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Loggerhead Turtle Bycatch in the Gulf of Gab&#65533;s, Tunisia: An Overview

Khaled Echwikhi[1,2], Imed Jribi[2], Abderrahmen Bouain[2] & Mohamed Nejmeddine Bradai[1]

[1]*National Institute of Sea Sciences and Technologies, P.O.Box 1035, 3018 Sfax, Tunisia (E-mail: chouikhikhaled@yahoo.fr);*

[2]*Sfax Faculty of Sciences P.O. Box 1171, 3000 Sfax, Tunisia*

The loggerhead turtle, *Caretta caretta*, is considered the most common sea turtle species in the Mediterranean and is therefore included in most international wildlife conservation treaties (Eckert *et al*. 2000). Groombridge (1990) recommended that this species should be possibly considered as critically endangered for the Mediterranean region.

The main nesting concentrations of the loggerhead turtle in the Mediterranean are confined almost exclusively to the eastern basin (mainly Greece, Cyprus, Libya and Turkey) (Margaritoulis *et al*. 2003). Demographic studies indicate that the loss of late juveniles (straight carapace length = 30 to 80 cm) and adults has a more dramatic impact on populations than the loss of younger individuals such as eggs, hatchlings and younger juveniles (Crouse *et al*. 1987). Therefore, although rookery protection has been a priority for marine turtle conservation, this measure will be unsuccessful without the effective protection of large juveniles and adults. In fact, the impact of fishery related mortalities is one of the most important anthropogenic factors for loggerhead turtles in the Mediterranean. An assessment of fisheries interactions and associated mortalities is one of the priorities adopted by the Action Plan for the Conservation of Mediterranean Marine Turtles (RAC/SPA 2001).

More than 150,000 captures per year may take place in the Mediterranean by trawlers, longliners and set netters, with possibly over 50,000 deaths per year. Bycatch is drastically high in the western part of the Mediterranean especially around the Balearic Islands (Aguilar *et al*. 1995; Caminas *et al*. 2001) where there is an occurrence of a high concentration of sea turtles due to the entrance of animals from the Atlantic Ocean via Gibraltar (Argano *et al*. 1992; Caminas & De la Serna 1995).

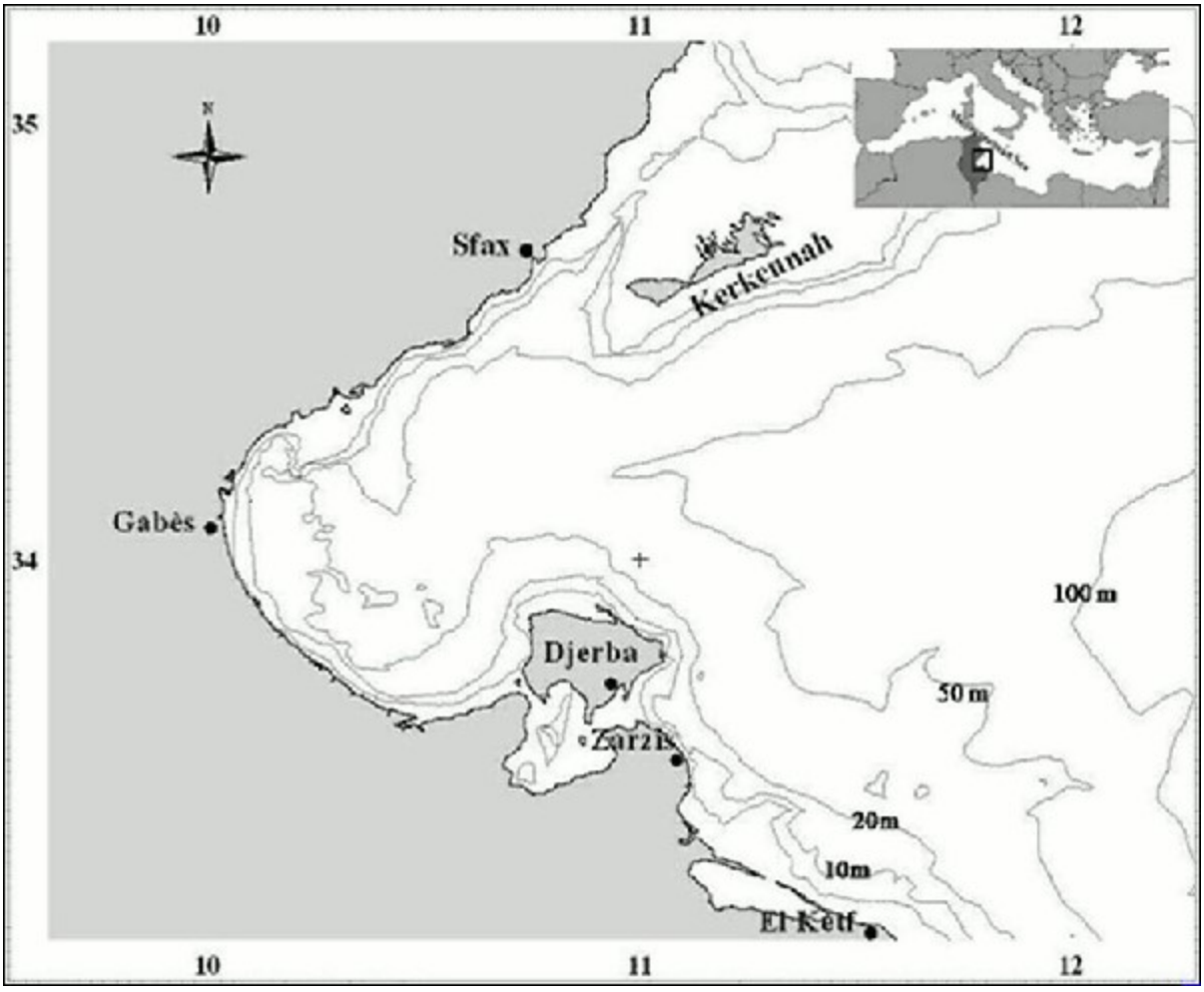

Figure 1. The Gulf of Gabes.

Results obtained from genetic markers (Casale *et al*. 2008) and tagging programs (Bradai *et al*. 2009; Bentivegna 2002) lead to the conclusion that the region of the Gulf of Gabes (Fig. 1) is an important wintering and feeding area for the loggerhead turtle in the Mediterranean Sea. In this region, a fleet of dozens of fishing vessels, using many kinds of fishing gears (including longline, trawl, gillnet and trammelnet), operating during different seasons and targeting a wide variety of commercially important species, interacts with this endangered species. In order to assess the importance of potential threats for different fishing gears and consequently the possibility to institute alternative approaches to mitigate these threats, many studies have been conducted focusing on turtle fishing gear interactions (Bradai 1992, 1993; Jribi *et al*. 2007, 2008; Echwikhi *et al*. 2010a; 2010b).

The first preliminary data on the bycatch of loggerhead turtles in the Gulf of Gabes were obtained from interviews with professional fishermen in numerous ports (Bradai 1992 and 1993). During interviews, fishermen were asked about gears used by season, number of turtle captured, season of catch, size of turtles, etc. Since 2001, bycatch data have been obtained from records taken by onboard observers during trips conducted in different zones of the Gulf of Gabes (Jribi *et al*. 2007, 2008; Echwikhi *et al*. 2010a,b). Data recorded included gear types used, characteristics of gear type, fishing operations and catch characteristics. Information on sea turtles captured included species, geographical position, Curved Carapace Length notch to tip (CCLn-t) and physical condition. To assess the interactions of this species with fishing activities, many catch rates were estimated: number of turtle captured/trip, number of turtles captured/day, number of turtles captured per 1000 hooks for longlines, number of turtles captured/h*d for trawls (h is the headrope length/30.5 m and d is the haul duration in hour units) and number of turtles captured per km2 of net/day for gillnet.

	Catch rates	Total capture	Mortality rates	References
Pelagic longline	0.823 (0.568-0.158) turtle/1000 hooks	486.48 (334.93-683.30)	0%	Jribi et al. 2008
Pelagic longline	0.806 (0.802–0.810) turtle/1000 hooks	437.086 (299.09-608.63)	12.12%	Echwikhi et al. 2010a
Bottom longline	0.278 (0.179-0.415) turtle/1000 hooks	732.89 (469.50-1090.21)	33%	Jribi et al. 2008
Bottom longline	0.333 (0.236-0.591) turtle/1000 hooks	142 (99.93-167.20)	43.75%	Unpub. data
Trawl	0.0063 turtle/h.d	5458±1652	3.33%	Jribi et al. 2007
Trawl	N/A	2000-2500	N/A	Bradai 1992
Gillnets	0.527 (0.403–0.649)/ km2/day	443.6 (357.65- 501.25)	69.44%	Echwikhi et al. 2010b

Table 1. Catch rates recorded (95% C.I.), total capture estimated and mortalities rates registered by different gears in the Gulf of Gab&#65533;s.

Investigations carried out by Bradai (1993) in 20 ports in the Gulf of Gabes, indicate that incidental capture of loggerhead turtle was registered by many types of fishing gear, such as pelagic and bottom longlines, trawl, gillnets and purse seine. According to fishermen interviewed, the majority of turtles incidentally caught were in good condition, although a few cases of mortality were mentioned from trammel nets (5.17%) and longlines (0.53%).Catch rates registered during studies conducted by onboard observers show variation across gears (Table 1). These data show the importance of interaction of loggerhead turtle with different gears, and suggest a high population density of loggerhead turtles in the Gulf of Gabes. Total loggerhead capture in pelagic longlines is among the highest for sea turtles recorded in the Mediterranean Sea (Jribi *et al*. 2008; Echwikhi *et al*. 2010a). The threat caused by pelagic longlines on loggerhead population is not limited to the Gulf of Gabes or the Mediterranean as a whole. Lewison *et al*. (2004) reported that pelagic longlines are frequently referred to as the major threat to sea turtles worldwide; more than 200,000 loggerheads were taken as bycatch in pelagic longline fisheries during 2000. Sea turtle interactions with bottom longlines have not been well studied in the Mediterranean; this type of gear is used in the Gulf of Gabes and may pose a serious threat to loggerhead turtles.

In the Gulf of Gabes, loggerhead turtles are captured by trawl fishing throughout the year; winter, spring and summer are periods when the catch rates are highest. The study by Jribi *et al*. (2007) showed that trawlers have a large impact on sea turtles in the Gulf of Gabes. The total catch is among the highest in the Mediterranean (5458&#65533;1652) and exceeds previous estimates: 3500&#65533;4000 (Laurent *et al*. 1990) and 2000&#65533;2500 (Bradai 1992).

In addition to commercial fishing gear (i.e. trawl and longline), artisanal gillnet fishing poses a high threat to loggerhead turtles (Bradai 1993; Echwikhi *et al*. 2010b). Studies concerning gillnets in the Mediterranean are rare. Gillnets represent a threat for sea turtles mainly inhabiting coastal waters (Lazar *et al*. 2004), however the quantification of capture rates in these widely dispersed fisheries is difficult to assess, due to the large number of small fishing vessels dispersed along the entire Mediterranean coastline.

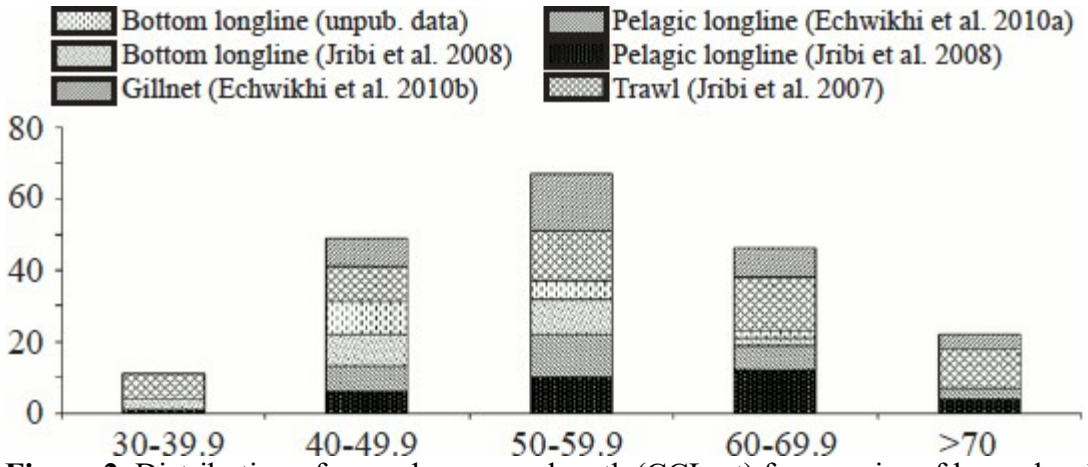

Figure 2. Distribution of curved carapace length (CCLn-t) frequencies of loggerhead turtles captured by different gears in many studies conducted in the Gulf of Gabes.

The majority of turtles captured in gillnets were juveniles and subadults classed 50 and70 cm CCLn-t (Figure 2). Generally, the wide continental shelves of the eastern Mediterranean (Tunisia and Libya; north Adriatic; Egypt; Southeastern Turkey) and especially the Gulf of Gabes, constitute neritic foraging habitat for loggerhead turtles. The coincidence of the departure of some adult turtles to reproduce in the north of the Mediterranean (mainly Greece) and the use of longline and gillnets in the summer period increases the proportion of juveniles captured.

In terms of mortality, the highest rates were registered by gillnet and bottom longlines (Table 1). For bottom longlines, hooks are close to the bottom and the turtles captured were smaller; therefore they might not be able to reach the surface to breath and eventually die by asphyxia. For similar reasons, the high mortality rates associated with gillnets may be a result of the long soak time. This gear is left at sea for one or more days, which is well beyond the apnea tolerance range of turtles (Echwikhi *et al*. 2010b).

Mortalities rates recorded by pelagic longlines and trawls were the lowest. For the pelagic longlines, hooks were set close to the surface (4 to 5 meters depth), so a captured animal is perhaps more likely to reach the surface to breath. For trawls, the low mortality may be explained essentially by the shorter haul duration (mean: 86.83 min) in the Gulf of Gabes (Jribi *et al*. 2007).

All studies conducted show that gillnets, trawls and longlines pose a serious threat to loggerhead population in the Gulf of Gabes. This is explained by three reasons: first, these gears caught specimens in the neritic stage (large juveniles and adults), during which increased mortality rates can have a particularly profound effect on loggerhead populations (Laurent *et al*. 1992). Second, gillnets and longlines are mainly deployed at generally low depths, not exceeding 60m, where loggerhead turtles are generally concentrated (Polovina *et al*. 2003). Third, the highest fishing effort occurred during the summer months, when these reptiles inhabit inshore waters.

To reduce turtle by catch, different mitigation measures could be adopted. Generic solutions include spatial and temporal restrictions on fishing (especially in locations and during periods of high concentration of turtles) and also reducing the soak time duration for gillnet fisheries. Furthermore, specific solutions could be involved. Echwikhi *et al*. (2010a) demonstrated that the use of pieces of stingrays as a bait instead of mackerel reduces turtle bycatch with pelagic longline and increased the capture of the target species. However, some stingray species are threatened, thus further research is needed to identify alternative baits from non-threatened species. The use of circle hooks was identified as a promising tool to reduce turtle bycatch with pelagic longline in many fishing areas (Piovano *et al*. 2009). For gillnet fishery, recently some measures to mitigate sea turtle bycatch have been presented, such eliminating buoys on the float line (Peckham *et al*. 2009) and illuminating nets (Wang *et al*. 2009). These techniques should be tested in the Gulf of Gabes and throughout the Mediterranean Sea.

In addition, the role of professional fishermen is certainly of fundamental importance in sea turtle conservation programs. During the different studies, awareness campaigns aimed at fishermen were conducted; these campaigns explain how to treat captured turtles and how to apply recovery techniques to comatose turtles. Injured specimens continue to be occasionally transferred to a specialized rescue center, founded in 2004 at Monastir (near the middle of Tunisia's coastline).

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