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Loggerhead turtle (*Caretta caretta*) by-catch and mortality in the Mediterranean Sea

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Loggerhead turtle main distribution areas in the Mediterranean Sea (Camiñas, 2005).

The loggerhead sea turtle, *Caretta caretta*, belongs to a monophyletic group of chelonians that comprises 7 species adapted to marine environments. It is a long-living, slowly maturing species, listed as Endangered by the IUCN.

- **Morphology**: elongated carapace, upside with 5 lateral brown scutes, underside with 3 lateral scutes without pores; length up to 120cm.
- **Feeding**: mainly fish, but also: pelagic tunicates, crustaceans, mollusks and other invertebrates. Early juveniles prey upon epipelagic animals; large juveniles: benthic and pelagic prey; adults upon benthic animals..
- **Reproduction**: every 2 – 4 years the females lay 100 - 160 eggs; hatchlings emerge after 60 days and crawl to seawater.
- **Distribution**: tropical to warm temperate areas (Mediterranean Sea, Atlantic, Indian and western Pacific oceans). Both large juveniles and adults prefer western Mediterranean in summer and spring time whereas they forage and overwinter in the East Medit. in cold periods.

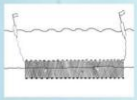
Sea turtles are currently threatened in all life stages both on nesting beaches and at sea due to human activities being Fishering the major threat.

By-catch. Fishing Gears

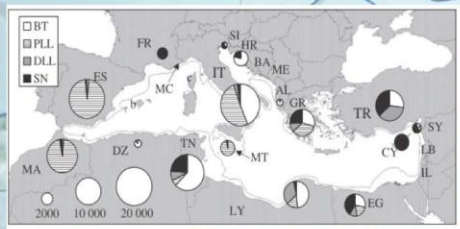
1. Pelagic longline: 57000 captures per year in total, >1000/year in: Spain, Morocco, Italy, Greece, Malta, Egypt, Libya and Tunisia. The most affected marine areas are: Alboran/Balearic sea, the central Mediterranean and the Ionian. ≈ 50% ascribed to small-scale fisheries.

2. Bottom trawl: 39000 captures per year in total, > 1000/year in: Tunisia, Italy, Libya, Turkey, Greece, Croatia, and Egypt. The most affected marine areas are the North African continental shelves (Tunisia, Libya, Egypt), the Adriatic, the Levantine basin and the Aegean. Mainly due to industrial fisheries

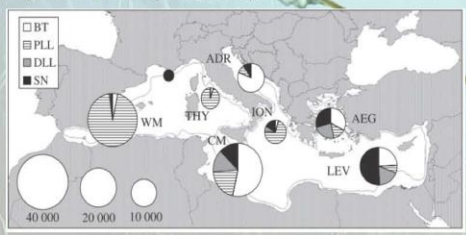
3. Demersal longline: 13000 captures per year in total, > 1000/year in: Turkey, Libya, Tunisia, Greece. The most affected marine areas are the north African continental shelf (Tunisia, Libya, Egypt), the Levantine basin and the Aegean. Mainly due to small-scale fisheries.



4. Set net: There are 23000 captures per year in total, > 1000/year in: Libya, Turkey, Tunisia, Cyprus, Greece, Croatia and France. The most affected marine areas are the north African continental shelf (Tunisia, Libya, Egypt), the Levantine basin, the Aegean and the Adriatic. Mainly due to small-scale fisheries.



Proportions of turtles captured annually in the Mediterranean by country, and fishing gear estimated from fishery statistics and catch rates. BT, bottom trawl; PLL, pelagic longline; DLL, demersal longline; SN, set net (Casale, 2010).



Proportions of turtles captured annually in the Mediterranean by sea area and fishing gear estimated from fishery statistics and catch rates. Same legend as above (Casale, 2010).

Other mortality causes

1. Predation: White shark (*Carcharodon carcharias*) and Monk seal (*Monachus monachus*), occasional and opportunistic predators in the Mediterranean Seaen.

2. Vessel collisions: ≈ 14% mortality. Turtles hardly ever escape from vessels travelling faster than 4 km/h.

3. Habitat degradation: reduces hatchling recruitment through the progressive destruction of nesting sites.

4. Marine debris: floating plastics are usually consumed. Detected in about one third of loggerheads from Adriatic sea but especially in the western and central Mediterranean ones.

5. Heavy metal concentrations: *Caretta caretta* exhibits high metal (Hg, Cd and "lead") concentrations because of its carnivorous diet. However, metal levels are not likely to be high enough to affect them.

6. Climate change:
a) Sea level rise decreases the availability of suitable nesting sites.
b) Sand temperature changes sex ratio (males need lower temperatures to hatch).

Fishing impact over the population

- There is an **overlap** between **fisheries activities** and **ontogenetic habitats** for different life stages of loggerheads.
- **Trawls** operate in areas occupied by larger, **older turtles** with more reproductively 'valuable' turtles than fisheries that **longlines** which operate in areas occupied by smaller, **younger turtles**.
- In the Spanish longline fishery, loggerhead **sizes** were **smallest** in **albacore** tuna *Thunnus alalunga* sets, larger in swordfish *Xiphias gladius* sets, and largest in bluefin tuna *Thunnus thynnus* sets.
- The annual **survival probabilities** of loggerhead turtles in the Mediterranean is **0.73**.

Mitigation Measures

1. **Modifications of fishing gears**:
   a) Using 16/0 circle hooks because they are less likely to be swallowed.
   b) Further research on branchline characteristics (material, length, thickness, etc.).
   c) Using Turtle Excluder Device (TED) to reduce the time of submergence and mortality.
2. **Modifications of fishing operations**:
   a) Night-time fishing, because most turtles are captured during daylight.
   b) Using mackerel baits instead of squid ones to reduce by-catch.
   c) Using deeper longlines and nets.
   d) Reducing vessel speed to 4 km/h and fishing distance from the coast up to 35 miles.
3. **Fisheries closures**: reduce fishing effort in areas and seasons where/when turtles concentrate.
4. **Educate fishermen** about procedures to reduce post-release mortality.

Conclusions

1. Loggerhead turtle populations are more affected by fishing gears such as bottom trawlers and pelagic longlines, and by fishing in the eastern basin of the Mediterranean Sea.

2. Bottom trawl have bigger impacts than pelagic longlines. It is because of the lower trawls individual selectivity.

3. There are many more mortality causes to be consider considered.

4. Strict fishing control and mitigation measures should be carried out.

Both climate change and habitat degradation are increasing mortality factors. But unfortunately, mitigation measures are difficult to find due to its complexity. The other threats could be solved by agreements with fishermen guilds and improving fishing gears and technics. Fishermen guilds are concerned about the welfare of the loggerhead turtle as long as those solutions do not imply a decrease on the size of their target species.

Camiñas, J. A. (2005). Marinas y las flotas españolas en el mediteráneo occidental y golfo de Cádiz. *Secretaría general de pesca maritima*.
Casale, P. (2010). Sea turtle by-catch in the Mediterranean. *Fish and Fisheries*, 12(3), 299–316.