip with the left hand and the tagging gun in the right. It is difficult for a single person to tag the right flipper, if the turtle is using it to cover up the nest and usually an assistant has to hold the flipper. It is more practical to use the tagging gun with both hands. **Do not turn turtles over to tag them. (Photos 52 & 53)**

-**Watch out for flapping flippers as they can cause injuries, mind your shins.**

-**Beware of sand thrown up by the flippers, mind your eyes.**

Hatchery techniques and nest protection

Guidelines as to the order of priority in selecting the method for the protection of eggs and hatchlings have been given in chapter VII on "Turtle Conservation - Perspectives and Priorities". That chapter should be read carefully before embarking on any turtle conservation project. The aim of the present chapter is to give technical information on the techniques involved once the situation has been properly diagnosed and the choices have been made on how best to protect turtle eggs and hatchlings.

Location of eggs in the nest

To locate the eggs a short, thin stick (a cane will do) of about 1 cm in diameter and 70-90 cm in length is pushed gently into the sand at various places in the nest. The sand "gives" easily where the egg-chamber is. For the Green Turtle the egg-chamber is usually about 2 metres from starting point of the nest, i.e., where the turtle began digging. For the Loggerhead this distance is shorter - usually about 0.5 m to 1 m. At the end of the nest there is a depression caused by the turtle as she digs up sand to cover the chamber. The shape (direction) of the "footprints" in the tracks and the point of departure of the tracks from the nest are indicators of the start point and the end of a nest. Tracks going to the nest are covered by sand thrown up by the turtle in digging and covering up the nest. **The tracks leading away from a successful nest go straight back to the sea**. "Tries", i.e., unsuccessful nesting, result in tracks which usually lead to another "try", or to a completed nest. Tracks which do not lead to a nest are known as "false-crawls". **(Photo 22)**

On most beaches it is not usually possible to locate the egg-chamber in Green Turtle nests with a stick, as the chamber is fairly deep, unless a layer of sand (30 cm or more), is removed first. Loggerhead nests do not usually present such a problem. **Caution: The stick should be used gently to avoid damage to the eggs.** Where the turtle is seen to lay, it is good practice to mark the location of the chamber with a stick. This will prevent unnecessary risks to the eggs on the following day. Two sets of sticks on either side of the nest, out of reach of the nesting turtle, can also be used to get a "fix" on the chamber. **(Photo 54)**

Protecting eggs in situ.

Protecting nests *in situ* can be achieved by placing a protective cage on top of the egg-chamber. Half this cage (about 20 cm) has to be buried in the sand to stop foxes or other predators from digging under it or upending it. Such cages are intended for the protection of the eggs during incubation and should not restrain the emerging hatchlings from going out to sea. The cages to be used are, therefore, of a different design to hatchery cages. The cages used to protect eggs *in situ* have a gap (slit) at the level of the sand which allows hatchlings to escape from the cage but prevents large predators (foxes etc.) from getting at the eggs. The reason for this different approach is that it is not usually practical to continuously monitor for emergences many cages scattered around a beach or on several beaches. This practice does not protect the hatchlings from predators during their dash down to the sea but it does protect the nest during incubation. It also prevents a predator from digging up the nest if the predator follows the trail of hatchlings back to the nest. **Where such cages are used it should be ensured that the escape slit in the cage is on the surface of the sand and that it remains on that level during the expected period of hatching.** Wind and other disturbances of the sand can block the slit and the nests should be regularly and carefully monitored especially during the period of the expected hatching. **(Photo 55)**

Number the nest and fill the Log-sheet, recording all the information that is available. The rest of the information will have to be completed upon the completion of hatching, when the nest should be dug up to take count of the situation.

Handling of eggs - transplantation of nests

If a clear-cut decision has already been taken to move the eggs to a hatchery, the eggs can be collected while the turtle is laying by scooping them out of the chamber while they are being dropped. Care should be taken not to disturb the turtle. Such egg-collecting is more practical with Loggerheads, which keep their rear flippers apart whilst laying. For Green Turtle nests and for nests which need to be moved subsequent to laying, the following are recommended:

> After the location of the egg-chamber has been ascertained, a layer of sand should be carefully removed using a sand-removing shovel. Lower down it is preferable to work with the hands. Fresh eggs (up to 12 hours after they are laid) are said to be unaffected by turning. It is preferable not to turn the eggs whatever their age. **The eggs should not be turned if they have been laid more than 12 hours before transplantation.** Turning the eggs will break the extra-embryonic membranes and blood vessels and kill the embryo. It is preferable (and more practical) to remove the eggs early in the morning and not at midday to avoid marked temperature changes. **(Photo 56)**
>
> Eggs can be moved in a narrow, vertical cooling-box preferably square or cylindrical. Cooling-boxes should have a single handle and be about 30 cm in height and 25 cm in diameter or width (internal dimensions). These are very

practical. Larger boxes are not recommended, as temperature and humidity changes are likely to be greater in such boxes. Smaller boxes may not accommodate large clutches of eggs. The eggs should be placed on a layer of moist sand (2-3 cm thick), taken from the same depth as the chamber, and then stacked in layers. They should be counted as they are placed in the box. They should then be covered by a layer (3-4 cm) of moist sand, taken from around the egg-chamber of the nest. This is to stop the eggs from moving during transportation and to keep them moist. It also reduces temperature changes. Moist sand ensures that the humidity remains high. It also forms a cohesive layer which ensures that sand does not fall in the air spaces between the eggs. A cloth placed on top of the eggs, before adding the top layer of sand, can help stop the sand from trickling between them. This cloth should have a wide enough mesh to allow for ventilation but not wide enough for sand to fall through it. The cloth should be preferably synthetic as it will be less likely to host bacteria and fungi. The whole process, from removing the eggs from the nest to covering them up with sand in the cooling box, should be quick in order to avoid evaporation, temperature changes etc. **(Photos 58 & 59)**

Do not handle eggs with your hands if you have been using suntan oils, insect repellents etc. Wash your hands before handling eggs.

Information on each nest should be recorded in detail in the Log-sheets after the eggs have been transferred to the cooling-box. The cooling-boxes should be numbered and cross-referenced with the Log-sheet to keep track of the nests upon transplantation.

Eggs should be transported with the minimum of vibration. Long trips, especially on bumpy dirt-track roads, should be avoided as they will significantly lower hatchability rates. During transportation, the cooling-boxes with the eggs should be cushioned on a layer of rubber foam, or be placed on the car seats and secured there. Better still, they can be carried on the passengers' laps.

Hatchery location

The hatchery should be as near as possible to the nesting beaches. The hatchery site should be high up on the beach to avoid any possible flooding during periods of rough weather. The area should be fenced off with rope or better still, it should be wire-meshed to keep visitors and the occasional predators out. Wire-mesh is a must if predation is likely to occur.

Selecting a beach for the hatchery, if there is such a choice to be made, depends on many factors. It is prudent to choose a beach or a location on a beach from which there is no visual contact with habitation (lights etc.). **Keep in mind that the hatchlings from the hatchery will imprint on the hatchery beach and will come back to it to nest themselves when they mature.** This means that in selecting the hatchery beach the selection is made with the knowledge that that beach will continue to be available to the turtles for nesting and that it will not in a few years time be a tourist beach. Therefore it is prudent to set up hatcheries on beaches that are in protected areas or at least that their protection is imminent in the forceable future.

For practical reasons it is better to choose a beach in which the nature of the sand facilitates digging. Coarse sand beaches require the removal of considerable quantities of sand before a chamber can be dug.

The hatchery site should be located, if possible, on a part of the beach which is not often used by turtles for nesting (e.g., behind a patch of rocks on the waterline).

Summer storms with very heavy rains can cause inundation and destroy a whole year's egg production. Although this is a rare event in this part of the world, it is recommended to have available large polythene sheets to cover the hatchery in the event of heavy downpours. **(Photos 61 & 62)**

Replanting of Nests

Egg-chambers should be dug in the **moist sand** after the top layer of dry sand has been removed and, in the case of Loggerheads, the first 5 cm or so of moist sand has also been removed. In the case of Green turtle nests the chamber should be dug after the first 15 cm of wet sand has first been removed. These numbers are just guidelines and obviously they will vary with the beach. The aim should be to construct such a chamber that when the eggs are placed in it they are at the right depth and, at the same time, they more or less fill the chamber. The need to fill the chamber with eggs is important to avoid the "funneling" of the weight of the sand on top of them onto the eggs. **The best way to estimate the depth of the chamber is by measuring the depth of the chamber of "natural" nests, of the species concerned, on the hatchery beach**. If there is no nesting on that beach, the depth of chambers on a beach **with similar grain size sand** can be measured and used as a guideline. (See also chapter on "Nests and Nesting") **(Photo 57)**

The size of the chamber should depend on the size of the clutch to be re-buried. The diameter of the new egg-chamber for a Loggerhead nest should be about 13-16 cm on top, widening by about 5 cm lower down. Green turtle chambers should be a little wider, i.e., 16-19 cm in diameter on top, widening by about 5 cm lower down. Large nests with more than 120 large turtle eggs can be split and re-buried as two nests, with an equal number of eggs in each. This often results in a better hatching rate than when very large numbers of eggs are buried in one chamber. **Wide chambers should be avoided** as the sand covering the eggs will collapse on top of them compressing them or filling the airspace between them.

The eggs should be recounted as they are placed in the new egg-chamber. Care should be taken not to turn the eggs while transferring them to the new chamber. When the eggs have been put into place they should be **covered carefully with the moist sand which was removed in making the egg chamber, making sure that as little sand as possible falls between the eggs**. Freshly laid eggs are covered in mucus and during their removal they are likely to end up covered in sand. Older eggs dry up and pose no such problem. Washing sand off fresh eggs prior to their re-burial by dipping them quickly into a bucket of fresh water was practiced at the Lara hatchery for a while. A control re-burial of unwashed eggs, however, proved that there were no significant differences in hatchability rates and washing was discontinued. (It should be remembered that the mucus layer which covers freshly laid eggs, in addition to its other purposes, helps in the formation of a "lid" to the original chamber. This prevents sand from trickling between the eggs). After the eggs and the chamber are covered with moist sand the remaining depression is filled in with dry sand. The sand should then be levelled off and a protective cage placed over the nest, making sure the nest is in the centre of the cage and that are no gaps left between the wire mesh of the cage and the sand. The nest should then be numbered. **(Photo 63)**

All relevant data should be recorded in the Log-sheet. Nests should be planted 1.5 m apart, to give hatchery workers adequate working space.

After hatching, eggshells, unfertilized eggs, etc. should be removed from the chamber (and the hatchery). Eggshells are not easily biodegradable and they will be found there in subsequent seasons.

Protective cages

The most practical protective cage so far designed for the hatchery is a circular, conical cage, 40 cm in diameter at the top and 60 cm at the bottom and 30 cm in height. Such cages fit into each other. They are ideal for stacking and storing purposes. The three supporting "pillars" are 45 cm in length of which 15 cm act as pegs for anchoring the cage into the sand. Too small a mesh size will shade the nest, reducing sand temperature and too wide a mesh size will allow hatchlings to escape. The size of hatchlings within the same species varies considerably. Loggerhead hatchlings can be quite small. Mesh sizes that might trap the heads of the hatchlings should not be used.

For the frame, an aluminium strip about 3 mm thick and 2-3 cm wide is rigid enough, the "pillars" being of angled or similar rigid aluminium. Galvanized or plastic-covered wire-mesh 1 cm X 1 cm or 1 cm X 2 cm (used vertically) is best for the sides of the cages and for the lid, if necessary. **(Photo 64)**

Cages for nests to be protected *in situ* differ from hatchery cages as they are intended to prevent predators such as foxes from getting at the eggs. They are similar in construction to the above but they are cylindrical, 50-60 cm in diameter, with an extra 15 cm in height. They have a 3-4 cm slit for half the circumference, at about 20 cm below the top of the cage. This slit allows hatchlings to escape. The cage is buried to the level of the slit. **Make sure that the cage is buried with the slit facing the sea**. These cages should be provided with a wire-mesh lid, preferably provided with an opening (hinged) flap.

Incubation temperature and sex-determination

Incubation takes about seven weeks but may vary from 44 to 60 days or more, varying with the incubation temperature (which varies with latitude, date of laying, the nature of the beach, etc.).

Incubation temperature is very important as it determines the sex of the embryo. The sex of the embryo is apparently determined at about the third week of incubation. High temperatures of about 31°-32° C or more result in the production of females while low temperatures of less than 28°C result in the production of males. For Green turtles the pivotal temperature is between 28.75°C and 29.75°C and for Loggerheads 30°C. (34, 35, 36). The pivotal temperature apparently varies somewhat on a global scale and has still to be determined for the Mediterranean.

In Cyprus the range of sand and egg-chamber temperatures (before metabolic heat raises the temperature even higher during the last few days before hatching), varies from 27°-31°C, warming up around August. These temperatures produce a spectrum of male/female ratios in the nests. As already mentioned factors such as the date of laying (and the period of incubation), the depth of the nest, and the nature of the beach determine chamber temperatures. Hence it is important, when transplanting nests, to place the eggs at the right depth. In the early years of a hatchery programme it is advisable to monitor temperature in the nests and in the sand nearby at various depths. Characteristics of the sand itself on the hatchery beach (grain size, chemical make up, etc.) will determine the optimum depth for the right incubation temperatures. A starting guide to this has been given in the chapter on "Hatchery Location" and "Replanting of Nests". **Beaches with different grain size or other characteristics of the sand may produce the same temperature at different depths**. Keep in mind that the beach selected for the hatchery should be able to sustain natural nesting by turtles should the hatchery work be discontinued at some stage due to a recovery of that population.

It should be noted that the temperature in the nest itself will be higher than that of the surrounding sand as a result of metabolic heat. The temperature of the eggs gets even higher just prior to hatching and may then be 2-3° C or more above the temperature of the sand.

The temperature in the egg-chamber can be monitored with a thermistor probe, (or several probes buried at different depths). Such work requires an accuracy of at least 0.1°C.

Eggs will hatch at temperatures as low as 22°C (although resulting in all-males) and as high as 32°C or even higher resulting in all-females, though a low hatchability rate is likely.

Hatching and releasing of hatchlings

The hatching success-rate varies significantly with the handling of the eggs and incubation techniques. With good care and following the techniques described in this manual, hatching rates can be very high. Some of the eggs are almost always unfertilized or are in any case infertile. In undisturbed Green and Loggerhead Turtle nests, protected *in situ* on Lara and Toxeftra beaches, on average, 10% and 15% of the eggs, respectively, were found infertile. The hatching success-rate in transplanted Green Turtle nests at Lara Station is a little under 80% while the rate for Loggerhead nests is about 65%. The number of infertile eggs in undisturbed Loggerhead nests is apparently often higher than in undisturbed Green Turtle nests (37).

Upon completion of hatching, i.e., three days after the first hatchlings emerged from the sand, the nest should be dug up to take stock of the situation and to rescue the odd hatchling that may be stuck in the nest. Count the eggshells, the unfertilised eggs, and determine how many eggs were non-viable, i.e., how many eggs have dead embryos in them. Determine at what stage the embryo is. It is more convenient to classify dead embryos into two categories (stages of development): early embryonic stage and late embryonic stage. The degree of success of the transplantation of the eggs can be determined by the number of non-viable eggs. Embryos dying at an early stage of development are usually an indication of problems at the relocation stage of the eggs. Common problems are:

-digging up eggs laid more than 12 hours old and turning them either during their removal or replanting or during transportation;

-vibration or shaking of eggs during transportation.

Embryos dying at a late stage of development (they are usually at the stage of absorbing the remaining yolk into the body cavity) are more associated with badly made chambers which result in an inadequate oxygen supply to the increasing needs of the embryos. The chambers may be too wide resulting in the sand collapsing on top of the eggs and filling the air spaces in the chamber, or it may be that the nest was in the first place badly covered and that dry sand fell between the eggs upon covering the chamber. Occasionally live hatchlings at the "pipping" stage can be found in the nest with the yolk still showing. These should be kept on moist sand for two or three days until the navel closes and then released. **(Photo 72)**

Fill in the Log-sheet every time there are hatchlings emerging from the nest and upon digging up the nest. Cross-check the number of hatchlings collected with the number of empty eggshells dug up. Cross-check all the figures with the number of eggs originally collected and reburied in the hatchery.

The hatchlings emerge from the nest usually 2-4 days after hatching. It takes time for the carapace to straighten and for the hatchlings to be ready to surface. Not all the eggs hatch at exactly the same time and hatching-time can vary by one to two days. It takes the hatchling about one to three days to get out of the egg from the moment of breaking the eggshell (pipping). **(Photo 37)**

The hatchlings usually emerge in batches (usually one or two batches per day) over 2-3 days, occasionally all the hatchlings will emerge together from the nest. The hatchlings rise from the chamber in a batch forming a cone, their bodies nearly vertical, helping each other as they rise towards the surface. Single hatchlings will sometimes emerge, though this is often a sign of disturbance or something unusual happening in the nest. If, on the second night after the first emergence, no sizeable batch of hatchlings emerges, then the nest should be dug up. Stragglers or hatchlings trapped in eggshells are frequent.

Hatchlings emerge usually at night after 10 p.m., though earlier night-emergences have been recorded. Hatchlings may sometimes emerge during the day, though this is probably a sign of human disturbance. **Hatchlings emerging during the night should be released as soon as possible.** Emergence takes place during a period of mass "frenzy" (triggered by a drop in sand temperature). This drop in temperature first affects the top hatchlings which activate the whole batch by their movement. This "frenzied" state helps the hatchlings to scramble to the sea very quickly and to swim to "safer", deeper waters. This frenzy continues for several hours and hatchlings keep on swimming straight out to the open sea. During the following day, hatchlings kept behind go through several periods of such frenzied activity. **(Photos 65, 66, 67 & 71)**

Low evening and night temperatures can make hatchlings lethargic and slow in making their way to the sea. Care should be taken not to keep hatchlings at such low temperatures for any length of time. Hatchlings that emerge too late to be collected and released during the night should be collected in the morning and released early in the evening, after dark. They should be kept warm, but not hot, in semi-closed cooling boxes. Such hatchlings should not be kept in water.

Hatchlings should be released high on the beach at the level of the nest, or directly from the hatchery cages if possible, and allowed to crawl down to the water by themselves. This is done to safeguard possible imprinting mechanisms. It may be a futile exercise but it should be undertaken as a precautionary measure.

Hatchlings need not feed for 1-2 days after emerging. They have an adequate supply of yolk to keep them going.

Nests which are hatching under cages should be checked frequently and regularly for day-emergences. Nests known to be hatching under cages should be shaded for the hottest part of the day. **If the hatchlings remain in the sun in the cage even for a few minutes after emerging they will die very quickly.** Hatchlings collected during the day should also be kept and released early in the evening under the same conditions as above. **(Photo 60)**

Hatchlings will normally go towards the sea as soon as they emerge. They are drawn to the brightest part of the horizon - which is normally the sea. However, lights will easily attract them, especially on moonless nights and hatchlings can be disorientated and led (even by a small torch) away from the sea. Lights should be out when releases are made - and should remain so for at least half an hour after the last hatchling has gone to the sea. **(Photos 68, 69 & 70)**

When releasing hatchlings, make sure that predators such as ghost-crabs do not catch them. The largest of the crabs should be chased away before the hatchlings reach the lower part of the beach and the surf zone. Ghost-crabs are not easy to detect in the surf. Ghost-crab burrows in the path of the hatchlings should be obstructed just before releasing the hatchlings.

Tagging of hatchlings

There is as yet no practical and reliable way of tagging hatchlings. Experiments have been carried out with a variety of techniques, none of which are satisfactory. Notching of the marginal scutes in hatchlings and juveniles appears to give permanent results though it can easily result in a deformed carapace in adults. In any case this is not a foolproof method of marking hatchlings as natural injuries may result in similar scars or deformities in adults. **(Photos 73 & 74)** Transplantation of white plastron tissue to the carapace of Green turtles also seems to work but this is not practical when dealing with thousands of hatchlings. Other methods have also been suggested (e.g., implanting skull-tags, as in salmon) but none have proved practical or advisable so far. Keep in mind that any tags that may interfere with the ability of turtles to detect geomagnetic forces should be avoided as turtles apparently navigate on such environmental cues. In the absence of reliable tagging techniques for hatchlings, the results of hatchery programmes or indeed of any conservation programme aimed at protecting eggs and hatchlings can only be assessed, at present, by studying populations and in particular by making multi-year censuses of females on nesting beaches.

Rearing turtles in captivity

The present chapter is included under "Conservation Techniques" for convenience reasons only and, as already mentioned under the chapter on "Turtle Conservation - Perspectives and Priorities", head-starting is not considered as a management option.

The present chapter is not intended for turtle farming in any way and is included only as a starting guide for experimental "head-starting" work or for rearing individuals in captivity for other scientific reasons. "Head-starting" means rearing hatchlings to a certain size or age and releasing them.

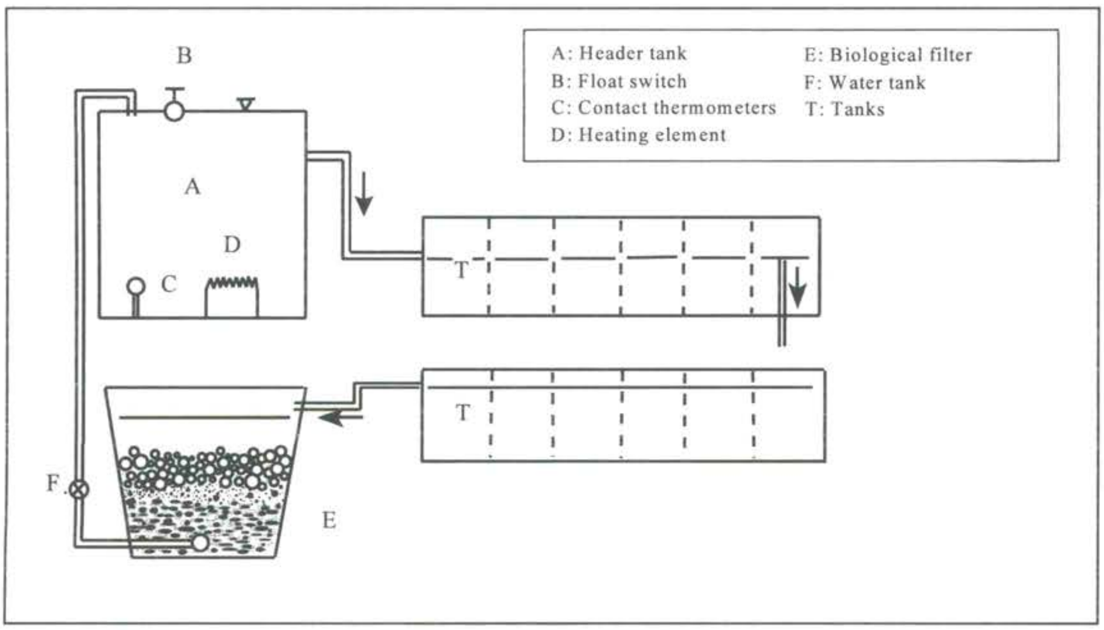
Head-Starting

Head-starting is a somewhat controversial practice and its effectiveness has yet to be proved. Nonetheless it has some merits which need to be explored further. Predation on turtles that have been head-started is likely to be much lower than on hatchlings. Moreover, these head-started turtles can be tagged and their progress in the wild can more easily be monitored. **As, however, there are no indications as yet as to the effectiveness of head-starting, this practice should not be deployed as a conservation technique nor should its use excuse the non-implementation of other conservation measures to protect adult turtles, eggs and hatchlings and turtle nesting and foraging habitats**.

Rearing hatchlings of Green and Loggerhead turtles is relatively simple once they have started feeding. Initially they will feed or try to feed on any white object in the water. Small pieces of squid can provide a start. The squid should be phased out or at least be supplemented by a dry diet of fresh, floating (or well-bound, sinking) pelleted food. Green turtles will also feed on sea-grasses or lucern though it is best to wait until the turtle is 2-3 years old. Hatchlings from both species are normally opportunistic feeders (mainly carnivorous) during their first few years, i.e., during their epipelagic stage and will thrive on high protein dry diets - supplemented with the occasional fish and squid.

Fish food with protein levels of 40-50% proved to be suitable for rearing young turtles which can assimilate high levels of protein. Green turtles feed on sea-grasses, which have a protein level of about 13%. The ability of these turtles to assimilate high protein levels is probably not due to physiological limitations but probably due to ecological considerations (38, 39, 40). Inadequate diets will lead to deformities and even death.

Temperature over the first winter is critical and should not be allowed to drop below 16°C. This usually requires either a heated recirculating system or a through system from a suitable source of sea-water. The optimum water temperature for rearing hatchlings is 25°C. Under Mediterranean conditions, it is recommended to rear hatchlings until they are about one year old in closed systems equipped with a suitable biological filter and with an adequate replenishment of fresh sea-water. The diagram below gives a schematic view of the layout of such a closed system. This diagram is not to scale and dimensions can be adjusted according to the number of hatchlings to be reared. Each hatchling requires an initial surface area of about 1000 cm^2. This area should be increased as the hatchlings grow. Crowding hatchlings - or older turtles - will lead to aggressive behaviour and biting and to the development of necrotic lesions. Lesions from a type of Herpes virus may also develop (see chapter on "Diseases and other problems"). Such symptoms must be taken as signs of crowding and space should be adjusted accordingly.



The hatchlings should be fed at least 2-3 times a day, juveniles can be fed 1-2 times a day. Feeding rates are dependent on temperature. At 25°C typical feeding rates with pelleted food are 1.5% of the body weight per day for turtles weighing from 500 gm to 10 kgs. Keep the depth of the water shallow (15-20 cm) until hatchlings learn to dive and feed (if they are to be fed on food that sinks). Hatchlings should be fed to demand.

After their first year, young turtles can easily be reared in floating cages, or in ponds with an adequate water supply. Cages are preferable for a number of reasons - such as better water exchange etc. Avoid polluted areas when deciding on the location of sea-cages. Part of the keeping-tanks or cages should be shaded, at least in summer. These cages and tanks should have adequate space. As a guideline, yearlings will require at least $0.3m^3$ of water each (see also the chapter on "Diseases and other problems"). **(Photo 75)**

Hatchlings to be head-started should be allowed to walk down the beach and preferably allowed to swim for a while before being picked up to be reared. This is to safeguard as much as possible any imprinting mechanisms for locating natal beaches. To safeguard genetic diversity these hatchlings should preferably originate from different nests.

Releasing head-started turtles has proved that these turtles can survive in the wild. It has yet to be proved that head-started turtles retain their imprinting in locating their natal beaches. The best age for releasing these turtles - if there is an optimum age - is not known. Until more information becomes available on the merits, if any, of head-starting for conservation purposes, do not use more than a very small percentage (2%-3%) of the hatchlings for head-starting programmes. Release head-started turtles by letting them walk down their natal beaches. It is preferable to release such turtles in the warmer months when they are more active. **(Photo 76)**

Diseases and other problems

A variety of diseases and other problems may be encountered. Only the commonest are included here.

The hatchlings may bite each other especially in the rear flippers and on the neck - and can cause each other severe injuries. Crowding aggravates this. Systematic biting of the rear flippers can be disastrous, as this means that if these turtles mature they will not be able to nest. If it can be arranged, the hatchlings should be kept in individual compartments or in compartments containing a few individuals each. Loggerhead turtles are more aggressive than Green turtles. Do not keep Loggerhead turtles and Green turtles together. At least 20-30 litres of water with a surface area of about 1000 cm^2 should be provided for each hatchling. This space should be increased as the hatchlings grow.

White patches of skin (necrotic lesions) often appear on the head and the neck but also on the flippers, when the turtles are not kept in separate compartments and especially when the turtles are crowded. These lesions are probably wounds from bites which subsequently become infected. These can be effectively treated with Gentian Violet. Regular treatment (every day) for a few days with 1% Gentian Violet (3N) in water solution is effective. The turtles should be treated locally with Gentian Violet solution applied with a brush. Turtles should be treated out of the water. They should be dried with paper tissues prior to treatment and kept out of the water for about half an hour after treatment. If left untreated, the infections can cause severe damage (blindness, loss of limbs) and can lead to death. A Herpes virus type lesion, which manifests itself when turtles are stressed has also been described. Crowding, organic pollution and sudden temperature changes (and especially heat stress) are obvious causes. Manipulation of the water temperature seems to help (41). Several other diseases such as mycotic pneumonia, parasitic gastritis and a coccidia infection have been described (11). Most can be prevented by providing the turtles with good food, adequate space and a supply of clean, fresh sea-water at the right temperature. **Do not release sick turtles - whatever they may suffer from.** Make sure of a good diagnosis. Keep in mind that diseases from head-started turtles may be (however remote this may be) transmitted to turtles in the wild.

X. BEACH MANAGEMENT

Beach management for turtle conservation purposes aims at protecting nesting females and pre-nesting females, their eggs and the resulting hatchlings. Inevitably, beach management relates to the control of human activity on the beach and in the surrounding area, including the sea.

Threats from human activities

The main threats to the various stages of the nesting and hatching processes are listed below for each stage of these processes:

Nesting and pre-nesting stage

Water-skiing, paragliding, powerboats, fishing (with nets in particular) in shallow waters, surfing etc. are dangers and are likely to disturb female turtles approaching nesting beaches. Powerboats and speedboats in particular (and fishing nets) can also cause injuries to turtles.

At night, human activity on the beaches or in the surrounding area is likely to disturb nesting turtles. People moving on the beaches, lights, torches, flash-guns, moving shadows etc. will scare the turtles (especially Green turtles) away from the beach when they come up to nest. Car-lights visible from the beach will also disturb turtles. Obstacles on the beaches such as umbrella-stands and sun-beds can hinder nesting or make it impossible under certain circumstances.

The use of vehicles on the beach or its intensive use by people compacts the sand and can make nesting impossible.

Incubation stage

After nesting, the use of vehicles on the beach may lead to a compaction of sand which may cause nests to collapse or make it impossible for the hatchlings to emerge from the nest.

The intensive use of the beach by bathers may also result in similar problems. The shade made by umbrellas and sun-beds can cause temperature changes in the nest, and may change the male to female ratio. Umbrella-spikes stuck in the sand may also damage the nests.

Reaching the sea

Lights anywhere near the beach are a considerable danger to hatchlings as they lure the hatchlings away from the sea. Apart from predation, this is the main danger to hatchlings. By being lured away from the sea period the hatchlings remain on land is extended. Hatchlings will die of high temperatures on land if they do not reach the sea at night. Hatchlings remaining on the beach for any length of time will also face a greatly increased risk of predation. There is also the possibility of erroneous imprinting.

Obstacles on the surface of the sand such as deep car-tyre grooves etc. can also extend the hatchlings' stay on the beaches with similar results.

Management measures - legislation

It is highly desirable to implement beach management measures restricting or controlling public access to the nesting areas during the nesting period and the incubating period. This includes the sea area adjacent to the beaches. The following recommendations are based on the management measures implemented at the Lara Reserve in Cyprus. This is an area in which there is no development.

For the period starting on the 1st June and ending on the 30th October, the following measures are recommended:

(1) The public should not be allowed on or near the beaches at night, i.e., for the period starting one hour before sunset and ending at sunrise. The extent of the land area to be covered obviously depends on local circumstances but this should be a zone large enough to ensure no disturbance to nesting turtles and emerging hatchlings.

(2) Driving on the beaches should be forbidden.

(3) The use of sun-beds, umbrellas etc. should be forbidden on the beaches.

(4) The use of boats and fishing (except with a rod and line) should be banned in the sea area adjoining the beaches, to a specified depth (20 m isobath) or to a set distance from the shore (1-1.5 km or more-depending on the area).

The public should be suitably warned by appropriate notices on the periphery of the protected area and in the vicinity of the beaches.

These recommendations are made on the assumption that the beaches and the hinterland to be protected are not "developed". In areas which are partly developed, mitigating measures such as the control of lights (public and private) may be of some help. Shading of lights or the use of lights which are not directly visible from the beach is recommended. Fences and hedges on the seaward side of existing roads etc. could minimize interference from car lights or other low-level lights.

Such mitigating measures may help in the case of Loggerhead turtles, but are less likely to be effective with Green turtles, which are far more sensitive, even to stationary lights.

Important nesting beaches in "undeveloped" areas should be protected from any "development", which might lead to future problems and conflicts, by declaring them and their environs, specially protected areas (marine and coastal reserves, etc.). This should be done at the earliest possible stage, preferably before there is any pressure for development. These protected areas should include a wide enough zone in the hinterland to prevent the kind of development that will have a direct (line of vision) impact or may lead to more intensive use of these beaches.

Public awareness is extremely important in any conservation project. In addition to notices etc. it is very worthwhile to set up information centres where appropriate, providing leaflets, stickers, posters, etc. These help the public to understand what is going on and why the management measures are essential.

National legislation

In several chapters of this Manual, mention is made of legislation (Fisheries and Turtles, Beach Management Measures etc.). Suggestions for detailed legislative texts for the conservation of turtles which could be applicable to all countries of the region cannot be given here.

Detailed legislation for the Lara Reserve in Cyprus deals with nesting habitat protection. A summary is given on page 54. Another Regulation, in the same legislation, provides for the protection of turtles and their eggs. National legislation should aim at protecting turtles not only during the nesting period, albeit the most crucial period, but throughout their lifetime. Fishing seasons, depths etc. have been discussed in the chapter on "Fisheries and Turtles". Such legislation should, therefore, aim at regulating all fishing activities that have an impact on the capture of turtles at sea. It should also cover the possession and use, including sale, of turtles or turtle parts or any attempt at the above. Legislation without adequate enforcement is of course of little use. It should of course have adequate penalties for violations in order to be effective.

XI. CONVENTIONS

Turtles in the Mediterranean are protected by several Conventions. A brief summary of the provisions relevant to turtles is given here:

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

All marine turtles are listed in Appendix I of this Convention. The species in this Appendix are subject to strict trade regulations.

Convention on the Protection of European Wildlife and Natural Habitats (Bern Convention 1979).

Both *Caretta caretta* and *Chelonia mydas* are listed in Appendix II of this Convention. The species in this Appendix are to be strictly protected by the Contracting Parties and so are their habitats (especially nesting habitats).

Convention on conservation of Migratory Species of Wild Animals (Bonn Convention, 1979)

Both species of marine turtles (Green and Loggerhead) are included in Appendix I and Appendix II of this Convention. Parties are bound to strictly protect these species and to endeavour to conclude Agreements for their conservation. The Mediterranean riparian countries that are members of this Convention at present are: Egypt, France, Israel, Italy, Monaco, Morocco, Spain, Tunisia. The European Community is also a party to the Convention.

Convention on the Protection of the Mediterranean Sea Against Pollution (Barcelona Convention, 1976) - Protocol concerning Mediterranean Specially Protected Areas (Geneva, 1982)

Within the Framework of the Barcelona Convention the Specially Protected Areas Protocol is the main instrument dealing with the conservation of wilderness. Parties to the Protocol engage themselves to take all appropriate measures to protect marine and coastal areas which are important in safeguarding natural resources and natural sites of the Mediterranean Sea area. This is to be achieved by the establishment of protected areas aimed at safeguarding , *inter alia,* " ...The genetic diversity , as well as satisfactory population levels, of species, and their breeding grounds and habitats;..." (Art. 3, 2a). Marine turtles have been recognised as species whose protection is a priority within the framework of the Convention. In 1985 the Contracting Parties adopted a declaration on the targets to be achieved within the decade 1985-1995. This became known as the Genoa Declaration. Among these priority targets the "protection of the endangered marine species (e.g., monk seal and the Mediterranean sea turtles)" is included. Following the Genoa declaration, an Action Plan for the conservation of the Mediterranean marine turtles was adopted.

The Specially Protected Areas Protocol is currentlly (1995) being revised.

Other legal instruments, which relate to the conservation of marine turtles, and which are currently in place, include the African Convention for the Conservation of Nature and Natural Resources (Algiers, 1968) and EEC Directive on the conservation of natural habitats and wild fauna and flora (Directive 9243 of May 21st 1992)

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ANNEX - LOGSHEET

YEAR 199...

Species.. **Nest Number**..
Tag Number..Number of eggs..

1. Nests protected *in situ* ("wild nests"): Location.. Date............................
Observations..
Person recording... Person locating eggs/placing cage...

2. Nest collection data: Location .... Date............................
Nest distance from sea .... Collection time.............................. Age of eggs............................
Small/deformed eggs .... Eggs broken or discarded............... No. of eggs collected..............
Total number of eggs ....
Depth: Top Eggs .... Bottom of chamber .... Diam. of chamber: Top .... Bottom ....
Observations..
Arrival time at Station................... Burial time.................... Collected by.................. Buried by..........

3. Tagging/female turtle data: Location... Date...........................
Tag Number .... Type......................... New/Old* Flipper: Left/Right/Both*
Laying/Tagging time .... Marks/Barnacles...
Carapace dimensions (CCL/CCW) .... Tracks(cm).......................
Observations..
.... Photo Yes/No
Sea state .... Tide level..
Moon (time of setting/rising).. Person tagging or observing.................................

4. Hatching data (for both *in situ* protected nests and for hatchery nests)

Hatchlings emerging																									
Time Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Hatchlings No/day

Nest opening: Date: Time: Person opening nest:	No. of hatchlings	
Other observations:	Hatchlings - total	
	Unfertilized eggs	
	Non viable E** L***	
	Dead in egg	
Person observing/recording:........................	Dead in nest	
	TOTAL	

* Delete as appropriate **- Early embryonic stage ***- Late embryonic stage

PHOTOGRAPHS

PLATE 1

1. Adult female Loggerhead Turtle; note that there are five side plates, the anterior one being smaller than the rest

2. Adult female Green Turtle; note that there are four side plates

1

2

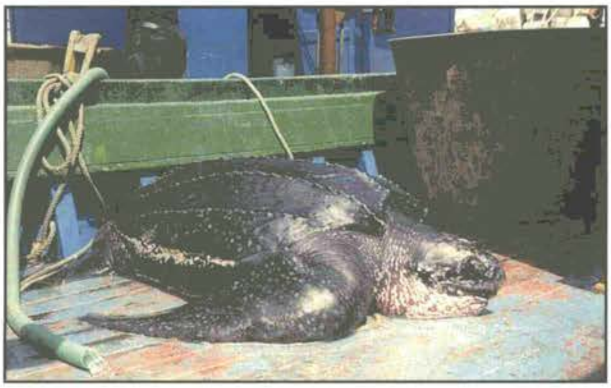
PLATE 1

PLATE 2

3. Adult male Green Turtle; note long tail (the turtle is being released after being caught in nets)
4. Adult male Loggerhead Turtle; note long tail
5. Leatherback Turtle
6. *Trionyx triunguis,* this is a freshwater species
7. Female Green Turtle showing scar on third marginal plate from claws of males

3

4



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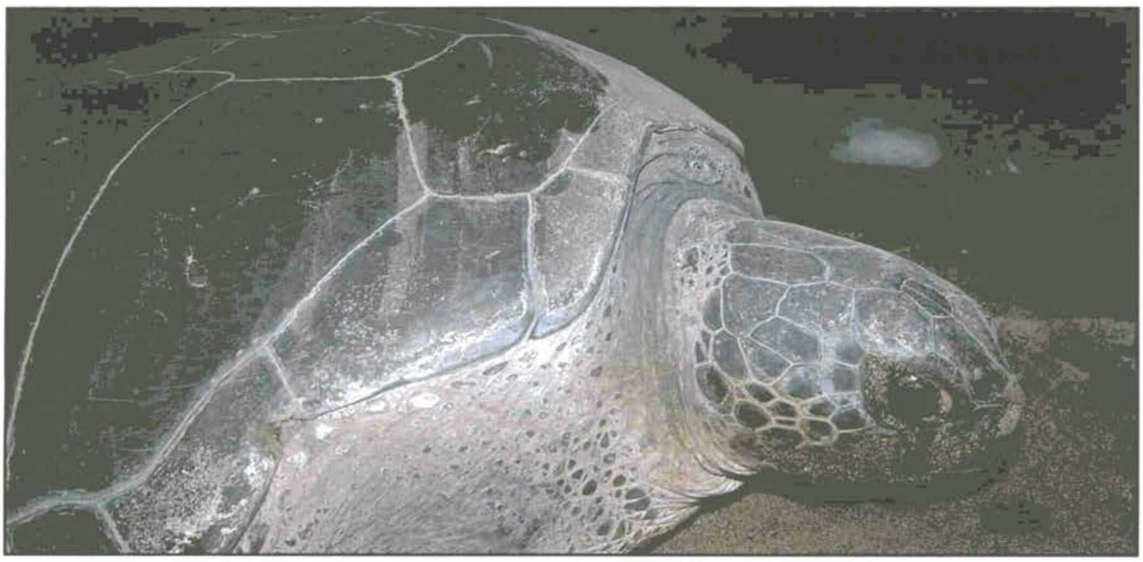

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PLATE 2

PLATE 3

8. Loggerhead hatchlings
9. Green Turtle hatchling
10. Ventral aspect of Green and Loggerhead hatchlings. The Green hatchling has the white underside.
11. Measuring hatchlings

8

9

10

11

PLATE 3

PLATE 4

12. Juvenile Loggerhead - side view; note keels on central and side plates

13. Juvenile Loggerhead - ventral view

14. Green Turtle - dorsal view

15. Green turtle - ventral view

12

13

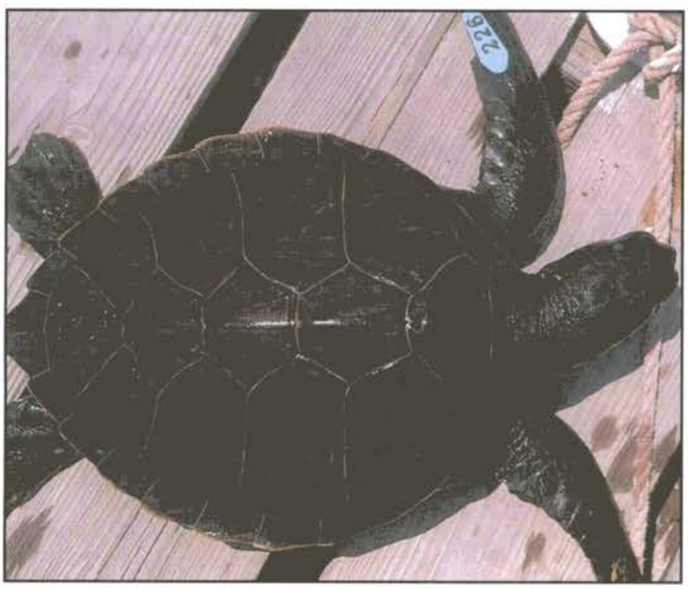

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PLATE 4

PLATE 5

16. Multiple plates in sub-adult
17. Green turtle with no plates
18. The crab *Planes minutus* lives in the cloaca of Loggerhead turtles
19. *Chelonibia testudinaria,* a commensal barnacle

16

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PLATE 5

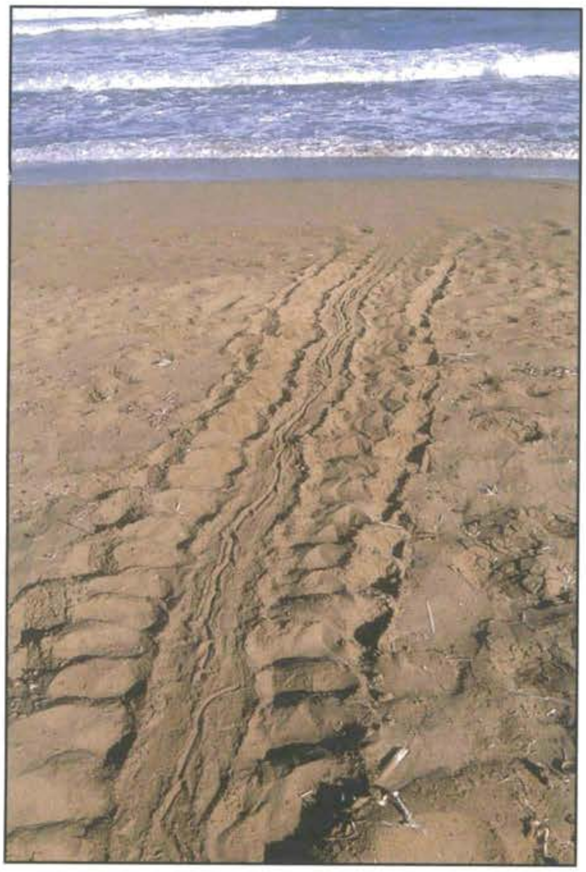
PLATE 6

20. Tracks - Loggerhead Turtle

21. Tracks - Green Turtle; note close parallel "steps"

22. "False crawl"

20



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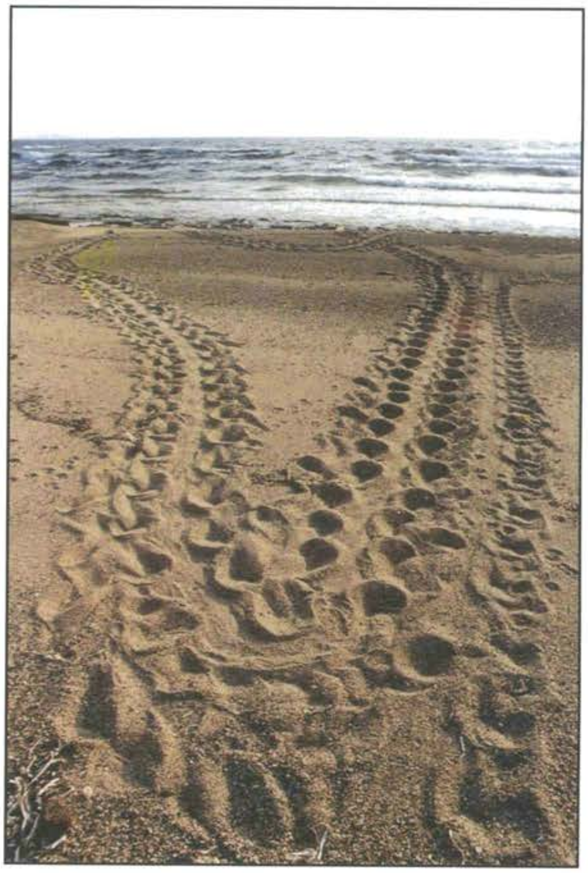

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PLATE 6

PLATE 7

23. Loggerhead nest
24. Loggerhead nest . The stick was used to mark the position of the chamber
25. Loggerhead Turtle covering the nest. Note that the digging is very shallow
26. Loggerhead Turtle laying. Note that the rear flippers are kept apart

23

24

25

26

PLATE 7

PLATE 8

27. Green Turtle nest

28. Green Turtle nest. The stick marks the position of the egg chamber

27

28

PLATE 8

PLATE 9

29. Green Turtle laying. Note position of rear flippers more or less cupping the egg chamber

30. Green Turtle covering up the nest

29

30

PLATE 9

PLATE 10

31. Characteristic Green Turtle nesting activity. Note the high profile of the beach

32. Moderately low profile beach; note surf-swept zone. Many nests are covered by the waves, even during minor storms and are destroyed

31

32

PLATE 10

PLATE 11

33. Eggs being laid are covered with mucous

34. Two to three-day old egg

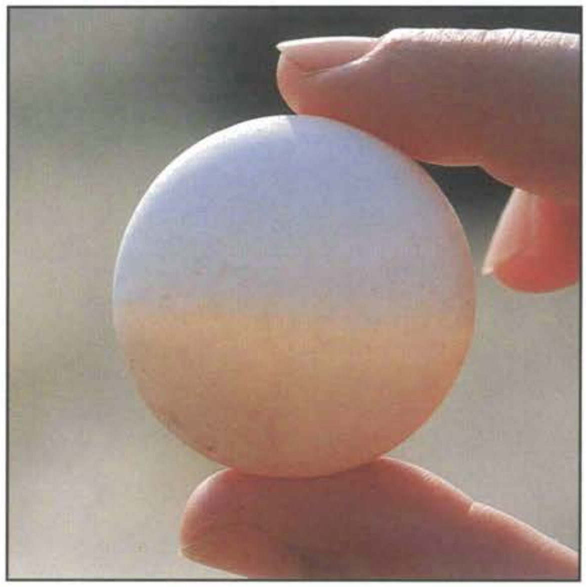
35. One week old egg. Note opaque top half of the egg; the translucent part turns gradually opaque, in 10-12 days the complete egg turns white

36. Egg nearing hatching; note that the shell is “crumbly” and is dented

37. Green Turtle hatching, this stage is known as “pipping”; note brittle eggshell

33

34



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37

PLATE 11

PLATE 12

38. Turtle killed for shell

39. Probable shark bite on Green Turtle

40. Fox predation on nest

38

39

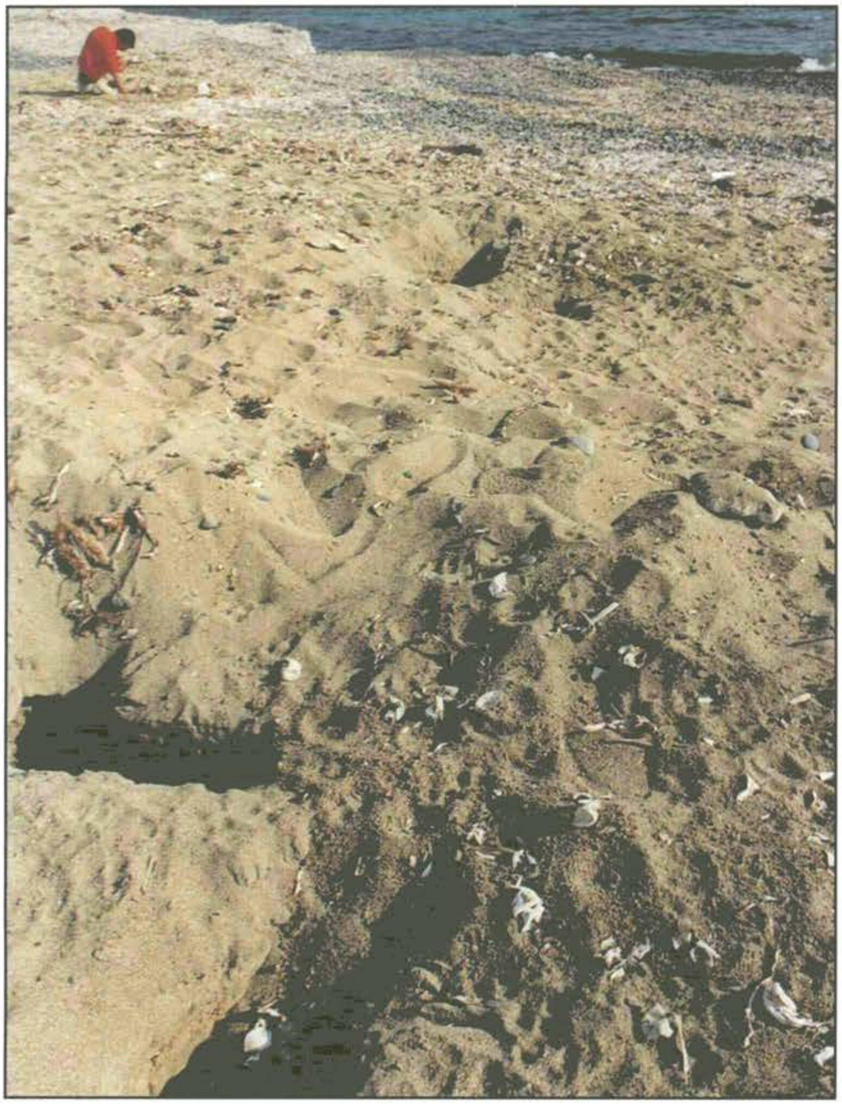

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PLATE 12

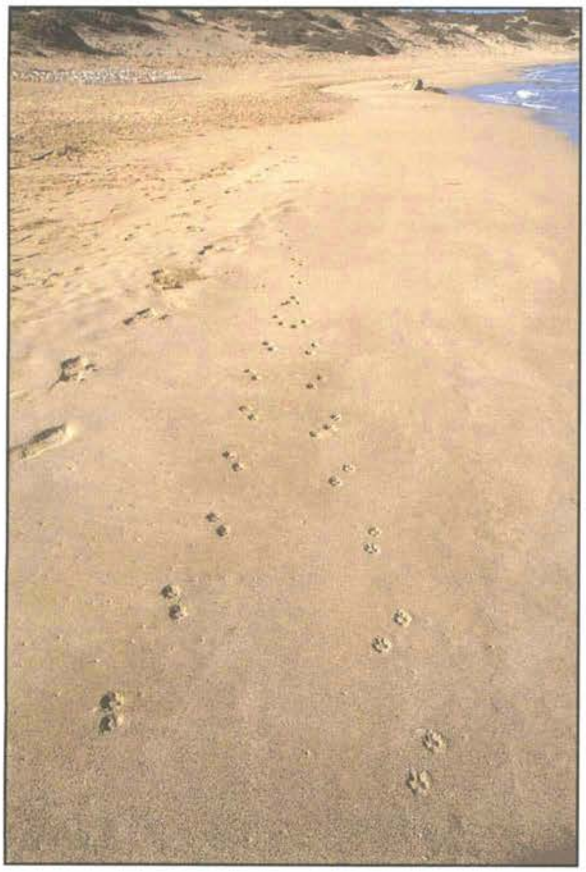
PLATE 13

41. Ghost crab (*Ocypode cursor*)

42. Fox tracks on beach; the fox will patrol the beach several times a night

43. Ghost crab burrow

41



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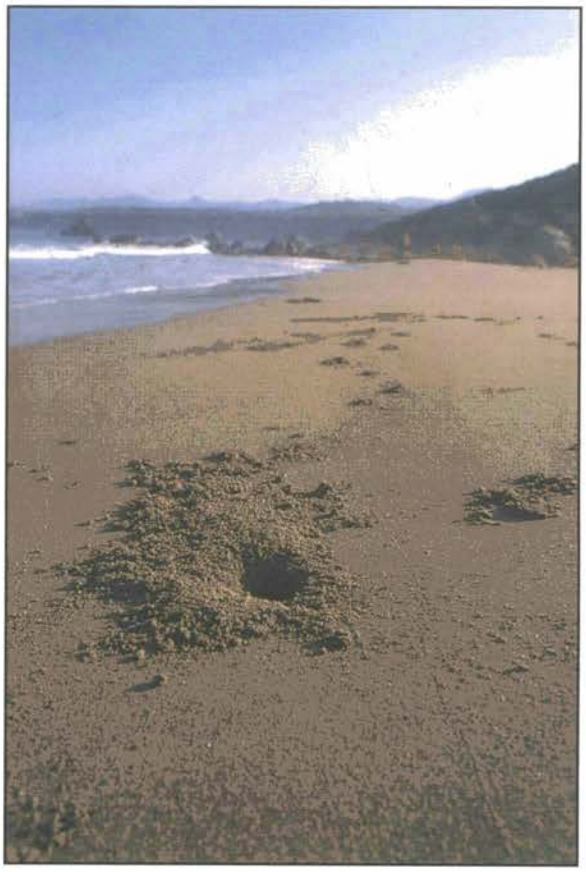

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PLATE 14

44. Pouch with tagging and measuring gear

45. Image intensifier, note red filter on torch

44

45

PLATE 14

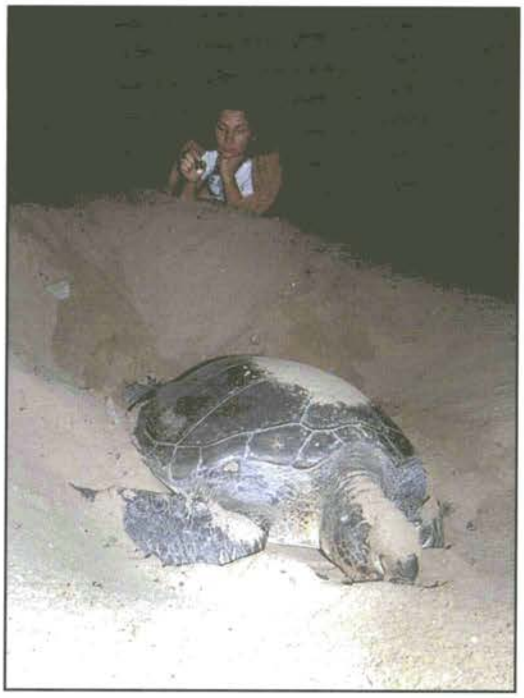
PLATE 15

46. Approaching nesting turtles, especially Green turtles, should be done very carefully. Approach to tag etc, after ascertaining that they have started laying. If possible use image intensifiers. Approach from behind, after checking which way the turtle is facing. Do not use a torch until you make sure that the turtle is laying. Read carefully the chapter on "Spotting and approaching nesting turtles"

47. Green Turtle nesting. While nesting these turtles will usually not be visible above the level of the beach after they dig their body pit

48. Green Turtle with metal tag

49. Green Turtle; note the location of tag on flipper and that the number faces upwards so that it can be read more easily; note also double tagging



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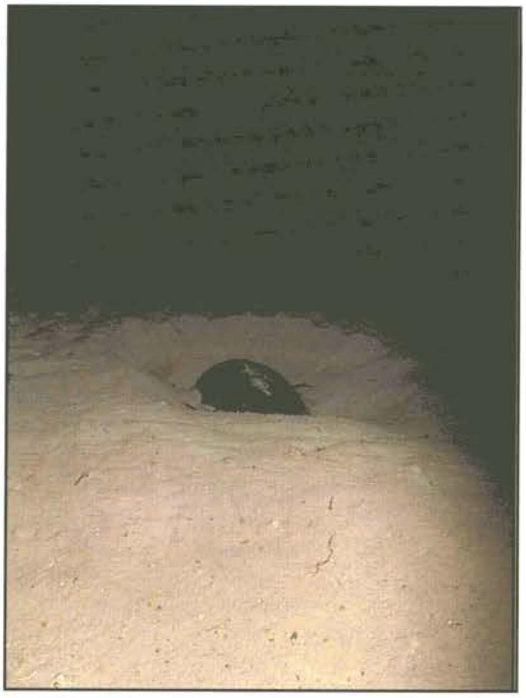

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PLATE 15

PLATE 16

50. Measuring turtle for curved carapace length (CCL)

51. Measuring straight carapace length (SCL) and width with special calibers is more cumbersome and may result in fewer records

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PLATE 16

PLATE 17

52. Tagging position for tagging the right flipper

53. Tagging position for tagging the left flipper

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PLATE 17

PLATE 18

54. Locating eggs in the nest with a stick; care is needed not to damage the eggs. A layer of sand at least 30 cm deep needs to be removed before using this in Green Turtle nests

55. Cage for *in situ* protection in place. About 20 cm of the cage are buried in the sand to stop predators from reaching the eggs or hatchlings. There is a slit about 3 cm in height for about half the circumference of the cage, at sand level, to allow hatchlings to escape to the sea. The cage is buried with the slit facing the sea

56. A special shovel for skimming the sand is very useful; it should be as light as possible

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PLATE 18

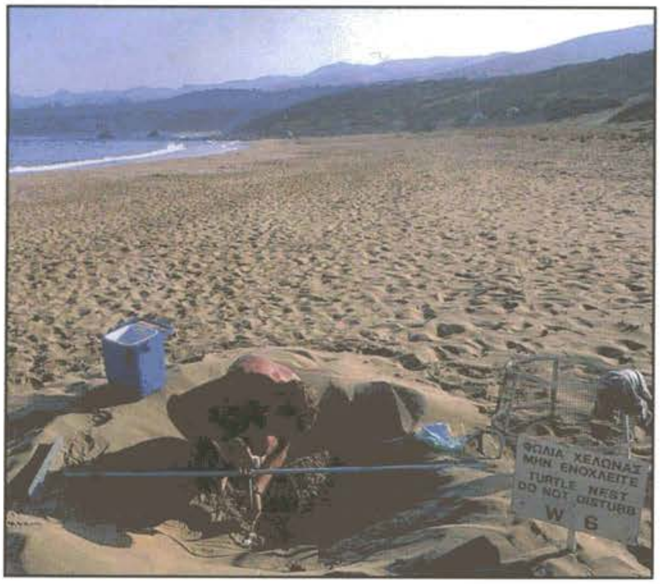
PLATE 19

57. Measuring the depth of the top eggs in the nest. The depth of the bottom of the chamber can be measured the same way

58. Relocating freshly laid eggs (i.e., from the night before). Square or cylindrical cooling boxes are used for the transportation of eggs

59. Relocation of endangered nest to the hatchery. The eggs in the picture are two days old. Note white (opaque) disc forming on top where the embryo started developing. Great care should be taken not to turn or shake the eggs at this stage. Eggs should preferably be moved as soon as possible after laying

60. Lara hatchery; note straw mats used during the hottest part of the day for shading the nests in which hatchlings have started emerging



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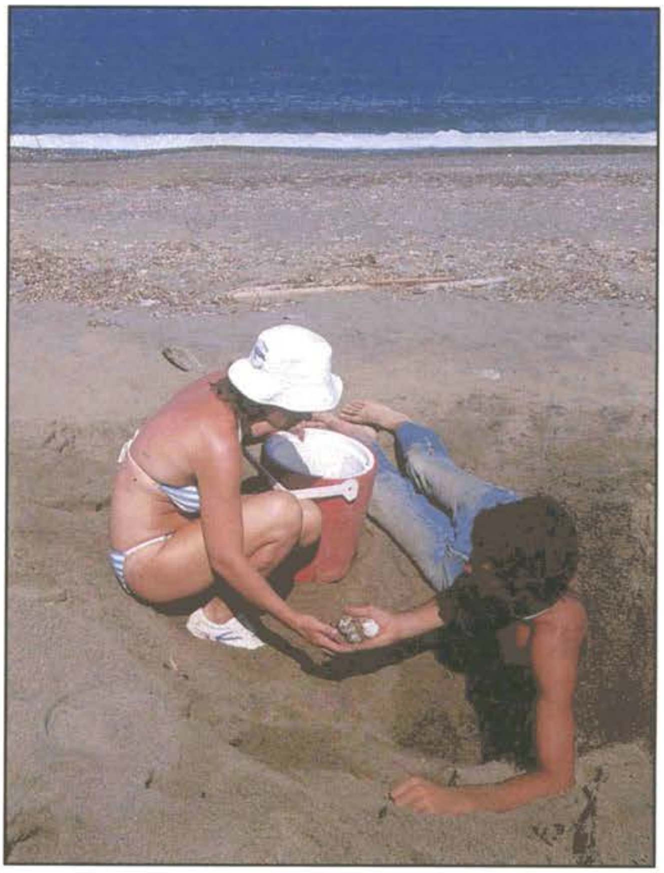

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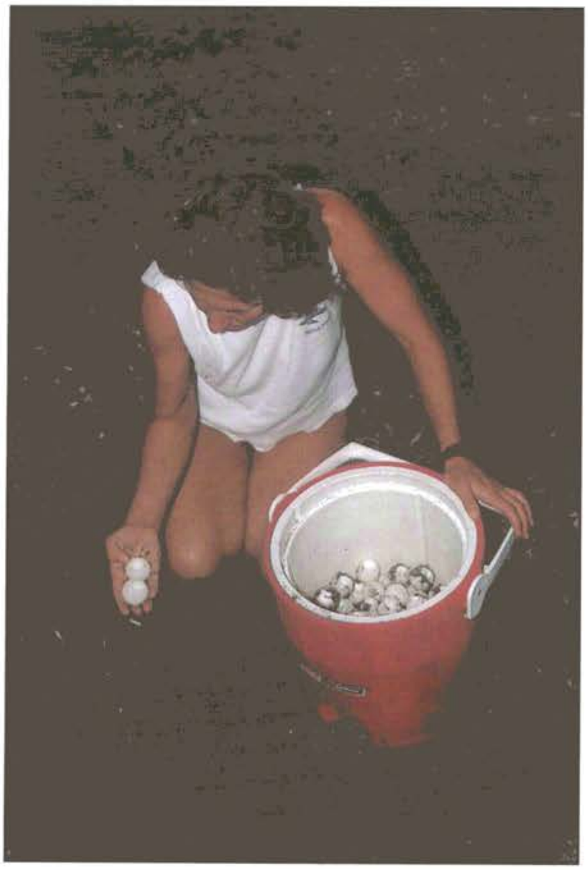

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PLATE 19

PLATE 20

61. Lara Station; the hatchery can be seen on the right.

62. Lara Station

63. Replanting of eggs in the chamber and placing thermistor probe in new chamber

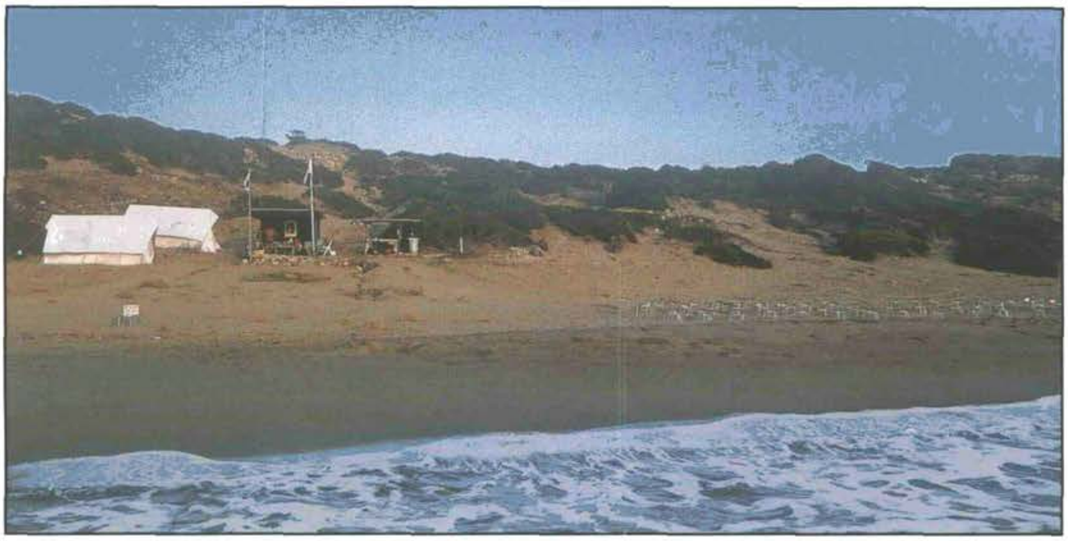

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PLATE 20

PLATE 21

64. Hatchery cage over a Loggerhead nest . The nest is near hatching and a sand "funnel" on top of such nests (chambers) often precedes the emergence of hatchlings by a few days. Such "funnelling" is more common on beaches with shallow nests and is normal

65. Hatchlings breaking surface, they may stay in this position for some time before emerging, especially in shaded cages during daylight hours

66. Batch of Green hatchlings emerging from the sand. Note near vertical position of hatchlings coming out of the sand

67. Batch of Green Turtle hatchlings after emerging in cage; hatchlings emerging during the night should be released as soon as possible after emerging

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PLATE 21

PLATE 22

68. Hatchlings always orientate towards the sea both at night (if there are no other lights about) and during the day

69. Hatchlings will be attracted to lights on, or near the beach; and they can be led away from the sea by such lights

70. Even a small torch is enough to disorientate hatchlings, especially on a moonless night; note hatchlings converging on the light from a torch

71. Hatchlings make their dash to the sea in a period of frenzied activity which continues as they swim to open waters

72. Green Turtle at late embryonic stage; the yolk will be absorbed into the body cavity in a day or so; hatchlings found at this stage should be kept on moist sand for two to three days until the navel closes and then released

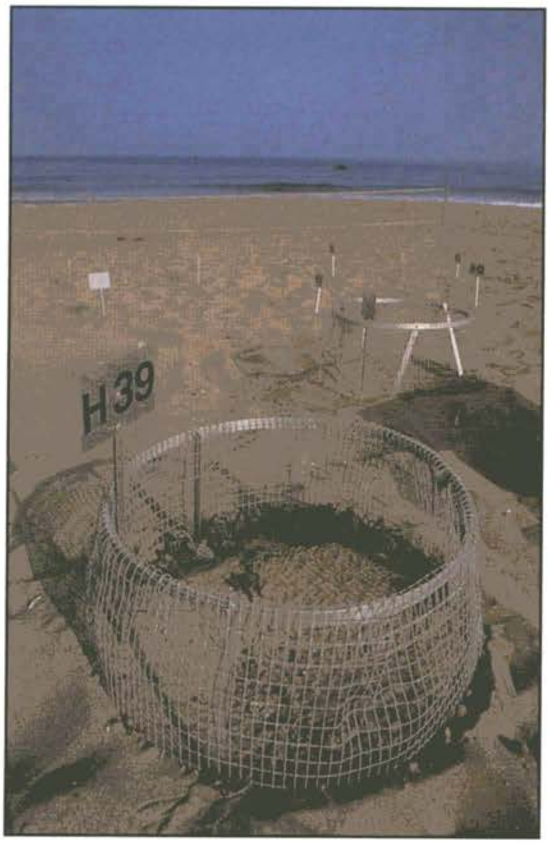

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PLATE 22

PLATE 23

73. Notching of one year old turtle
74. Notch fate in five year old Green Turtle; note notches deforming the last marginal plates on both sides
75. Sea cages for rearing turtles

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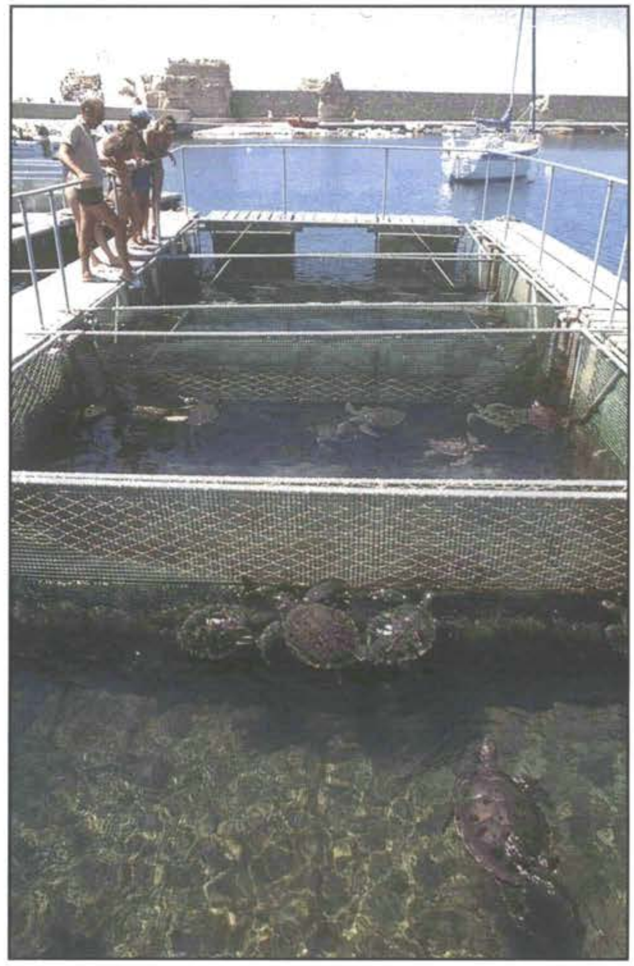

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PLATE 24

76. Release of head-started turtles; head-starting still needs to be proven as a conservation technique

77. Training course at Lara Station

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PLATE 24