V.6. FISHERIES INTERACTIONS WITH MARINE TURTLES

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INTRODUCTION

Three species of marine turtles, namely the loggerhead turtle *Caretta caretta*, the green turtle *Chelonia mydas*, and the leatherback turtle *Dermochelys coriacea* are encountered in the Hellenic seas, as well as in the Mediterranean. Of these, the first two reproduce in the Mediterranean and have evolved local populations, while the leatherback turtle is a visitor from the Atlantic. Only *Caretta caretta* is known to nest in Hellas, concentrating about 60% of the total documented nesting of this species in the Mediterranean (MARGARITOULIS *et al.,* 2003a).

Caretta caretta and *Chelonia mydas* are listed as Endangered and *Dermochelys coriacea* as Critically Endangered in the IUCN Red List of Threatened Species. All three species are protected in Hellas by national legislation including several ratified international conventions (e.g. Bern Convention, Bonn Convention, Barcelona Convention) as well as European Community regulations (e.g. CITES) and directives (e.g. 92/43 Habitats Directive).

In Hellas, all species of sea turtles are known to interact with fishing activities, often with a negative impact on either the turtles or the fishing gear, or both.

BIOLOGICAL NOTES ON SEA TURTLES

Sea turtles are a highly migratory species; therefore, they should be examined in a regional context. This is most apparent in the case of a semi-enclosed sea such as the Mediterranean.

1. Caretta caretta

It is a cosmopolitan species, frequenting tropical and temperate latitudes as well as open and coastal waters. The loggerhead populations in the Mediterranean exhibit a certain degree of isolation from the ones in the Atlantic (BOWEN *et al.,* 1993).

Nesting Areas: Nesting in the Mediterranean occurs almost exclusively in the eastern basin, and mainly in Hellas (3 000 nests/yr), Turkey (1 400 nests/yr) and Cyprus (600 nests/yr). According to long-term documented data, the single most important nesting site, and the one with the highest nest density, is Laganas Bay on the island of Zakynthos. Nesting areas in Hellas have been classified, according to specific criteria, as "major" (Kyparissia Bay, Rethymnon, Lakonikos Bay, Bay of Chania), and "moderate" (Koroni, Bay of Messara, Kotychi, Kefallonia, Kos and several others) (MARGARITOULIS *et al.,* 2003a).

Marine Habitats: Loggerhead turtles pass through two ecological stages in their lifetime. During the "oceanic" stage they frequent open waters and feed upon pelagic prey, while during the "neritic" stage they settle in shallow coastal waters and feed upon benthic prey.

It is worthwhile to note that loggerhead turtles, hatched on northwestern Atlantic beaches, enter the Mediterranean Sea through the Straits of Gibraltar, during their oceanic-stage migration. The presence of Atlantic turtles in the western Mediterranean was initially discovered by the frequent captures in surface longlines of juvenile loggerheads, the high numbers of which could not be justified as originating from only the Mediterranean stock; this has been subsequently corroborated by genetic studies. These Atlantic-oriented individuals do not reproduce in the Mediterranean but share the same or adjacent oceanic habitats with juveniles from the Mediterranean stock. Besides the western Mediterranean, another important oceanic habitat, probably hosting juveniles from Hellas, has been recently identified between the southern Adriatic Sea and the northern Ionian Sea.

Large-sized turtles (i.e. in their neritic stage) are usually found in the eastern Mediterranean. This has been determined through frequent captures in bottom trawlers in the shallow waters of the northern Adriatic (CASALE *et al.,* 2004), and the Gulf of Gabès in Tunisia (JRIBI *et al.,* 2004), as was also shown by the post-nesting migrations of adult females which were tagged in Hellas and subsequently captured in these two areas (Figure 1). In Hellas, as derived by the size of turtles captured in fishing gear or found stranded, several areas can be considered as neritic habitats (e.g. Lakonikos Bay, Amvrakikos Bay, Thracian Sea).

2. Chelonia mydas

It has a circumglobal distribution, frequenting mainly tropical latitudes as well as open and shallow waters. Genetic divergence has shown a strong degree of isolation from the Atlantic popu-

Figure 1: Post-nesting movements of loggerhead turtles, tagged in Hellas (Zakynthos and Kyparissia Bay) in the period 1982-2004. From a total of about 3 200 tagged females, 129 (4.0%) have been recovered at distances longer than 150 km from the respective nesting area. Of the recovered individuals, 28% were found in the Gulf of Gabès and 43% in the Adriatic Sea. Arrows are indicative and do not suggest migratory routes.

lations. Nesting in the Mediterranean is restricted to its easternmost part (mainly in Turkey, Cyprus and Syria) with an average number of nests of about 1 200 per year. Satellite tracking has shown that some females nesting in Cyprus migrate to northern Africa during winter. The most important foraging area is found between Turkey and Egypt. However, a foraging habitat for juvenile green turtles has been recently identified in Lakonikos Bay, southern Hellas.

3. Dermochelys coriacea

It is the largest marine turtle and, although its nesting is restricted to the tropical zone, it has the widest latitudinal distribution at sea among all marine turtles. In the Mediterranean this species, appearing in large juvenile and adult size classes, is considered a regular visitor from the Atlantic. By comparing catch rates in longlines, it is derived that the leatherback's occurrence in the Mediterranean is much lower than that observed in the Atlantic. Available data from Hellas indicate that this species appears mainly in the Aegean Sea (MARGARITOULIS, 1986).

INTERACTION WITH FISHERIES

A major threat to marine turtle populations originates from their interaction with fishing activities. Since marine turtles are migratory, interactions with fishing gear in one Mediterranean country may affect sea turtle populations in another. Conservation efforts in a sea turtle nesting area can be undermined by the impact caused by fisheries by-catch on the same population in another area or country.

Thousands of turtles are captured every year in various fishing gears throughout the Mediterranean, including Hellas. However, the mortality rate of the captured turtles is not known. For better clarification of the above, it is useful to differentiate "mortality" into two components: (1) the "direct mortality" which is directly observed at gear retrieval, and (2) the "delayed or post-release mortality" which occurs after the release of a captured turtle. In contrast to the easily determined "direct mortality", the "delayed mortality" is extremely difficult to assess. Indeed, although most captured turtles are alive at gear retrieval (and usually released alive immediately or soon after), it is very difficult to determine how many of these will die because of damage incurred by this interaction. As reported in more detail below, death to a turtle released after capture can occur many days, weeks or even months, after a fisheries' interaction.

In addition to the mortalities caused by the interaction alone, turtles may be intentionally killed or injured by fishermen. There are several reasons for this behaviour. Sometimes turtles are seen by fishermen as competitors for fish. Longline fishermen may kill them to recover expensive hooks. Furthermore, they can be killed because of prejudice, ignorance or superstition, as well as revenge because of the damage caused to fishing gear. From a sample of 524 turtle strandings found along the

Figure 2: Loggerhead turtle with healed injury on head, inflicted intentionally after its capture in gill nets (© ARCHELON).

coasts of Hellas, over 23% had injuries presumably inflicted intentionally by fishermen (KOPSIDA *et al.,* 2002). Also, from a sample of 226 injured turtles admitted to ARCHELON's Rescue Centre in Glyfada, 34% suffered from head trauma (Figure 2) in most cases deliberately inflicted after capture in fishing gear (PANAGOPOULOS *et al.,* 2003).

Relevant data from sea turtle rescue centres can provide a general idea of the proportion of affected turtles because of fisheries' interactions. During the 10-year period 1997-2006, 441 injured turtles were admitted to ARCHELON's Rescue Centre in Glyfada. Of these, 306 (69.4%) bore signs of fisheries' interaction (i.e. ingested hooks or lines, intentional blows, entanglement in nets). The annual percentage of the fisheries' induced injuries ranged from 59.4% to 78.9% (Figure 3).

Another important factor of fisheries' impact on turtle populations stems from the size class of the affected turtles. It has been shown that large-sized turtles have a greater reproductive value than small-sized ones. Therefore, fishing gears used mostly in shallow waters (e.g. beach seines, trawls, static nets), frequented by the large-sized "neritic" specimens, have a greater impact on turtle populations than those used in open waters (e.g. drifting longline), frequented by the small-sized "oceanic" specimens, even if the latter gears catch more turtles.

The fishing gears with a major impact on sea turtles in the Mediterranean, and most probably in Hellas, are the drifting longline, the static gill net, the bottom trawler and the beach seine. The impact caused to turtles by these gears is briefly described below.

Drifting longline

This gear is responsible for the highest number of turtle captures in the Mediterranean and, according to the available data, also in Hellas. Several tens of thousand captures occur every year in the Mediterranean (CAMIÑAS, 1988; GEROSA & CASALE, 1999; DEFLORIO *et al.,* 2005), and LEWISON *et al.* (2004) estimated at least 60 000-80 000 turtle captures per year mainly in the western Mediterranean. An onboard observer study in Hellenic drifting longlines during 1999 and 2000 estimated the total loggerhead captures to be 1 145 (in 1999) and 5 474 (in 2000) (KAPANTAGAKIS & LIOUDAKIS, 2006). A similar study in the Ionian Sea provided an estimated total capture, by the Italian longline fleet, of 1 084 turtles (in 1999) and 4 447 turtles (in 2000) (DEFLORIO *et al.,* 2005). The vast majority of turtles captured in drifting

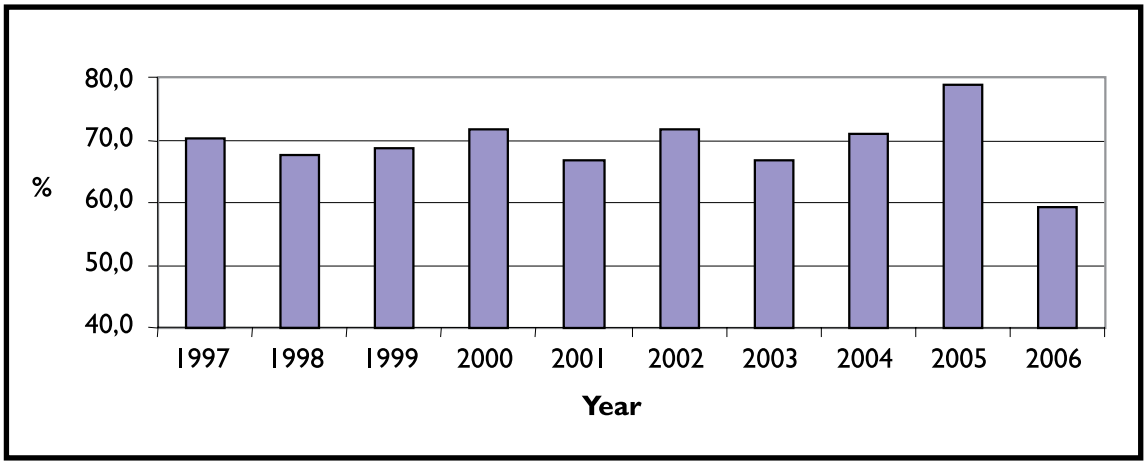

Figure 3: Annual percentage of turtles bearing signs of fisheries interaction (e.g. ingested hooks, entanglement in fishing lines and nets, intentional blows) from the ones admitted to ARCHELON's Sea Turtle Rescue Centre in Glyfada, during the period 1997-2006 (total number of admitted turtles: 441).

Figure 4: Juvenile loggerhead turtle hooked in drifting longline (© ARCHELON).

longlines are *Caretta caretta* with very few *Chelonia mydas* and *Dermochelys coriacea*. Turtles captured in drifting longlines are usually released by fishermen by cutting the branch line, without hauling the turtle onboard. Therefore, in most cases released turtles go away with an ingested hook and a piece of nylon line (Figure 4).

Turtle mortality in drifting longlines

Many factors influence the overall mortality induced by longlines, making its assessment rather difficult. Direct mortality in longlines is relatively low (zero in DEFLORIO *et al.,* 2005; about 5% in KAPANTAGAKIS & LIOUDAKIS, 2006), but delayed mortality is probably very high. About half of the 200 turtles which were caught by the Italian longline fleet in the Ionian Sea had hooks that

Figure 5: Fisherman releasing juvenile green turtle found alive in static gill nets (© ARCHELON).

could not be removed and remained deeply embedded in the digestive track (DEFLORIO *et al.,* 2005). Two independent studies on hooked turtles, hosted at rescue centers in the Mediterranean, showed mortality rates of 34% (AGUILAR *et al.,* 1995) and 33% (FREGGI & CASALE, 2006). It is interesting to note that a considerable proportion of "delayed" mortality is caused by the line itself which may cause lethal damage to the intestine, especially if the line is held in place by an anchored hook. Affected turtles are unable to digest food; they gradually become debilitated and subsequently die of starvation.

Static gill net

There are several types of this kind of set nets. In the Mediterranean and in Hellas, these gears are operated by numerous and widespread small-scale and artisan fishermen, and therefore, it is very difficult to determine their overall impact on turtles (Figure 5). Nevertheless, circumstantial evidence and the assumed high overall fishing effort suggest that turtle captures in this fishing gear may be very considerable.

Turtle mortality in static gill nets

A turtle captured in these nets usually drowns as it is not possible, in most cases, for it to swim to the

surface to breathe. Available data indicate a very high direct mortality rate, usually higher than 50% and even over 90% (see review of CASALE *et al.,* 2005). In Hellas, turtle mortality in static gill nets has not been assessed but it is suspected that it might be similar to that estimated for drifting longlines. If a turtle is found alive in a static net, fishermen try to release it by cutting the nets; otherwise the nets can be severely damaged. Thus, released turtles may go away wrapped in pieces of nylon nets, which sometimes cause necrosis of their flippers (Figure 6) as well as other problems. Moreover, this gear seems to draw the largest portion of intentional killings or attempts at it, as derived from anecdotal evidence and interviews with fishermen, as well as from injured turtles admitted to rescue centres (KOPSIDA *et al.,* 2002).

Figure 6: Treatment of flipper necrosis due to entanglement in fishing lines (© ARCHELON).

Bottom trawlers

An onboard observer study estimated 4 300 loggerhead turtle captures per year by the Italian trawler fleet in the northern Adriatic Sea (CASALE *et al.,* 2004), which is an important foraging area for turtles nesting in Hellas (Figure 1). Similarly, in the Gulf of Gabès off Tunisia, another important foraging area for turtles nesting in Hellas (Figure 1), about 5 500 turtles are captured per year by the Tunisian trawl fishery (JRIBI *et al.,* 2004). After a two-year study onboard Hellenic trawlers, in the Thracian Sea (northern Aegean) and the Ionian Sea (Gulf of Patras, western Gulf of Corinth, Echinades islands), the total turtle captures have been estimated at 0-418 captures/yr (Thracian Sea) and 0-448 captures/yr (Ionian Sea); the wide range being attributable to the small number of turtles caught (MARGARITOULIS *et al.,* 2003b). It is interesting to note that both species (*Caretta caretta* and *Chelonia mydas)* were captured at trawling depths of less than 50 m. All captured turtles were alive and, following measurements and tagging, were released. The usual practice of trawl fishermen in Hellas is to release captured turtles immediately by throwing them overboard. However, as it will be shown in the following section, this practice is not always the appropriate one.

Turtle mortality in bottom trawlers

Mortality of turtles caught in bottom trawlers depends largely on haul duration, which varies according to different factors (e.g. target species, sea bottom, type of vessel). Longer haul durations may increase: (1) the proportion of dead turtles in the net (direct mortality), and (2) the proportion of turtles in a comatose state, caused by apnea. It is important to note that comatose turtles thrown overboard usually die because they are unable to swim and therefore, cannot reach the surface to breathe (delayed mortality). Trawl fishermen can substantially reduce this type of "delayed mortality" by keeping comatose turtles onboard and allowing them to recover before releasing them. Indeed, in the northern Adriatic Sea CASALE *et al.*, (2004) estimated 9.4% of direct mortality and 43.8% of maximum potential delayed mortality (assuming that all comatose turtles would die). In the above mentioned two-year study in Hellas, zero direct mortality and no comatose turtles (i.e. no delayed mortality) have been observed, probably a result of short haul durations (ranging 68-185 min) (MARGARITOULIS *et al.,* 2003b).

Beach seines

This gear is used in shallow water and therefore, it has a considerable impact on large-sized "neritic" turtles, especially in certain areas of Hellas (e.g. Lakonikos Bay). The threat from this gear was more serious in previous years, due to the large number of these vessels. However, the gradual withdrawal of this type of fishing gear will certainly ease the pressure imposed on turtles.

Figure 7: Public release of injured turtle after its rehabilitation at the Rescue Centre(© ARCHELON).

CONSERVATION EFFORTS AND PROPOSALS

The many incidents of injured marine turtles reported in Hellas have prompted ARCHELON to establish a Sea Turtle Rescue Centre in Glyfada, Attica, in cooperation with the local Municipality. The Centre has a capacity to simultaneously treat 25 turtles under the supervision of a specialized veterinarian. The Centre receives about 44 turtles per year (Figure 3), of which about 50% are successfully rehabilitated and released (Figure 7).

Injured turtles are brought to the Rescue Centre thanks to a nationwide Stranding Network, comprised of public services (mainly Coast Guard stations), NGOs and concerned citizens.

Both the Rescue Centre and the Stranding Network were greatly improved by relevant LIFE-Nature projects, co-funded by the European Commission. These projects also included cooperative actions with fishermen in known "hot spot" areas, such as Lakonikos Bay, Amvrakikos Bay and Kriti. The most recent of these projects, entitled "Reduction of mortality of *Caretta caretta* in the Hellenic seas", covered the entire country with emphasis in western Hellas and Kriti where, due to the high incidence of turtle captures, two First-Aid Stations were established. Further, the collection and analysis of more stranding data provided the opportunity to identify some additional "hot spot" areas (e.g. Messiniakos Bay, Thracian Sea, Argolikos Bay). Special public awareness events were organized in these areas aiming at sensitising fishermen, local authorities and schoolchildren. It is useful to note that in the context of this project about 30 Memoranda of Understanding (MoU) have been signed by local Fishermen's Associations. The MoU, drafted in consultation with a fishermen's association, includes among others, the need to compensate fishermen who suffer damage or loss of gear by turtle interactions.

It is clearly understood that some mitigation measures are needed to lessen turtle by-catch during fishing activities. It is also understood that fishing activity is a major economic and recreational resource. With these prerequisites in mind, UNEP's RAC/SPA (Regional Activity Centre for Specially Protected Areas), which coordinates the implementation of the Action Plan for the Conservation of Marine Turtles in the Mediterranean (adopted by all Mediterranean countries through the Bar-

celona Convention), has published a booklet with instructions for fishermen towards reducing turtle mortality during or after a turtle's capture. The booklet has been translated in several Mediterranean languages, including Hellenic. In addition to this, ARCHELON has issued a number of leaflets, brochures, and posters for fishermen and relevant authorities in Hellas providing instructions on how to release captured turtles from various fishing gears.

Drawing from the above instructions, as well as from similar examples in non-Mediterranean countries (e.g. Australia, USA), we suggest the following actions to be implemented as a simple fundamental approach towards the assessment, and the reduction of turtle by-catch and associated mortalities in fishing gears used in Hellas:

- Assessment of turtle mortality rates in static gill nets
- Reduction of intentional killings or attempts

Design and implementation of educational programmes directed towards small-scale fishermen, with emphasis on static gill nets.

Evaluate progress through the national Sea Turtle Stranding Network and specific surveys in fishing ports.

- Mitigation of delayed (post-release) turtle mortality in trawlers and longlines

In trawlers: comatose turtles should remain onboard until they are able to swim.

In longlines: fishermen should cut the branch line as close to the turtle's mouth as possible, without hauling the turtle onboard.

Since marine turtles use different habitats and migrate across national boundaries during their life-cycles, any conservation effort should have a strong regional component. This is particularly evident for the semi-enclosed Mediterranean Sea, which is surrounded by 21 nations with different cultures, religions and needs, and where important populations of endangered marine turtles reproduce, forage, migrate and interact with various fishing gears. It is apparent that long-term conservation of these species in the Mediterranean is not an easy endeavour that can be undertaken by one or few countries but it requires well coordinated regional efforts. Moreover, marine turtles are also affected by many of the problems that humans are causing to the marine environment. Therefore, actions for the conservation of marine turtles contain a substantial potential for a positive impact on marine ecosystems, and reinforce international cooperation towards a rational management of marine habitats.

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