SCRS/2012/049 Collect. Vol. Sci. Pap. ICCAT, 69(4): 1788-1827 (2013)

A REVIEW OF FISHERIES WITHIN THE ICCAT CONVENTION AREA THAT INTERACT WITH SEA TURTLES

Rui Coelho[1, 2],, Joana Fernandez-Carvalho[2], Miguel N. Santos[2]

SUMMARY

There are currently growing concerns about the impacts of marine fisheries in vulnerable bycatch species, such as sea turtles. The International Commission for the Conservation of Atlantic Tunas (ICCAT) is preparing an assessment on the impacts of ICCAT fisheries on sea turtle population, with the assessments scheduled to start in 2013, and the data preparation starting in 2012. Integrated in this process, this document was prepared to compile and revise currently available information on interactions between fisheries and sea turtle population within the ICCAT Convention area, including the Atlantic Ocean and the Mediterranean Sea. More emphasis is given to interactions with ICCAT fisheries, such as pelagic longlines, purse seines, driftnets and tuna traps, but other non-ICCAT fisheries that operate within the ICCAT convention area, such as trawl and nets, are also addressed. A summary of the data currently available at the ICCAT Secretariat to carry out the analysis is also presented.

RÉSUMÉ

Les impacts des pêcheries marines sur les espèces accessoires vulnérables, comme les tortues marines, suscitent actuellement de plus en plus de préoccupations. La Commission internationale pour la conservation des thonidés de l'Atlantique (ICCAT) prépare une évaluation sur les impacts des pêcheries de l'ICCAT sur les populations de tortues marines, les évaluations devant démarrer en 2013 et la préparation des données ayant débuté en 2012. Dans le cadre de ce processus, ce document a été élaboré pour compiler et réviser les informations actuellement disponibles sur les interactions entre les pêcheries et la population de tortues marines au sein de la zone de la Convention de l'ICCAT, y compris l'océan Atlantique et la mer Méditerranée. Une plus grande importance est accordée aux interactions avec les pêcheries de l'ICCAT (p.ex. palangres pélagiques, sennes, filets dérivants et madragues thonières), mais l'on a également considéré d'autres pêcheries ne relevant pas de l'ICCAT qui opèrent dans la zone de la Convention de l'ICCAT (p.ex. chaluts et filets). Le document présente aussi un résumé des données actuellement disponibles au Secrétariat de l'ICCAT pour mener à bien les analyses.

RESUMEN

Existe actualmente una inquietud creciente sobre el impacto de las pesquerías marinas en especies vulnerables de captura fortuita, como las tortugas marinas. La Comisión Internacional para la Conservación del Atún (ICCAT) está preparando una evaluación del impacto de las pesquerías de ICCAT en las poblaciones de tortugas marinas, con una evaluación programada para 2013, y la preparación de datos en 2012. Integrado en este proceso, este documento se preparó para recopilar y revisar la información disponible actualmente sobre interacciones entre pesquerías y poblaciones de tortugas marinas dentro de la zona del Convenio de ICCAT, lo que incluye el océano Atlántico y el mar Mediterráneo. Se pone más énfasis en las interacciones con las pesquerías de ICCAT, como por ejemplo palangre pelágico, cerco, redes de enmalle y almadrabas, pero también se consideraron otras pesquerías que no recaen bajo el mandato de ICCAT y que operan en la zona del Convenio de ICCAT (como arrastre y redes). También se presenta un resumen de los datos actualmente disponibles en la Secretaría ICCAT para realizar el análisis.

KEYWORDS

Bycatch, ICCAT, pelagic fisheries, tuna and tuna-like fisheries, sea turtles.

---

[1] Centro de Ciências do Mar, Universidade do Algarve, Campus de Gambelas Ed 7, 8005-139 Faro, Portugal.

[2] Instituto Português do Mar e da Atmosfera I.P., Avenida 5 de Outubro s/n, 8700-305 Olhão, Portugal.

1. Introduction

Marine fisheries have a major anthropogenic influence on marine systems worldwide, affecting both marine populations and ecosystems, and warranting urgent and comprehensive management. Among the different key issues in marine fisheries, bycatch - the unintended capture of non-target organisms during fisheries operations, is a major problem. Among the marine mega fauna incidentally caught in pelagic fisheries, sea turtles are of special concern. There has been growing concern about the numbers of sea turtles caught and killed in pelagic fisheries, as well as on the impacts that such captures may have on the sea turtle populations worldwide.

All species of sea turtles are currently protected by International Intergovernmental Treaties such as CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), CMS (Convention on the Conservation of Migratory Species of Wild Animals), and are considered vulnerable or endangered at some level by Conservation NGOs such as the IUCN (International Union for the Conservation of Nature). The International Commission for the Conservation of Atlantic Tunas (ICCAT) is currently working on evaluating the interactions and impacts of tuna fisheries in sea turtle populations in the Atlantic Ocean. Population assessments are schedule for 2013, with data preparation starting in 2012. This process started with the compilation of the available information on these interactions (presented in this document), and will continue with the data analysis process during the next year.

The main purpose of this paper was to collect, compile and present information on the interactions between ICCAT fisheries and sea turtle population within the ICCAT convention area. An additional objective was to present information on non-ICCAT fisheries, or fisheries that do not report to ICCAT, which may also operate in ICCAT convention area and interact with sea turtle populations.

2. Sea turtle species incidentally caught in ICCAT fisheries

Six species of sea turtles occur in Atlantic and adjacent-seas that can be potentially bycatch in ICCAT fisheries (**Table 1**). Additionally, a generic sea turtles *nei* designation also exists for the cases where no species-specific information is collected or recorded (**Table 1**). In the Mediterranean Sea, only three of those species occur, specifically *Caretta Caretta*, *Chelonia mydas* and *Dermochelys coriacea*, but only the first two reproduce in the Mediterranean (Casale 2008).

The taxonomy of those sea turtle species can be represented as:

- Phylum: Chordata
  - Class: Reptilia
    - Order: Testudines
      - Family: Cheloniidae
        - *Caretta caretta*
        - *Chelonia mydas*
        - *Eretmochelys imbricata*
        - *Lepidochelys kempii*
        - *Lepidochelys olivacea*
      - Family: Dermochelyidae
        - *Dermochelys coriacea*

A summary of the conservation status of those species according to the IUCN Red List criteria, as well as their inclusion in international conventions and treaties, namely CITES and CMS are listed in **Table 2**.

2.1 Dermochelys coriacea (DKK)

The leatherback (*Dermochelys coriacea*) is the largest sea turtle, being the only lacking a hard bony shell. It has a worldwide distribution and is found from tropical to sub-polar waters. Its geographical range is extended to higher latitudes and colder waters than the other sea turtles species. The species nests mainly on sandy tropical (and more rarely subtropical) beaches, and the juveniles remain in tropical waters warmer than 26°C, near the coast, until reaching approximately 100 cm curved carapace length (Eckert and Dubois 2001). The adults are pelagic and live in the open ocean along a wide temperature range, sometimes in temperatures below 10°C, undertaking very long migrations and crossing the oceans (Sarti-Martinez 2000). Their diet consists mainly in soft-bodied animals, such as jellyfish and salps. The estimated age-at-maturity based on a skeletochronological analysis carried out by Zug and Parham (1996) was of 13-14 years, while a more recent study estimated a higher age-at-maturity (ranging from 24.5 to 29 yr) for the northwest Atlantic Ocean (Avens et al. 2009). The life-span for *D. coriacea* turtles is still uncertain, but may be of 30 years or more (Sarti-Martinez 2000).

Genetic analysis suggests that the Atlantic populations are distinct from the Pacific populations, suggesting a degree of reproductive independence (Dutton et al. 1999). However, the lineages in these two ocean basins are not as highly differentiated as those found for analogous assemblages of Cheloniidae species (Dutton et al. 1999).

Fossette et al (2011) investigated the movements of leatherback turtles from different nesting and foraging sites in the Atlantic Ocean using satellite telemetry, to assess the potential determinants affecting intra- and inter-population variability. The main conclusions of the paper were that the intra- and inter-population behavioral variability seems to be linked with the initial hatchling drift scenarios and be highly influenced by environmental conditions. The authors state that this high degree behavioral plasticity makes leatherback turtles conservation strategies more challenging, and stress the need for larger dataset for providing general recommendations in terms of conservation.

2.2 Lepidochelys olivacea (LKV)

The olive ridley (*Lepidochelys olivacea*) is the most abundant sea turtle, and has a circum-tropical distribution, with nesting occurring throughout tropical waters, and migratory circuits along tropical and some sub-tropical areas (Abreu-Grobois and Plotkin 2008). Nesting occurs in nearly 60 countries worldwide (Abreu-Grobois and Plotkin 2008) and may consist in a massive synchronized nesting called “arribadas” exclusive of the *Lepidochelys* genus. It is also unique to this genus to normally nest each year, without intervening non-breeding seasons, as shown by Dermochelyids and other Cheloniids (Plotkin 1995). Their diet includes algae, lobster, crabs, tunicates, mollusks, shrimp and fish. The age-at-maturity of this species has only been studied for the north central Pacific and has been estimated as 13 years ranging from 10 to 18 years (Zug et al. 2006).

Like other sea turtles, *L. olivacea* have complex life cycles that include multiple separated and diverse habitats. Females nest on tropical coastal sandy beaches, from which the hatchlings emerge and enter the marine environment. The juveniles remain in a pelagic phase, drifting and dispersing passively with major currents, until sexual maturity is reached (Musick and Limpus 1997, Kopitsky et al. 2000). After reaching sexual maturity, reproductively active males and females move towards coastal regions and congregate near nesting beaches (Plotkin et al. 1996, Kopitsky et al. 2000). The post-breeding migrations are complex, with no apparent migratory corridors, swimming hundreds to thousands of kilometers over large ocean ranges (Plotkin 1995, Morreale et al. 2007). An exception seems to be the in the western Atlantic region, where after breeding *L. olivacea* appear to remain in neritic waters (Pritchard 1976, Reichart 1993).

2.3 Lepidochelys kempii (LKY)

Of the several species of sea turtles, kemp’s ridleys (*Lepidochelys kempii*) is considered the smallest. Contrary to *L. olivacea* which is distributed predominately in the Pacific and Indian Oceans and the southern Atlantic Ocean, *L. kempii* is mainly restricted to the tropical and subtropical waters of the north Atlantic Ocean (Marquez 1994). Although they are distributed mainly throughout the Gulf of Mexico and U.S. Atlantic seaboard, there are records of the species near the Azores, in waters off Morocco, within the Mediterranean Sea (NMFS 2011) and in Equatorial water of the Atlantic Ocean (Santos et al. 2012). Similarly to *L. olivacea*, females of *L. kempii* display a unique synchronized nesting habit called “arribadas” being the only species that consistently nests during the day. This species is carnivorous feeding mainly on crabs, fish, jellyfish and mollusks. There are several estimates of mean age-at-maturity for this species ranging from 10 years (Caillouet et al. 1995) to 11 to 16 years (Zug et al. 1997).

Like other sea turtles, *L. kempii* displays a life history pattern characterized by four basic stages. First, the hatchling stage which occurs in a terrestrial zone (supra-littoral) where both oviposition and embryonic development occurs. After hatching the turtles actively swim offshore occupying the neritic zone until reaching the oceanic currents from the open ocean. This third oceanic juvenile stage can be divided into two distinct groups, one that remains in the current system of the northern and western Gulf of Mexico, and another that is transported to the Gulf Stream of the northwest Atlantic. Nevertheless, after their pelagic existence that can last from 1 to 4 years, the juveniles return to the neritic zone (nearshore) within the Gulf of Mexico and the northwest Atlantic (TEWG 2000, NMFS 2011). While nearshore waters provide the primary marine habitat for adults, it is not uncommon for adults to be found in offshore deeper waters. Telemetry studies have shown that even though adult females primarily inhabit shallow waters, they are capable of swimming long distances in a directed manner typically migrating between nesting and foraging areas (Shaver and Rubio 2008). The movements of adult males are less known, although it is acknowledged that most stay within nearshore waters.

2.4 Eretmochelys imbricata (TTH)

The hawksbill turtle (*Eretmochelys imbricata*) has a circum-tropical distribution throughout tropical and, to a lesser extent, subtropical waters, with populations centered mainly on tropical reefs (Bjorndal 1997). Although this species feeds mainly on sponges, they can also consume other invertebrates associated with coral reefs and algae (Bjorndal 1997, Domingo et al. 2006a). *E. imbricata* matures very slowly, with their age-at-maturity ranging from 20 to 40 years depending on the geographic area. In Puerto Rico the minimum age-at-maturity has been estimated as 14.7 years although the authors believe that in other places of the western Atlantic and Caribbean *E. imbricata* will take much longer to reach maturity (Diez and van Dam 2002, Mortimer and Donnelly 2008).

E. imbricata nest on insular and mainland sandy beaches throughout the tropics and subtropics. The hatchlings enter the sea, and are carried out to offshore currents into major gyre systems where they remain until reaching 20-30 cm carapace length. When reaching those sizes, the specimens recruit into coastal habitats, and develop in areas of coral reefs, rocky bottom habitats, sea grasses, mangroves and mud flats (NMFS 1993, Musick and Limpus 1997). As they increase in size, there is a tendency for the turtles to move into deeper waters and habitats (van Dam and Diez 1997, Bowen et al. 2007). After reaching sexual maturity, the specimens start to undertake complex migrations between foraging and breeding grounds (Dobbs et al. 1999, Mortimer and Bresson 1999), being capable of traveling large distances between these feeding and nesting habitats.

2.5 Caretta caretta (TTL)

The loggerhead sea turtle (*Caretta caretta*) has a worldwide distribution in tropical, sub-tropical and temperate areas, both in oceanic and shallower coastal regions. In general, in their life history, *C. caretta* tends to first frequent open waters feeding on pelagic invertebrates (Bjorndal 1997), where the juvenile development takes place. Following this oceanic stage, which can last a decade or longer, later juvenile stages and adults move to neritic habitats near the continental coastline (Bolten and Bjorndal 2003, Domingo et al. 2006a), and start feeding upon benthic invertebrates (e.g. whelks and conchs) and fish (Bjorndal 1997). Age-at-maturity for this species has been estimated at around 35 years of age (NMFS 2008). Genetic divergence indicates a degree of isolation between the Mediterranean and Atlantic populations of this species (Carreras et al. 2006). Caraccio et al. (2008) carried out a population genetics study in the Southwest Atlantic that suggest that some adult individuals move on the continental shelf carrying out feeding migrations from the nesting beaches in Brazil towards higher latitudes, while the juvenile turtles that pertain to diverse nesting colonies may carry out feeding migrations towards areas of high productivity in open waters of the southwestern Atlantic Ocean.

Information covering data until 1999 has recently been reviewed for the Mediterranean (Margaritoulis et al. 2003). In the Mediterranean Sea, nesting is rare in the western region with most nests found in the eastern basin, mainly in Greece, Libya, Turkey and Cyprus (Casale 2008).

2.6 Chelonia mydas (TUG)

The green turtle (*Chelonia mydas*) are the largest hard-shelled sea turtles. They have a circum-global distribution, occurring throughout tropical and, to a lesser extent, subtropical waters. In the Atlantic Ocean they occur in all areas (northeast, northwest, southeast, southwest, and central eastern and western) as well as in the Mediterranean Sea (Seminoff 2004). Adult *C. mydas* are the only sea turtles that feed almost exclusively on algae and seagrasses. Even though age-at-maturity varies greatly geographically, *C. mydas* are considered to be the species that takes the longest to reach maturity worldwide, ranging from 26 to 36 years old in the western Atlantic (Hirth 1997).

A comprehensive revision on this species life history and biology was carried out by Hirth (1997). Like other sea turtle species, *C. mydas* is highly migratory, undertakes complex movements and uses a wide variety of habitats during its lifetime. Nesting occurs in more than 80 countries worldwide (Hirth 1997), and it seems that they inhabit coastal waters of more than 140 countries (Groombridge and Luxmoore 1989, Hirth 1997). Carr (1987) proposed that after leaving the nesting beaches, the hatchlings go through an oceanic phase, possibly floating passively in major current (gyres) systems that serve as developmental grounds (Carr and Meylan 1980, NMFS 1991). After a number of years in these oceanic areas, the turtles move into neritic habitats where the development continues in areas rich on sea grasses and marine algae (Musick and Limpus 1997). Upon reaching sexual maturity, *C. mydas* starts complex breeding migrations between foraging and nesting grounds, undertaken every few years (Hirth 1997). Migrations are carried out by both the males and the females that may cross oceanic zones, travelling thousands of kilometres (Mortimer and Carr 1987, Mortimer and Portier 1989). During the non-breeding periods, the adults seem to live mainly in the coastal neritic feeding areas (Seminoff et al. 2003).

Hirth (1997) defined the following life history categories for *C. mydas*: 1) Hatching: from hatching to the first few weeks of life; 2) Juvenile: post-hatchling to 40 cm carapace length. This stage is essentially the carnivorous (or omnivorous) pelagic stage. When reaching about 40 cm carapace length *C. mydas* move to their near-shore feeding habitat and are chiefly herbivorous; 3) Sub-adult: from 41 cm to the onset of sexual maturity, at about 70 to 100 cm carapace length, depending on the population; 4) Adult: sexual maturity reached at >70-100 cm carapace length. The size at sexual maturity for males and females is presumed to be similar.

Genetic studies have indicated a genetic isolation between the Mediterranean and the Atlantic populations (Encalada et al. 1996). In the Mediterranean Sea, the nesting sites are restricted to the easternmost part of the basin, particularly to Turkey, Cyprus and Syria (Casale 2008). In this region, the most important foraging areas are in the eastern Mediterranean, between Turkey and Egypt (Turkozan and Durmus 2000, Oruç 2003) and in southern Greece (Margaritoulis and Teneketzis 2001). The occurrence of *C. mydas* in the western Mediterranean seems to be rarer (Casale 2008).

3. Fisheries that interact with sea turtles within the ICCAT convention area

There are a number of reports and papers that offer scientific information on various types of Atlantic tuna fisheries overseen by ICCAT, that report sea turtle interactions and bycatch. Some of these are compiled on the ICCAT Collective Volumes of Scientific Papers, available on the ICCAT public web site. Additionally, we searched for new papers and grey-literature reports in the Aquatic Sciences and Fisheries Abstracts (ASFA), the ISI Web of Knowledge, and in Google Scholar. Overall, more than 170 documents (including peer-reviewed papers, technical papers and reports) were collected and reviewed for this review These are now in the process of being incorporated into the ICCAT bibliography meta-database. What follows is a review of the major findings in terms of sea turtle bycatch, resumed by fishery and area. It is worth noting that some of the documents collected and reviewed reported the same information, and in order to duplication usually only one of the sources was listed.

3.1 ICCAT fisheries

3.1.1 Longline fisheries

3.1.1.1 North Atlantic

The **Tables 3 and 4** summarize the information described below, regarding the incidental bycatch of sea turtles by tuna and swordfish pelagic longline fisheries in the northwest and northeast Atlantic waters. The CPUE time series available from the US Pelagic Longline observer program are summarized on **Table 5** (for *C. caretta*) and **Table 6** (for *D. coriacea*).

Witzell (1984) reported sea turtle bycatch by the Japanese tuna longline fleet fishing in the Atlantic U.S. Fishery Conservation Zone between 1978 and 1981. The total number of turtles observed captured in the Atlantic and Gulf of Mexico was 27 (2 *D. coriacea* and 25 unidentified) and 30 (12 *D. coriacea* and 18 unidentified), respectively.

Some years later, Witzell (1999) reported sea turtles caught incidentally by the U.S. Atlantic pelagic longline fleet from 1992 through 1995. The data used in this analysis are from the National Marine Fisheries Service (NMFS) pelagic logbook program managed by the Southeast Fisheries Science Center, Miami Laboratory. During the period, a total of 1,264 *D. coriacea* and 1,313 *C. caretta* were recorded. The mean annual non-standardized CPUEs (n/1000 hooks) were 0.071 and 0.075, for the leatherback and loggerhead turtles, respectively. CPUE analysis indicated that the overall loggerhead sea turtle capture rates with light sticks were higher than without light sticks.

Johnson et al. (1999), Yeung (1999, 2001), Garrison (2003, 2005), Garrison and Richards (2004), Fairfield-Walsh and Garrison (2006, 2007, 2008), Garrison et al. (2009) and Garrison and Stokes (2010) reported estimations of sea turtles bycatch by the U.S. Atlantic pelagic longline fleet for the period 1992-2009, based on the U.S. Observer Program. During this period a total of 2,341 specimens were recorded by onboard observers, most corresponding to *D. coriacea* (1,164) and *C. caretta* (1,132). The overall estimated bycatch of sea turtle within the period was 8,879, with a minimum of 529 specimens in 2008 and a maximum of 6,298 during 1999. Most of these turtles were caught from the Grand Banks (NED) fishing area, outside of U.S. EEZ. **Tables 5 and 6** present a summary of the nominal CPUE time series for the period. However, it should be noted that technological changes occurred in the fishery during the time series period (changes to usage of circle hooks) and therefore the analysis and interpretation of these time series should be done with care.

Ferreira et al. (2001) reported sea turtle bycatch on the swordfish pelagic longline fishery season (May to December) in the Azores Archipelago. A total of 60 *C. caretta* and 3 *D. coriacea* were caught. The obtained non-standardized CPUEs (n/1000 hooks) of sea turtles was 0.24.

Epperly and Boggs (2004) reported sea turtle bycatch during experimental trials aiming to asses post-hooking mortality in the U.S. pelagic longline fishery operating at the Northeast Distance (NED) statistical reporting area of the North Atlantic Ocean. Overall 427 sea turtles were caught with a combination of standard J and circle hooks, corresponding 250 to *D. coriacea* and 177 to *C. caretta*, respectively.

Beerkircher et al. (2004) reported sea turtle bycatch by the U.S. pelagic longline tuna and swordfish fisheries for the period 1992 to 2002, based on the SEFSC Pelagic Observer Program Data. Overall 1,343 turtles were caught by the U.S. pelagic fleet, most of which corresponding to *C. caretta* (686) and *D. coriacea* (617). Based on the provided observer data non-standardized CPUEs (n/1000 hooks) were calculated as 0.15 for *C. caretta* and 0.17 for *D. coriacea*.

Watson et al. (2005) reported sea turtle bycatch during experimental fishing trials conducted between 2002-2003, at the Northeast Distance (NED) statistical reporting area of the North Atlantic Ocean. Within the course of the experiments, a total of 489 sets were made, corresponding to a total of 427,382 hooks deployed. Overall 96 *C. caretta* and 148 *D. coriacea* were caught with a combination of standard J and circle hooks. Non-standardized CPUEs (n/1000 hooks) were calculated: 0.22 for *C. caretta* and 0.35 for *D. coriacea*.

Kerstetter and Graves (2006) in a study on the effects of circle *versus* J-style hooks on target and non-target species in the U.S. pelagic longline mixed tuna and swordfish fishery along the mid-Atlantic continental shelf and the Yucatan Channel (between Mexico and Cuba), reported minimal catches of sea turtles. Overall 5 *C. caretta* and 4 *D. coriacea* were caught with a combination of standard J and circle hooks.

Read (2007) reviewed a number of studies, including those by Bolten et al. (2002), Bolten and Bjorndal (2003, 2004, 2005), Watson et al. (2003a, 2003b, 2004a, 2004b), conducted in the western North Atlantic (NED), the Azores and the Gulf of Mexico, with a combination of standard J and circle hooks. In the NED area a total of 188 *C. caretta* and 227 *D. coriacea* were caught; whereas in the Azores 437 *C. caretta* and 13 *D. coriacea* were caught; finally, in the Gulf of Mexico only *C. caretta* (3) were caught. The obtained non-standardized CPUEs (n/1000 hooks) were 0.19, 1.05 and 0.10 for *C. caretta*, and 0.23, 0.03 and 0.0 for *D. coriacea*, for the NED, Azores and Gulf of Mexico, respectively.

Brazner and McMillan (2008) reported estimated *C. caretta* bycatch by the Canadian pelagic longline fishery (targeting swordfish and tuna) on Canada's EEZ, based on the Canadian Observer Trip Report Information System, for the period 1999-2006. Within this period, based on the 701 loggerheads that were recorded as bycatch, an estimated amount of 9,592 specimens were caught. The estimated non-standardized CPUE (n/1000 hooks) was 0.75.

Mejuto et al. (2008) reported sea turtle bycatch on a selectivity study using different types of hooks and baits on a Spanish pelagic longline fishery targeting swordfish. Three different areas were surveyed NW, NE and E Tropical. A total of 171 *C. caretta* and 69 *D. coriacea* were caught, using a total of 162,289 hooks of different types (J-style and circle). The obtained non-standardized CPUEs (n/1000 hooks) were 1.758, 0.104 and 0.421 for *C. caretta*, and 0.349, 0.391 and 0.631 for *D. coriacea*, for NW, NE and E Tropical areas, respectively.

Carruthers et al. (2009) reported sea turtle bycatch by the Canadian pelagic longline fleet targeting swordfish and tuna on the National EEZ (along the Scotian Shelf, Grand Banks and Flemish Cape) and international waters, based on onboard observer data compiled within the Canadian monitoring program. A total of 407 *C. caretta* were caught during 859 sets, using different types of J-style and circle hooks.

Moore et al. (2009) revised the available information on observer programs, catch estimates, statutes and regulations for bycatch of marine mammals, sea turtles and sea-birds in U.S. fisheries, both in Atlantic and Pacific waters. According to the authors, the primary concerns of U.S. fisheries operating in the Atlantic Ocean and Gulf of Mexico in terms of sea turtles is for *C caretta*, as the southeastern U.S. comprise one of the largest aggregate nesting rookeries for loggerhead turtles, and the U.S. continental shelf provides critical ontogenetic habitat for the population. For the U.S. Atlantic pelagic longline fleet, and using data from the fishery observer program (3.8% observer coverage since 1992), an estimated 727 *C. caretta* have been hooked annually between 1992 and 2006, with an estimated mortality rate of 0.052. During the same years, an estimated 753 *D. coriacea* have been captured annually, with an estimated mortality rate of 0.027. Several regulations exist in this fishery to reduce sea turtle bycatch and mortality, including time-area closures, mandatory use of circle hooks and bait requirements. As a result of the circle hook regulations, sea turtle bycatch in the Atlantic pelagic longline fishery appear to have decreased since 2004, but the authors alert that the effectiveness of such regulatory measures are difficult to assess, given their recent implementation and variable bycatch estimates through time. The authors also analyze other U.S. fisheries that interact with sea turtles, including the Gulf of Mexico shrimp trawl fishery, the mid-Atlantic trawl fleet targeting fishes, and the southeast bottom longline fishery targeting sharks, and the summaries of their findings are presented in this paper in the section on "non-ICCAT fisheries".

Finkbeiner et al. (2011) reported estimated sea turtle bycatch and mortality in USA fisheries between 1990 and 2007, based on available information on sea turtle bycatch in U.S. fisheries from peer-reviewed publications, U.S. National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA) Technical Memoranda, and NMFS Fisheries Science Center Reports. According to the authors, the pelagic longline fisheries in responsible for less than 1% of the overall annual turtle bycatch in U.S. fisheries. A more detailed analysis of this paper is discussed below, under the section of "non-ICCAT fisheries", as this paper also addressed other fisheries such as bottom trawls, nets, bottom longlines, etc.

3.1.1.2 South Atlantic

A revision on the impact of several fishing gears, including longline fisheries, for the SW Atlantic was carried out by Domingo et al. (2006a) that compiled the available literature until that date. Since the publication of that report, several additional papers have been published mentioning interactions between fisheries and sea turtles for the region, as well as papers reporting comparisons between J-style and circle hooks. Several papers have presented annual nominal CPUE series (e.g. Domingo et al. 2006b, López-Mendilaharsu et al. 2007), while a recent paper by Pons et al. (2010) presented a standardized CPUE series for *C. caretta* between 1998 and 2007. For the SE Atlantic there are also some technical reports and papers reporting interactions of the commercial longline fisheries with sea turtles, and one work on the comparison between J-style with circle hooks. The interactions of these longline fisheries in both the SW and SE Atlantic are briefly described below, and summarized in **Table 7** (for the SW Atlantic) and **Table 8** (for the SE Atlantic). Available data on sea turtle mortality rates are summarized in **Table 9**, while the available annual CPUE series for the region are summarized in **Table 10** (for *C. caretta*) and **Table 11** (for *D. coriacea*).

According to Domingo et al. (2006a) the longline fleet operating in the SW Atlantic region is mainly an industrial fishery, with vessels from Brazil and Uruguay that operate in their National EEZs, as well as in international waters. Additionally, an international fleet also operates in the region since the 1950s, with vessels from the nations of Brazil, Uruguay, Japan, China, Chinese Taipei, Spain, South Africa and Namibia. The main target species of this fishery are tuna and tuna-like species, swordfish, billfishes and pelagic sharks.

Achaval et al. (2000) reported data from 9 fishing trips, corresponding to 99 fishing sets and 90,194 hooks, between 1994 and 1996. Two longline *metiers* were used, specifically Spanish-type and Florida-type longlines. A total of 73 *C. caretta* and 32 *D. coriacea* were caught. Non-standardized CPUEs (n/1000 hooks) were calculated at 0.81 for *C. caretta* and 0.35 for *D.* coriacea. Two *D. coriacea* specimens (6.3%) were captured dead. Achaval et al. (2000) hypothesized that those deaths may have occurred due to the entanglement of the specimens with the fishing gear after being hooked.

Kotas et al. (2004) reported incidental captures of *C. caretta* and *D. coriacea* by commercial pelagic longliners operating off southern Brazil, both inside the Brazilian EEZ and the adjacent International waters, between March and October 1998. The data was collected by fishery observers during 3 trips, where a total of 34 longline sets were monitored. The captures of 145 *C. caretta* and 20 *D. coriacea* during those trips were reported. The authors also presented non-standardized CPUEs (n/1000 hooks) that were calculated as 4.31 for loggerheads and 0.59 for leatherbacks.

Pinedo and Polacheck (2004) presented results from sea turtle captures during a research cruise carried out in the vicinity of the shelf edge break in southern Brazil, using a longline gear similar to that employed by the commercial fleet that operates out of Santos, Brazil to target swordfish (*Xiphias gladius*). They reported the total capture of 19 sea turtles with an overall catch rate of 1.5 turtles (species combined) per 1000 hooks.

Carranza et al. (2006) reported the catches of one fishing trip from a Uruguayan vessel to the eastern tropical Atlantic Ocean, where 79 sets (corresponding to 102,700 hooks) were carried out in the region of the Gulf of Guinea and to the North of Saint Helena Islands. A total of 49 sea turtles, corresponding to 40 *D. coriacea* and 9 *L. olivacea* were captured. Nominal CPUEs (n/1000 hooks) were calculated for each species in each region: *D. coriacea*: 0.64 in the Gulf of Guinea and 0.30 in Saint Helena; *L. olivacea*: 0.38 in the Gulf of Guinea and 0 (no catches) in Saint Helena.

Domingo et al (2006b) presented a document to ICCAT reporting interactions of the Brazilian and Uruguayan fleets with surface pelagic longlines targeting swordfish, tunas and sharks. That study analysed data collected from 2,077 fishing sets by onboard observers between 1998 and 2004, corresponding to a total of 3,149,638 hooks. A total of 1,128 *C. caretta*, 259 *D. coriacea*, 29 *L. olivacea* and 28 *C. mydas* were reported. The authors presented yearly values of catches (n) as well as yearly values of non-standardized CPUEs (n/1000 hooks) for that period. The nominal CPUEs ranged between 0.13-1.71 for *C. caretta*, and 0.04-0.41 for *D. coriacea*.

López-Mendilaharsu et al. (2007) presented a document to ICCAT with information obtained by onboard fishery observers between 1998 and 2005 for the Brazilian and Uruguayan pelagic longline fleets. The information was based on 1,729 sets, corresponding to 2,643,851 hooks deployed in the region between 28ºS to 38ºS of the South Atlantic Ocean. The total catch of sea turtles was composed of 1,693 *C. caretta* and 238 *D. coriacea*. Non-standardized CPUEs (n/1000 hooks) were calculated and presented. For *C. caretta*, the combined CPUE for the study period was of 0.64, varying between 0.42 (2004) and 2.45 (2001). For *D. coriacea*, the combined CPUE was 0.09, varying between 0.05 (2003-2004) and 0.70 (2001). Nominal monthly CPUEs were also calculated and presented.

In 2007, the company MRAG Ltd in collaboration with Lamans, S.A. and AZTI-Tecnalia carried out experimental trials to determine the effects of hook (circle *vs.* J-style) and bait (squid *vs.* mackerel) on swordfish and sea turtle catches. Those studies were carried out in three regions: southern Atlantic, eastern and western Mediterranean (Anon 2008), with the details of the methodology described in more detail in Coelho et al. (2013). For the southern Atlantic region, a total of 70 fishing sets were carried out between February and April 2007, corresponding to 44,705 hooks deployed (accounting for all the hook/bait combinations tested). A total of 36 *C. caretta* and 9 *D. coriacea* were captured in the southern Atlantic trials, and of those 2 *C. caretta* died. Average CPUEs were 0.08 for *C. caretta* and 0.02 for *D. coriacea*, with the report mentioning that higher CPUEs were obtained when using squid as bait, while the hook effects were not conclusive.

Bugoni et al. (2008) reported sea bird and sea turtle bycatch in seven fisheries that take place in Brazil, defined as: fast trolling targeting tuna and tuna-like species, slow trolling targeting bigeye tuna, hand-lining, surface longline targeting dolphinfish, pelagic longline targeting swordfish, bottom drop-line, and pole-and-line with live bait. On those seven fisheries, a total of 44 sea turtles were captured in the surface longlines targeting dolphinfish, and 1 sea turtle was captured in the surface longlines targeting swordfish. Non-standardized CPUEs (combined sea turtle species per 1000 hooks) were calculated as 1.08 for the DOL longline fishery and 0.08 for the SWO longline fishery.

Giffoni et al. (2008) presented a document to ICCAT reporting interactions of the combined Brazilian and Uruguayan surface longline fleets operating in the SW Atlantic region. The data was collected by onboard fishery observers between January 2005 and July 2007, and monitored 2,614 fishing sets corresponding to 3,730,655 hooks. A total of 2,277 sea turtles were captured in the period, corresponding to 1,965 *C. caretta* and 312 *D. coriacea*. The authors presented non-standardized CPUEs (n/1000 hooks), with an estimated overall (study area and period combined) CPUE for *C. caretta* of 0.5267, and for *D. coriacea* of 0.0836. Seasonal CPUEs were also calculated, with the highest CPUE values for *C. caretta* registered during the fall (0.7453) and winter (0.6980), and for *D. coriacea* during the winter (0.1208) and spring (0.1610).

Honig et al. (2008) presented a document to ICCAT reporting incidental sea turtle captures by commercial longline fishing activities in the SE Atlantic, in the Benguela Large Marine Ecosystem region, specifically with the catches for the fleets of the nations of South Africa, Namibia and Angola. Most data regarding sea turtles interactions refer to the South African fleet, with the reporting of 118 sea turtle specimens during 375 fishing sets (341 targeting swordfish and 34 targeting tunas) where 520,000 hooks were monitored. This catch was composed by 60% *C. caretta*, 16% *D. coriacea*, 2% *C. mydas*, 3% *E. imbricata*, and 19% unidentified sea turtles.

Sales et al (2008) presented data on sea turtles catches from the Brazilian fleet operating in the SW Atlantic Ocean both in the Brazilian EEZ and adjacent international waters. The authors reported data between 2001 and 2005, recorded by onboard fishery observers that monitored 311 fishing trips, corresponding to 7,385 fishing sets and 11,348,069 hooks deployed. A total of 1,386 sea turtles were incidentally captured, corresponding to 789 *C. caretta*, 341 *D. coriacea*, 45 *C. mydas*, 81 *L. olivacea* and 130 unidentified specimens. The authors also presented the numbers of each species recorded alive and dead, which allowed the estimation of the hooking mortality rates.

Domingo et al. (2009) presented a document to ICCAT reporting experimental trials with the effects to hooks (J-style *versus* circle) on catches for the Uruguayan fleet, including data on sea turtles. The experiment was carried out onboard an industrial longliner fishing in the southwestern Atlantic, between January and November 2007. A total of 77,628 hooks (39,026 J-style and 38,602 circle) were deployed over 165 fishing sets. Overall, a total of 69 *C. caretta* were caught during those sets, with 28 captured with circle and 41 with J-style hooks. The respective nominal CPUEs (n/1000 hooks) were calculated as 0.73 for circle and 1.05 for J-style hooks.

Huang et al. (2009) and Huang (2011) reported sea turtle bycatch by the Taiwanese pelagic longline fleet targeting tuna (albacore and bigeye) between 2004 and 2008. For 2007 the non-standardized CPUEs (n/1000 hooks) at high latitudes varied between 0.0004–0.0027, whereas in tropical regions was 0.0145.

Petersen et al. (2009) presented data collected by onboard fishery observers on both South African flagged pelagic longline vessels targeting swordfish, and Asian flagged pelagic longline vessels (operating under joint venture agreements with South African rights-holders) targeting tunas. The data was collected between 1998 and 2005, and was recorded from 2,256 fishing sets, corresponding to approximately 4.4 million hooks deployed. A total of 181 turtles were captured, corresponding to 78 *C. caretta*, 44 *D. coriacea*, 5 *E. imbricata*, 3 *C. mydas* and 51 sea turtles not identified. A GLM model was created to calculate the expected sea turtles CPUEs, and extrapolations were made for the total sea turtle bycatch for the area of operation of those fleets. The details on those modeling and extrapolation techniques are described in more detail in et al. (2013).

Pons et al. (2009) evaluated the performance of different Machine Learning Methods to predict the unreported data on *Caretta caretta* bycatch by the Uruguayan longline fishery in the Southwestern Atlantic Ocean. The methods that were evaluated were Classification And Regression Trees, Random Forest, CForest and Support Vector Machines, and model selections was done by the minor predictive error rate. The data used came from onboard observed data to predict logbook unreported loggerhead by-catch during 1998 to 2007. Random Forests and CForest were the method selected because of the lower predictive error rates. The Random Forest approach predicted a total capture of 13,065 and CForest 12,892 loggerhead by the fishery during the study period.

Pons et al. (2010) presented a standardized annual CPUE series for *C. caretta* captured in the SW Atlantic by the Brazilian and Uruguayan fleets, between 1998 and 2007, with data collected by onboard fishery observers. The CPUE series standardization was carried out with Generalized Linear Models (GLMs) with the Delta-lognormal method, with a more detailed description of this methodology presented in et al. (2013). The data was recorded from 4,276 fishing sets, corresponding to 6,272,344 hooks deployed, where 3,778 loggerhead turtles were incidentally captured. The standardized CPUEs (n/1000 hooks) varied between 0.38 (2005) and 1.78 (2007). The variables that were considered significantly influential in the loggerhead captures were fishing area, year, season, sea surface temperature and gear type.

Sales et al. (2010) compared circle hooks (18/0 10º offset) with straight J-style hooks (9/0, 0º offset), with the latter being the hook traditionally used by the Brazilian fleet targeting tunas, sharks and swordfish. A total of 229 sets, corresponding to 145,828 hooks, were carried out in the southern Brazilian EEZ and adjacent international waters. A total of 199 sea turtles were captured: 170 *C. caretta*, 27 *D. coriacea* and 2 *C. mydas*, with nominal CPUEs (n/1000 hooks) calculated as: *C. caretta*: 1.605 with J-style and 0.727 with circle hooks; *D. coriacea*: 0.274 with J-style and 0.096 with circle hooks; *C. mydas*: 0.014 with both hook styles.

Pacheco et al. (2011) also compared J-style (9/0, 10º offset) with circle hooks (18/0, 0º offset) during 81 experimental fishing sets carried out in the equatorial western Atlantic Ocean (northeast Brazil), using squid as bait. A total of 30 sea turtles were captured, corresponding to 16 *D. coriacea*, 10 *C. mydas* and 4 *L. olivacea*. Nominal CPUEs were calculated for the captures with each hook style. The mortalities were also estimated, with all *L. olivacea* and *C. mydas* (captured with both hook styles) alive, while 8.3% of the *D. coriacea* captured with J-style hooks were dead.

Santos et al. (2012) carried out experimental trials comparing the effects of both hook style (J, circle with 10º offset and circle with 0º offset) and bait type (mackerel and squid) on both the sea turtle, the targeted species and other bycatch in the fishery. Data was collected by fishery observers in a total of 221 longline sets, corresponding to 305,352 hooks (101,784 of each hook style), that were carried out along the Equatorial Atlantic region between January 2009 and March 2011. A total of 231 sea turtles was caught, specifically 161 *L. olivacea*, 58 *D. coriacea*, 10 *C. caretta* and 2 *L. kempii*. For the most captured sea turtle species (*L. olivacea* and *D. coriacea*) significant reductions in the catch rates were recorded when changing between J-style and circle hooks, and when changing between squid and mackerel bait.

Pons et al. (2012) updated the standardized CPUEs for the loggerhead sea turtles caught by the Uruguayan and Brazilian longline fleets based on information from the observer programs of both countries between 1998 and 2010. To deal with the excess of zeros, the CPUE was standardized by GLMs using a delta lognormal approach. The data was analyzed from 5,337 fishing sets, and of those 1,765 (33%) sets had reported bycatches of loggerhead sea turtles.

A standardized annual CPUE series was presented for *C. caretta* captured in the SW Atlantic by the Brazilian and Uruguayan fleets, between 1998 and 2007, with data collected by onboard fishery observers. The CPUE series standardization was carried out with Generalized Linear Models (GLMs) with the Delta-lognormal method, with a more detailed description of this methodology presented in Coelho et al. (2013). The data was recorded from 4,276 fishing sets, corresponding to 6,272,344 hooks deployed, where 3,778 loggerhead turtles were incidentally captured. The standardized CPUEs (n/1000 hooks) varied between 0.38 (2005) and 1.78 (2007). The variables that were considered significantly influential in the loggerhead captures were fishing area, year, season, sea surface temperature and gear type.

3.1.1.3 Mediterranean Sea

Revisions on the interactions between several fishing gears and sea turtles in the Mediterranean Sea were reported by Casale (2008, 2011). Regarding pelagic longline fisheries, this author mentions that there are direct estimates indicating high numbers of sea turtles captured by the fleets from Greece, Italy, Morocco, Spain and Tunisia, and the most affected marine areas are the Alboran/Balearic area, the Strait of Sicily, and the Ionian Sea. The interactions of these pelagic longline fisheries are briefly described below, and summarized in **Table 12**. Available data on sea turtle mortality rates are summarized in **Table 13**. For this region, no time series on sea turtle CPUE data was found.

Aguilar et al. (1995) reported the impact of the Spanish swordfish longline fishery on the *C. caretta* population in the western Mediterranean. Onboard observers were placed on Spanish pelagic longliners targeting swordfish, during two summer seasons. Specifically, 67 fishing sets were monitored between July and September 1990 with the capture of 673 *C. caretta*, and 64 fishing sets were monitored between June and August 1991 with the capture of 425 *C. caretta*. During the two periods, 2 *D. coriacea* were also captured. Of those captured, 4 loggerheads were dead, with the authors discussing that more could eventually die due to hooking injuries.

Camiñas (1997) presented a document to ICCAT with estimations for the total numbers of *C. caretta* captured by the Spanish longline fleet operating in the western Mediterranean. The estimations were based on port samplings in the port of Alicante, between 1986 and 1995. Based on the values reported on those port samplings and considering the total effort for the Spanish longline fleet, the author estimated the total numbers of *C. caretta* that were captured by the Spanish fleet that ranged from 1,953 specimens during 1993 and 23,886 in 1990. The author also mention that most of the captures occur during the summer month, followed by the autumn and the spring, and that the winter captures are very scarce.

Panou et al. (1999) monitored vessels from the Greek pelagic longline fishery targeting swordfish. A total of 5 vessels were included in the study, with 785 fishing trips monitored. In that period, 157 *C. caretta* were captured, in 142 of the 785 fishing trips (18.1%). On average, 0.2 turtles were captured per trip and 7.7 per vessel and per year.

A European Union Project (Laurent et al. 2001) was carried out between 1999 and 2000 to estimate catch numbers, catch rates, mortalities and hooking locations of marine turtles in European Mediterranean drifting longline and trawl fisheries. The data was collected by onboard fishery observers in drifting longline activities from Spain, Italy (Ionian sea) and Greece, and from trawling activities in Italy (North Adriatic) and Greece. In the drifting longline fishery, 23 turtles were captured in the Greek monitoring program (22 *C. caretta* and 1 *D. coriacea*), 220 turtles in the Italian program (218 *C. caretta* and 2 *C. mydas*), and 2,127 turtles in the Spanish program (2,125 *C. caretta* and 2 *D. coriacea*). For the swordfish fishery, turtle CPUEs (n/1000 hooks) were estimated at 0.63±0.38 (95% CI) in Greece, 0.22±0.12 and 0.71± 0.14 in the Italian northern and southern Ionian Sea, and 1.15±0.73 in Spain. For the albacore fishery, turtle CPUEs varied from 0.50±0.19 and 0.20±0.06 in Italy, and 3.27±4.03 in Spain. Direct mortality was estimated at 4.3% in Greece (n=23), 0% in Italy (n=214) and 2.6% in Spain (n=676). However, most of the captured *C. caretta* were returned to the sea with a hook still inside, and the fate of those turtles (considered seriously injured) is unknown.

Camiñas et al (2003) reported the incidental catches of *C. caretta* and *D. coriacea* by the Spanish longline operating in the western Mediterranean. Data was recorded by onboard fishery observers that monitored 798 fishing sets between May 1999 and December 2000. A total of 2,125 *C. caretta* and 2 *D. coriacea* were captured during those sets. The authors also present the catch numbers and nominal CPUEs per year and for each of the 3 separate longline *metiers*: 1) longlines targeting albacore, 2) longlines targeting bluefin tuna and 3) longlines targeting swordfish.

Deflorio et al. (2005) reported captures of sea turtles in longline fisheries operating in Italian waters of the north and south Mediterranean Sea, collected within the framework of EC-DG-Fisheries 98/008 Project (Laurent et al. 2001). The data was collected between 1999 and 2000, in pelagic longlines targeting swordfish (SWO-LL) and albacore (ALB-LL). The SWO-LL fishery takes place between May and September, while the ALB-LL fishery takes place between October and December. The hook depths reported for each fishery were 12-16m for the SWO-LL, and 10-12m for the ALB-LL. During the study period, a total of 200 sea turtles were caught (198 *C. caretta* and 2 *C. mydas*). All captured sea turtles were released alive, but nearly half had hooks that could not be removed and remained deeply embedded in the digestive tract.

Camiñas et al. (2006) analyzed captures and direct mortality of *C. caretta* with different types of surface longlines operating from April and December and during the period between 1999 and 2004, for the Spanish surface longline fleet that fishes in the western Mediterranean. Overall, a total of 3,480 *C. caretta* incidental catches were observed, of which 46 were dead (1.32%). The authors further analyzed the data divided into 6 boat/fisheries types, depending on the vessel size and targeted species: 1) BFT: targeting bluefin tuna in vessels >12m without a “roler”; 2) BFTr: targeting bluefin tuna in vessels >12m with a “roler”; 3) SWA: targeting swordfish in vessels <12m without a “roler”; 4) SWB: targeting swordfish in vessels >12m without a “roler”; 5) SWBr: targeting swordfish in vessels >12m with a “roler”; and 6) ALB: targeting albacore vessels >12m without a “roler”. The various CPUEs and direct mortality rates for each vessel type and fishery were calculated and presented.

Baéz et al. (2007) studied the effects of fishing effort and eco-geographical factors on the bycatch of *C. caretta* captures by the Spanish surface longline fishery targeting swordfish that operates in the Balearic Sea (western Mediterranean). A total of 179 fishing operations were observed by onboard fishery observers and a total of 675 *C. caretta* were captured. The main results presented were that the probability of catching at least 1 loggerhead turtle were related to the distance of the fishing-ground to the coast. The authors suggest that limiting the use of drifting longline fishing activity to within 35 international nautical miles from the coast would reduce significantly the loggerhead bycatch, without affecting swordfish captures and with little resistance from the fishermen.

Casale et al. (2007) reported incidental catches of sea turtles in the Strait of Sicily (wider central Mediterranean area) using a voluntary logbook program for vessels harboring at the Lampedusa Island. The 3 main fisheries identified in the region were bottom trawl targeting mullets (*Mullus barbatus*, *Mullus surmuletus*), cephalopods (*Sepia officinalis*, *Octopus vulgaris*, *Loligo vulgaris*), and crustaceans (*Nephrops norvegicus*, *Penaeus kerathurus*, *Aristeus antennatus*, *Aristaemorpha foliacea*, *Parapeneus longirostris*, *Crangon crangon*, *Squilla mantis*); pelagic longlines targeting essentially swordfish (*Xiphias gladius*); and bottom longlines targeting dentex (*Dentex dentex*), dusky grouper (*Epinephelus marginatus*) and axillary seabream (*Pagellus acarne*). Two large trawlers were monitored between 2003 and 2005, and six smaller vessels using bottom trawls, pelagic longlines or bottom longlines were monitored in the summer of 2005. For the pelagic longlines, a total of 229 fishing days were monitored, corresponding to total of 93,100 hooks, with the reported capture of 91 *C. caretta*, and an estimated nominal CPUE (n/1000 hooks) of 0.977.

Jribi et at. (2008) compared *C. caretta* captures between surface longlines (targeting mainly sharks such as the sandbar, *Carcharhinus plumbeus*) and bottom longlines (targeting mainly groupers such as the white grouper, *Epinephelus aeneus*, and the dusky grouper, *Epinephelus guaza*) in the region of the Gulf of Gabès (south Tunisia). Catch rates of *C. caretta* were estimated at 0.823/1000 hooks for the surface longlines and 0.278/1000 hooks for the bottom longlines. Direct mortalities were estimated at 0% (n=33) for surface longlines, and 12.5% (n=24) for bottom longlines.

In the previous section of this paper (section on longline fisheries in the south Atlantic), the results from the MRAG-Lamans-AZTI study (Anon 2008) designed to determine the effects of hook (circle *vs.* J-style) and bait (squid *vs.* mackerel) on swordfish and sea tule catches was already reported for the south Atlantic study area. The same project also studied two areas of the Mediterranean, specifically in the eastern and western Mediterranean. In the eastern Mediterranean, the experimental fishing trials were carried out in the Ionian Sea (western Greece) between May and September 2007, while in the western Mediterranean the sea trials were carried out mainly around the Balearic Islands between July and September 2007. In the eastern Mediterranean a total of 120 fishing sets were carried out (60,000 hooks deployed), with the capture of 2 *C. caretta* specimens (both captured alive). In the western Mediterranean, 120 set were carried out (71,100 deployed hooks) with the capture of 77 *C. caretta*. Of those captured in the western Mediterranean, 6 specimens (7.8%) were dead.

Peristeraki et al. (2008) presented a document to ICCAT with data collected by fishery observers onboard the Greek fleet targeting swordfish. The data was collected between 2004 and 2006, covering 196 fishing sets onboard 18 different longline vessels. A total of 22 sea turtles were captured during the study, with a CPUE of 0.2 turtles per 1000 hooks (SD=0.6).

Piovano et al. (2009) compared the catches of *C. caretta* in the Strait of Sicily using two different hook styles, with different shapes but similar gape width (circle hook size 16/0 *vs*. J-style hook size 2), in shallow-set longline fisheries targeting swordfish. Seven experimental fishing trips were carried out in one vessel, with the use of 30,000 hooks. The experimental sets were conducted between July and October, over a period of three years, from 2005 to 2007. A total of 26 *C. caretta* (all immature-size) were captured during the study, with turtles caught at a statistically greater frequency on J-style hooks (n=20) than on circle hooks (n=6). Five sea turtles swallowed the hooks, on all cases in captures with J-style hooks. The nominal CPUEs estimated (n/1000 hooks) were 0.409 for circle hooks and 1.371 for J-style hooks.

Báez et al. (2010) studied the effects of bait (fish only *versus* a combination of fish and squid) on sea turtle (mainly *C. caretta*) captures by the Spanish longline fishery targeting swordfish in the western Mediterranean. The data came from an observer program onboard Spanish commercial surface longliners. When the fishery used fish-only bait the sea turtle captures were reduced, but the economic profit of the fishery was also diminished as there was a decrease in swordfish captures.

Burgess et al. (2010) presented a document to ICCAT reporting the bycatch of non-target species by the Maltese bluefin tuna longline fleet. 85 fishing days were monitored by onboard observers between April and June 2008, with 109,155 hooks monitored. Generalized Linear Mixed Models (GLMMs) were used to investigate the effects of environmental and spatiotemporal variables on the CPUE of non-target bycatch, and the details of this methodology are described in more detail on Coelho et al. (2013). *C. caretta* was the most abundant non-target bycatch species in this fishery, representing 40.3% of the total catch in number and 7.3% of the total catch in weight.

Echwikhi et al. (2010a) reported captures of *C. caretta* in a longline fishery frequently used in the summer period in the Gulf of Gabes (Tunisia) targeting mainly sandbar shark (*Carcharhinus plumbeus*). The hooks used in the fishery are baited with mackerel (*Scomber scombrus*) or pieces of stingray (*Dasyatis pastinaca*). A total of 48 fishing sets (corresponding to 35,950 hooks) were monitored by fishery observers, between July and September of 2007 and 2008. A total of 29 *C. caretta* were captured, with the majority being juveniles. Direct mortality was estimated at 20.7%.

3.1.2 Purse seine fisheries

Most of the information available for purse seiner fisheries refers to the operations taking place in the equatorial and tropical Atlantic region (mainly in the eastern Atlantic region) by vessels from purse seine fleets that usually target tropical tunas. Additionally, some information is also available for the vessels that operate in the Mediterranean Sea targeting spawners and juvenile bluefin tuna.

3.1.2.1 Atlantic

Delgado-de-Molina et al. (2005) presented data from the Spanish purse seine tropical tuna fishery in the Atlantic Ocean. The target species of this fishery are tropical tunas, mainly *Thunnus albacares*, *Thunnus obesus* and *Katsuwonus pelamis*. Data was collected by onboard fishery observers that covered 90 fishing trips between 2001 and 2004. Four sea turtles species were recorded, with the total catch numbers being 6 *C. caretta*, 5 D. coriacea, 8 *L. kempii* and 16 *L. olivacea*.

Sarralde et al. (2006) presented fishery observers data from the Spanish purse seine fleet covering fishing activity between 2001 and 2005, in the tropical Atlantic Ocean. A total 3,098 fishing days were covered, corresponding to 1,927 sets. The fishery observer's coverage varied between 7% of the sets in 2001 to 23% in 2003, with an average coverage of 16% of the total sets made by this fleet between 2001 and 2004. The authors presented the frequency of occurrence (in percentage) for each sea turtle species in both FAD (using fish aggregating devices) and FSC (free schools) purse seine sets: *C. caretta*: 0.1% (FSC), 0.6% (FAD); *C. mydas*: 0.3% (FSC), 0.4% (FAD), *D. coriacea*: 0.7% (FSC), 0.1% (FAD); *E. imbricata*: 0.4 (FAD), *L. kempii*: 0.8 (FAD); *L. olivacea*: 1.2 (FSC), 1.8 (FAD); and sea turtle nei: 0.4% (FSC), 0.4% (FAD). This first document by Sarralde et al. (2006) was followed the next year by Sarralde et al. (2007), also for the Spanish purse seine fleet targeting tropical tunas in the Atlantic Ocean. The 2007 document presented data between 2001 and 2006, corresponding to a total of 107 fishing trips, 3,168 days at sea, and 1,948 fishing sets. The frequency of occurrence (in percentage) for each sea turtle species was: *C. caretta*: 0.1% (FSC), 0.6% (FAD); *C. mydas*: 0.4% (FSC), 0.4% (FAD), *D. coriacea*: 1.1% (FSC), 0.1% (FAD); *E. imbricata*: 0.4 (FAD), *L. kempii*: 0.1% (FSC), 0.8 (FAD); *L. olivacea*: 1.3 (FSC), 1.8 (FAD); and sea turtle nei: 0.5% (FSC), 0.4% (FAD).

Chassot et al. (2009) presented estimates of discards and bycatch in the French purse seine fishery of the eastern Atlantic Ocean. The data was collected by onboard fishery observers during 7 trips that took place between January 2005 and January 2008, corresponding to a total of 287 days at sea and 180 observed purse seine sets. The sampling program coverage represented 3.2% and 9.1% of the total fishing trips made by the French purse seine fishery in 2006 and 2007, respectively. The results were stratified based on the fishing mode, namely with fishing aggregating devices (FAD) vs. free school (FSC). Three sea turtle species were recorded, specifically *L. kempii*, *L. olivacea* and *C. mydas*. The percentage of occurrence of *L. kempii* and *L. olivacea* were 1.87% on FSC and 1.52% on FAD, while the percentage of occurrence of *C. mydas* was 0.93% on FSC and 1.52% with FADs. Unidentified sea turtles were recorded with a percentage of occurrences of 1.86% on FSC. The authors mention that all sea turtles caught during these observer trips were released alive at sea.

Amandè et al. presented a document to ICCAT (SCRS/2009/146), that was later published in the peer-reviewed literature (Amandè et al. 2010), focusing bycatch from the Spanish and French purse seiners operating in the eastern tropical Atlantic and targeting tropical tunas. The data was collected through French and Spanish observer programs between 2003 and 2007, with a coverage of 27 fishing trips (598 fishing sets), corresponding to 2.9% coverage for the total effort of these two fleets (in terms of trips). The observations of sea turtles were occasional, with catch numbers almost equal under FAD associated (54%) and FSC sets (46%). A total of 40 sea turtle specimens were caught during those trips, with the species composition dominated by *C. mydas* (n=3 in FSC and n=9 in FAD), followed by *L. kempii* (n=4 in FSC and n=3 in FAD), *D. coriacea* (n=6 in FSC and n=1 in FAD), *C. caretta* (n=1 in FSC and n=5 in FAD), and *L. olivacea* (n=2 in FSC and n=3 in FAD). In general, *C. mydas* and *C. caretta* occurred more frequently under FADs, while *D. coriacea* appeared more frequently under FSC sets. Nearly 98% of the turtles caught were released alive at sea.

3.1.2.2 Mediterranean Sea

For the Mediterranean Sea, Fromentin et al. (2005) presented data from an observer program implemented in 2003 by IFREMER, for the French purse seiners targeting bluefin tuna in the Mediterranean. Two purse seiner vessels were monitored during the two main fishing seasons. One vessel was followed from 1 May to 10 July 2003 when was targeting mainly bluefin tuna spawners around the Balearic Islands and then through September 2003 in the Gulf of Lions when targeting bluefin tuna juveniles. The other vessel was monitored between mid May to mid July 2003 in Libyan waters when targeting bluefin tuna spawners and then through September 2003 when in the Gulf of Lion targeting juveniles. Overall, approximately 190 fishing days were monitored, and resulted in the capture of 4 *C. caretta*, all discarded alive.

A Scientific Project is currently ongoing within the 7th European Framework: Project MADE - Mitigating Adverse Ecological Impacts of Open Ocean Fisheries (Dagorn et al. 2009). This project is focusing the ecological impacts of both purse seine fisheries using FADs and open ocean longline fisheries. The Project is being carried out in various areas of several Oceans, and in the Atlantic Ocean experiments are being carried out in the NE and SW Atlantic, as well as in the Mediterranean Sea. It is expected that the outputs of this project will also contribute to the understanding of the impacts of open seas fisheries (particularly FAD purse seines and longlines) on sea turtle populations.

3.1.3 Drift nets

Drifting nets are usually made of one layer (similar to gillnets), can have several km long, several meters high, and usually a relatively large mesh size suitable for catching large pelagic fish such as swordfish, tunas and sharks in the open sea. On the other hand, set-nets are usually smaller, and have a relatively small mesh size suitable for catching small demersal fish in more coastal waters (Casale 2008). Using the definitions of ICCAT fisheries, and taking into account the target species, we believe that drift nets can be considered ICCAT fisheries given that they target swordfish, tunas, and other large pelagic species, while set-nets should not be considered ICCAT fisheries given that they target mainly demersal species in more coastal waters. The main cause of sea turtle mortality induced by nets is drowning, due to forced apnea. In this way, the fishing depth, net height or other characteristics are important, with set net intrinsically more harmful than driftnets as they may promote higher mortality rates (Casale 2008).

The United Nations adopted, in 1989 and 1991, Resolutions 44/225 and 46/215 recommending a moratorium on all large-scale pelagic driftnet fisheries. In 1992 the European Commission prohibited driftnet fishing activities in the Mediterranean with nets of more than 2.5 km in length, as did the General Fisheries Commission for the Mediterranean (GFCM) in 1997. In 1996, ICCAT adopted a Resolution (96-15: Resolution by ICCAT on Large-Scale Pelagic Driftnets) requesting CPCs to comply with the United Nations Resolutions regarding drift net fisheries. A total ban on driftnet fishing for large pelagic species by the EU fleet in the Mediterranean entered into force in 2002, and in 2003 ICCAT Recommended that the use of drift nets for fisheries of large pelagics in the Mediterranean should be prohibited (ICCAT Rec. 2003-04). Because of the Illegal, Unregulated and Unreported (IUU) nature of most drift net fisheries (FAO 2001), information describing operational characteristics and associated catches is limited.

Di Natale (1995) reported data from an observer program established by the Italian government for the Italian drift net fishery targeting swordfish. The main objectives of this program were to determine the impacts of this fishery in marine mammals and also on sea turtles. The observer program was carried out between November 1990 and April 1992 in the Ligurian and Tyrrhenian Seas, and covered a total of 100 commercial trips using driftnets to target swordfish. During the fishing operations 5 *C. caretta* were reported entangled in the nets. The vertical distribution showed a higher percentage of sea turtle catches (60%) in the upper third of the nets, with another 40% of the catches in the median third. No sea turtles were reported in the lower third of the nets. Estimated catch rates are of 0.057 and 0.046 turtles per day per vessel (respectively for the Ligurian and Tyrrhenian Seas), which corresponds to a CPUE of 0.005 *C. caretta* per Km of net. The authors mention that the impacts of this fishery on *C. caretta* populations seems “minimal” or “insignificant”, mostly because this species is very often released alive by the fishermen.

Silvani et al. (1999) reported catches onboard vessels operating with illegal drift nets close to the Gibraltar Strait (western Mediterranean) deploying nets of 3±4 km long that target mainly swordfish. This fishery has been illegal in Spain since 1991, but the authors contacted and persuaded the fisherman to place fisheries observers onboard those vessels. They present information from the 1992, 1993 and 1994 fishing seasons (July-August). A total of 13 fishing sets were monitored in 1992, 27 sets in 1993, and 54 sets in 1994. Thirty *C. caretta* (6 in 1993 and 24 in 1994) and 2 *D. coriacea* (both in 1994) were observed. All except one were alive when the nets were brought on board and, after disentanglement, were released alive to the sea. This fleet stopped its activity in 1994.

The European Union Project (DG-XIV-Fisheries Project Nº98/008) was mainly designed to determine the impacts of longline and trawl fisheries on sea turtle populations in the Mediterranean Sea (Laurent et al. 2001). However, during the course of the project, and for the Italian program, 77 observations were carried out onboard vessels using driftnets in the north Ionian Sea, corresponding to a total of 665,400 meters of nets deployed. Specifically, 332,200m of nets were monitored during 1999 (May to October), and 333,200m were monitored during 2000 (March to August). A total of 7 *C. caretta* were caught, and of those 2 specimens were found in a comatose status, but they were revived and released alive by the onboard observers.

Tudela et al. (2005) presented information on the IUU driftnet fishery in the Mediterranean, particularly from Morocco that seems to harbour the bulk of this fleet in the Mediterranean. A total of 369 fishing operations, with

4,140 km of nets deployed, were monitored by collaborator crewmembers between December 2002 and September 2003. This fleet is based in Al Hoceima (Alboran Sea, Morocco) and targets swordfish, operating year-round. The fleet is estimated at 177 units, using average net lengths between 6.5 and 7.1 km. A total of 46 specimens of *C. caretta* were caught during this study (in the period between December and May), with catch rates estimated at 0.211 turtles per fishing operation, corresponding to 0.026 turtles per km of net. In general, turtles were released alive whenever possible.

For the south Atlantic, Marcovaldi et al. (2006) mentions a drift net fishery in Brazil generally targeting sharks (primarily hammerheads *Sphyrna* spp.) that are sold for the domestic market (meat), while the fins are sold to the international markets. The fleet that is based in Ubatuba (São Paulo), is composed of approximately 50 vessels that use drift nets on a regular basis, and has been monitored since 2002 with the collaboration of the local fishermen. The preliminary data obtained from a few onboard observers and from anecdotal reports from fishermen suggests that most of the sea turtles captured in this fishery are *D. coriacea* (ca. 70%), followed by *C. caretta* (15%), and with occasional captures of *C. mydas* and *E. imbricata* turtles. The reports also mention a high mortality rate of sea turtles upon capture.

This same drift net fishery based in Ubatuba (São Paulo State) and Itajaí (Santa Catarina State) that targets hammerheads was also recently studied by Fiedler et al. (2012). The authors describe that the vessels of this fleet are wooden, with nets between 2,000 and 7,408 m long, made of twisted multifilament nylon or monofilament nylon, and with stretched mesh sizes ranging from 12 to 40 cm. Most vessels deploy driftnets only in austral spring (September to December) and summer (December to March), when the captures of sharks are high. Data for this study was collected voluntarily by vessel skippers, with 41 fishing trips (corresponding to 371 sets) covered between 2002 and 2008. A total of 351 sea turtles were incidentally captured. *D. coriacea* accounted for 77.3% of the turtle catch (n = 252, CPUE = 0.1405 turtles/km net), followed by *C. caretta* (n=47, CPUE = 0.0262 turtles/km net), *C. mydas* (n=27, CPUE = 0.0151 turtles/km net) and unidentified turtles (n=25, CPUE = 0.0139 turtles/km net). Immediate mortality was similar between the different species, accounted for 22.2% to 29.4% of turtles hauled onboard. Based on bootstrap procedures, the annual catch by this fishery ranges from 1,212 to 6,160 *D. coriacea* turtles.

3.1.4. Other ICCAT fisheries

In addition to the previously identified fisheries, other fisheries that can be considered ICCAT fisheries are possibly the tuna traps that operate in the Mediterranean Sea and adjacent waters of the Atlantic Ocean, given that those traps traditionally target bluefin tuna during the seasonal spawning migrations to the Mediterranean.

Historical information on this fishery was reported by Sara (1980) that presented a document to ICCAT with a description of the historical settings, operation and captures of the tuna traps in the Mediterranean Sea, particularly in Italy. The author refers in the document that sea turtles of the species *C. caretta* and *C. mydas* were traditionally caught in these traps, but quantitative values are not reported.

Marçalo et al. (2012) reported sea turtle bycatch in a bluefin tuna trap off southern Portugal for 2010 and 2011. During this period, 22 sea turtles were caught, the majority corresponding to *C. caretta* (21). Among these, most specimens (15) were caught in 2010 and only 7 were captured in 2011. Most of the sea turtles (86%) were released alive.

3.2 Non-ICCAT fisheries

Several sources of information are available on the impacts of other non-ICCAT fisheries for the Atlantic Ocean and the Mediterranean Sea. This section compiles some of this information in terms of geographical region as well as by fishing gear. Some papers are exclusive of particular fishing gears in particular geographical areas, while others are Ocean wide or even Global revisions (e.g. Gilman et al. 2010 and Finkbeiner et al. 2011, for the Atlantic; Casale 2011 and Allessandro and Antonello 2010, for the Mediterranean).

3.2.1 Atlantic

Domingo et al. (2006a) reported a fleet of artisanal surface longliners targeting mahi-mahi/dolphin fish (*Coryphaena hippurus*) that is based on the State of Espirito Santo (Brazil) and is composed of about 294 boats, and that can interact with sea turtles in the region.

Marcovaldi et al. (2006) reviewed the interactions between sea turtles and fisheries in Brazil. The two high seas fisheries identified were pelagic longline and drift nets and those were previously described in this paper, in their corresponding sections. Additional to these high seas fisheries, the authors also report 16 costal fisheries in various Brazilian States that that interact with sea turtles, including gill nets targeting fishes and lobsters, fixed and floating cages targeting fishes, and trawls targeting shrimp. The degree of interaction between these fisheries and sea turtles is unknown in most cases. The only case where numbers of captured sea turtles are mentioned is the case of the fixed cages targeting fishes in the State of Ceará that during 2003 captured 299 sea turtles, with nearly 100% of the turtles released alive.

Zeeberg et al. (2006) analyzed accidental capture of large mega-fauna (sea turtles, sharks, manta rays and dolphins) in an industrial pelagic trawl fishery carried out in West Africa targeting small pelagics such as sardinella, sardine and mackerel. The fishery operates nearly year-round with five to ten freezer-trawlers that are amongst the largest fishing vessels in the world. The authors analyzed 1,400 trawl sets carried out by a Dutch vessel carried out off Mauritania between October 2001 and May 2005. The bycatch of this fishery consisted mainly of larger predatory fishes (large sharks), while sea turtles were less frequent. Specifically, 5 sea turtles were captured in the study, and the authors extrapolated an annual bycatch of up to 50 sea turtles per year by the freezer-trawlers. The mortality rate seems high, with most animals arriving on deck dead due to suffocation and succumbing to water pressure while caught.

Lewinson and Crowder (2007) evaluated and put into perspective sea turtle bycatch of pelagic longline fisheries when compared to other fisheries. The authors mention that recently, bycatch from pelagic longlines has received increased attention and has been proposed as a primary source of turtle mortality. However, the authors also refer that preliminary data from gillnet and trawl fisheries seems to indicate that interactions of these fisheries with sea turtles is equally high or even higher than in longline fisheries, and with far higher mortality rates. The authors conclude that until those gillnet and trawl fisheries are subject to the same level of scrutiny given to pelagic longlines, the overall understanding of the impacts of commercial fisheries on sea turtle populations will be incomplete.

Honig et al (2008) mentioned the existence of an artisanal longline fishery in Angola that targets seabirds, and another artisanal fishery that uses gill nets and handlines to target seabreams (Sparidae), groupers (Serranidae), hakes (*Merluccius* sp.), and small pelagics such as sardines (*Sardinella* sp.) and horse mackerel (*Trachurus trachurus*). That artisanal fishery had 2,078 vessels operating during 2000-2001, 1,933 vessels during 2002-2003 and 2,939 vessels during 2004-2005. Based on skipper interviews (30 fishers interviews), it was reported that there is the infrequently catch of few sea turtles in these fisheries, having the fishers identified *L. olivacea*, *D. coriacea*, *C. caretta* and *E. imbricata*.

Besides the impacts referred for pelagic longlines (already cited in the respective section of this paper), Petersen (2009) refers that in South African waters the sea turtles are also at risk from captures by the purse-seine, shrimp trawl and the pelagic trawl fisheries. The author also refers captures of sea turtles by the shark protection nets off KwaZulu-Natal, in the IOTC (non-ICCAT) area.

Murray (2009a, 2009b) reported sea turtle bycatch in the US mid-Atlantic gillnet fishery during the period 1995-2006. Gillnet data used for this paper was obtained from gillnets that were either anchored to the bottom (96% of hauls) or unanchored but fishing on the ocean bottom (4% of hauls), with both fishing gears considered as sink gillnets. Based on this observer program a total bycatch of 72 turtles was recorded during 32,984 net hauls. Most turtles caught belonged to *C. caretta* (41), followed by un-identified species (13), *L. kempii* (8) and *D. coriacea* and *C. mydas* (5 specimens each). The mean annual estimated bycatch of *C. caretta* during 2002 - 2006 was 288 turtles.

Moore et al. (2009), already cited in this document regarding the US pelagic longline fishery in the Atlantic, also analyzed other US fisheries that can impact sea turtles. According to the authors, the majority of sea turtle bycatch in US fisheries occurs in the southeastern Atlantic and Gulf of Mexico shrimp trawl fishery, which consists of more than >18,000 vessels, and which may cause a sea turtle mortality that exceeds that of all other US fisheries combined. Other fishery addressed by Moore et al (2009) is the multi-species multi-gear mid-Atlantic bottom trawls that bycatches mainly *C. caretta* and *L. kempii*, particularly during the summer trawls targeting flounder. The use of Turtle Excluder Devices (TEDs) on both the shrimp and flounder trawls has been required since 1987 and 1996, respectively. However, the development of fully effective TEDs took nearly two decades and there are still issues with low use-compliance for the shrimp trawl fishery. Estimates for the mid-Atlantic bottom trawl fleet targeting fishes, including summer flounder trawls and other trawls for other fishes from 1996 to 2004, point to an average catch of 616 *C. caretta* per year, but with a mortality rate of 0.43 that can represent annually seven times more *C. caretta* kills than for the pelagic longline fleet. Another fishery focused is the southeast demersal longlines targeting sharks where *C. caretta* bycatch was estimated in the low hundreds from 2003 to 2006, but with substantial mortality, from a few dozen to approximately 150 turtles each year. Also targeting sharks, the authors also mention a driftnet fishery in the southeast region that seems to have a low impact on sea turtles, in the order of a few individuals per year. Finally, the authors refer captures of *C. caretta*, *L. kempii*, and *C. mydas* in inshore gillnets and inshore pound nets.

Moore et al. (2010) carried out a pilot study focused on the impact of artisanal fisheries on sea turtles and marine mammals, in countries where there are few data on artisanal fishing effort, catch or bycatch. These fisheries may represent a particularly major challenge for threatened species conservation, as artisanal fisheries comprise >95% of the world's fishermen. The authors carried out interview based surveys on several countries, and in the Atlantic Ocean the countries focused were Sierra Leone and Nigeria in West Africa, and Jamaica in the Caribbean. The artisanal fisheries identified in these countries included gillnets, beach seines, longlines, handlines/hook and line, trawls and others. Bycatch occurrences of sea turtles in gillnets fisheries seem to be particularly frequent, but other fishing gears may contribute substantially to the bycatch in some areas. The authors of this pilot study concluded that these interview based rapid assessment approaches may rapidly yield coarse-level information of effort and bycatch over large areas, and at low costs.

In a worldwide perspective, Gilman et al. (2010) reviewed assessments of turtle interactions in coastal net fisheries around the world. Even though there are much less studies addressing these net fisheries when compared to trawls or longlines, the authors highlight that there are a growing number of studies documenting relatively high levels of sea turtle capture in these fisheries, which are now understood to be a large anthropogenic source of sea turtle mortality. Several studies from three areas/fisheries of the Atlantic Ocean were reviewed, compiled and their results summarized by the authors. In the Virginia Chesapeake Bay pound net fishery, aerial surveys, surface vessel surveys and scuba surveys have been conducted since 1983 to assess the levels of sea turtle capture. Pound nets were found to be responsible for 3–33% of stranded turtles in the Bay (corresponding to 6-165 sea turtles annually), most of which were *C. caretta* and *L. kempii*. In addition, each year, 200 to 500 sea turtles strand in the lower portion of the Bay. In North Carolina, the monitoring methodology of the Pamlico Sound large mesh (>12.7 cm str. mesh) southern flounder gillnet fishery and small mesh (<12.7 cm str. mesh) spotted seatrout (*Cynoscion nebulosus*) gillnet fisheries includes the sea turtle stranding network records of stranded turtles along the State's coastline and the at-sea monitoring of gillnet vessels from the North Carolina Division of Marine Fisheries. Strandings reached their highest statewide level in 2000 with 831 turtles reported statewide, although prior to 1995 the annual average was 200 turtles. From 2001 to 2007 an average of 399 strandings per year were reported. During the 2007 season 8% of the large mesh gillnet trips along the Outer banks were observed with 20 sea turtle captures being reported (5 were dead). In the small mesh gillnet 4% of the trips were observed with no reported captures. An extrapolated fleet-wide bycatch rate of 0.3 turtle per 1000 yards of net per day was estimated by the authors. Finally, when reviewing the Spanish mackerel (*Scomberomorus brasiliensis*) and king mackerel (*S. cavalla*) surface gillnet fishery in Caribbean waters of Trinidad, a total of 6,996 sea turtle captures were calculated for the year 2000 using extrapolations from fishers interview data (3,796 reported captures from interviews from 27 landing sites).

Finkbeiner et al. (2011) calculated cumulative estimates of sea turtle bycatch between 1990 and 2007 in U.S. fisheries by compiling and analyzing publications providing extrapolated fleet-wide estimates of sea turtle bycatch and mortality. The reviewed literature (which is listed as supplemental data in the paper) included peer-reviewed publications and scientific reports from the U.S. National Marine Fisheries Service (NMFS) and National Oceanic and Atmospheric Administration (NOAA) with both observed and estimated bycatch and mortality data. The authors identified and analyzed 13 fisheries known to interact with sea turtles in the Atlantic which were then grouped in three main categories: 1) gillnets and pound nets, including the North Carolina inshore gillnet, mid-Atlantic gillnet, southeast shark driftnet, North Carolina pound net and Virginia pound net; 2) longlines and vertical lines, including the Gulf of Mexico reef fish fishery, Atlantic shark bottom longline, Atlantic/Gulf of Mexico pelagic longline, South East snapper/grouper and Gulf of Mexico/Caribbean handline and; 3) trawls/dredges, including the mid-Atlantic bottom trawl, mid-Atlantic scallop trawl/dredge and Southeast/Gulf of Mexico shrimp trawl. The Southeast/Gulf of Mexico shrimp trawl fishery was found to account for the majority of the sea turtle bycatch in US fisheries (up to 98%) and for more than 80% of all the mortality, with the Gulf of Mexico portion of the fishery comprising a large percentage of the total interactions (73%). Caution is urged by the authors in the interpretation of these estimates, however, due to low observer coverage in that fishery. Furthermore, the authors calculated a reduction of the estimated annual mean turtle bycatch, from 340,500 prior to the 2003 TED regulation to 133,400 turtles post 2003. Following the shrimp trawls, the greatest annual sea turtle interactions in the Atlantic were identified respectively as the Atlantic/Gulf of Mexico pelagic longline, the mid-Atlantic bottom trawl, the Virginia pound net, and the Gulf of Mexico reef fish longline fisheries. Regarding the highest annual sea turtle mortality, second to the shrimp trawls was the mid-Atlantic bottom trawl, the Gulf of Mexico reef fish longline, the mid-Atlantic gillnets, and the mid-Atlantic scallop dredge fisheries, respectively (annual mean estimates are available in the paper for all gears). In addition, species-specific estimations are also available in the study with *L. kempii* identified as the species that suffered the highest absolute mortality from fisheries bycatch in the USA. The paper presents a Supplemental Data II document that lists the metadata, methods and sources of uncertainty while generating the cumulative bycatch estimates.

3.2.2 Mediterranean Sea

Bradai and El-Abed (1998) reported occurrences of *D. coriacea* in Tunisian waters (35 observations) until the mid 1990s, with most specimens captured with artisanal trammel nets, bottom trawls and driftnets. The authors refer that since the 1980s, it is common practice to return those captured sea turtles to the sea.

Nada (2001) reported the trade of sea turtles in the Alexandria fish market in Egypt, from regular visits to the market and fishers interviews. The study was conducted over a 6 month period, from December 1998 to May 1999. Those turtles offered for sale in the market were captured in nets. A total of 135 turtles were seen on sale during the 6 month period, with the majority (85%) being *C. caretta*, while the remaining were *C. mydas*. The numbers of sea turtles seen for sale tended to increase towards the summer.

Tudela (2004) compiled information on the impacts of several fishing gears in the Mediterranean, and presented this in a FAO Report. According to the author, the surface longline and driftnet fleets operating in the Mediterranean are the major threats to the survival of sea turtles, although bottom trawls and gillnets are responsible for some catches. The author mentions that fixed nets can cause sea turtle mortality since turtles get caught when trying to feed on the entrapped fish. Other fisheries mentioned are trawlers and purse seiners reported for the Spanish Mediterranean coast. The total annual bycatches by the Tunisian small-scale fleet (comprising fixed nets, purse seines, bottom and surface longlines, and tuna fishing gears) operating in the Gulf of Gabès are estimated at 5,000 individuals, with an additional 2,000–2,500 turtles caught by the larger trawling fleet (composed of 300 units), whereas illegal small trawlers are thought to capture additional hundreds to thousands of individuals annually. The highest catch rates in the region correspond to bottom longliners, with average maximums of nearly 23 turtles per boat per year.

Casale et al. (2004) reported onboard observations on midwater and bottom trawlers in the north Adriatic Sea between 1999 and 2000. A total of 2,057 hauls were directly observed during 415 fishing days; these included 1,561 hauls during 262 fishing days for bottom trawlers and 496 hauls during 153 fishing days for midwater trawlers. No sea turtles were captured on midwater trawlers, while 62 sea turtles (all *C. caretta*) were caught on the bottom trawlers corresponding to a catch rate of 0.0195 turtles per standard haul and per 100 km^2. In addition, the authors estimated a minimum total catch of 161 turtle captures per year for the midwater trawlers from data provided by cooperating captains. For the bottom trawl fleet a catch rate of 4,273 turtle captures/year was estimated. The authors highlight that the total catch in the whole north Adriatic is likely to be much higher than their estimates due both to the unknown effort of multi-gear vessels and the great differences in the trawling effort between the northeast (15 times higher) and southwest parts of the Adriatic sea.

Jribi et al. (2008) compared *C. caretta* captures between surface longlines (targeting mainly sharks such as sandbar *Carcharhinus plumbeus*) and bottom longlines (targeting mainly groupers such as white grouper *Epinephelus aeneus*, and dusky grouper *E. guaza*) in the region of the Gulf of Gabès (south Tunisia). Catch rates of *C. caretta* were estimated at 0.823/1000 hooks for the surface longlines and 0.278/1000 hooks for the bottom longlines. Direct mortalities were estimated at 0% (n=33) for surface longlines, and 12.5% (n=24) for bottom longlines.

Casale (2008) presented a review of sea turtle captures in the Mediterranean and used it to estimate total captures of sea turtles by country. Regarding trawl fisheries, the author mentions that available direct estimates indicate high numbers of captures by fleets from Italy (0.052-1.121 turtles/day-boat), Tunisia (0.121-0.714 turtles/day-boat), Croatia (2-10 turtles/year-boat), Turkey (0.0529-0.25 turtles/day-boat) and Egypt (1-20 turtles/year-boat), and lower though important numbers for Greece (0.018-0.062 turtles/day-boat), Spain (0.018-0.07 turtles/month-boat) and Algeria (1.41 turtles/year-boat). Furthermore, the author states that Italy and Tunisia appear to be by far the countries with the most important total catch numbers, with potentially over 20,000 captures per year altogether. Other five countries are also referred to capture more than 2,000 turtles per year each, specifically Croatia, Greece, Turkey, Egypt, and Libya. Finally, the author estimates that Spain and Albania probably capture a few hundred sea turtles per year, each. Considering available direct estimates of set nets, the author indicates high numbers of captures in Croatia (2.81 turtles/year-boat), Egypt (754 turtles/year) and Tunisia (0.6 turtles/year-boat) by this fishery. The author further notes that there are indications of high interaction in Turkey and Cyprus too, although they refer to both longlines and set nets. When analyzing demersal longlines available direct estimates, the author emphasizes the high numbers of captures by Tunisian (22.83 turtles/year-boat) and Egyptian (1.9 turtles/year-boat) vessels. The countries with the highest number of captures (in the thousands per year) are probably Tunisia, Libya, Greece, Turkey, Egypt, Morocco, and Italy. As a final point, the author estimates total captures per year for the three main fisheries in the Mediterranean: bottom trawl with a minimum of 35,003 captured turtles and 20% of mortality, set nets with 16,378 captured turtles and 60% mortality, and demersal longlines with 12,408 captured turtles and 40% mortality.

Subsequent to this WWF Report, the same author presented a peer-reviewed paper (Casale 2011) revising sea turtle bycatch for the four most relevant fishing gears in the Mediterranean: bottom trawl, pelagic longline, demersal longline and set net. The information analyzed included data from onboard observers, fishers interviews and logbooks, in order to estimate the total sea turtle capture per year by country and fishing gear. The author alerts to the fact that small-scale vessels seem to represent most of the Mediterranean fleet, and are probably causing more incidental or intentional deaths than large vessels and that special attention should be paid to the eastern basin of the Mediterranean. The overall results indicated as estimation of over 132,000 sea turtle captures per year, with probably over 44,000 incidental deaths per year. Such estimated total captures were divided by 39,000 by bottom trawlers, 57,000 by pelagic longlines, 13,000 by demersal longlines and 23,000 by set nets. Second to pelagic longlines, bottom trawl was estimated to be the fishing gear that captures more sea turtles with an estimate of 39,000 captures per year and a mortality of 20% which corresponds to 7,800 deaths (estimated from seven sets of data from five countries with n = 433). From the 17 identified Mediterranean countries, more than 1,000 captures per year were estimated in Tunisia, Italy, Libya, Turkey, Greece, Croatia, and Egypt. Thus, the most affected marine areas seem to be the North African continental shelves (Tunisia, Libya, Egypt) the Adriatic, and the Levantine basin and the Aegean Sea. While *C. caretta* were reported in all of the identified countries and areas, *C. mydas* were explicitly reported from Egypt, Greece, Tunisia and Turkey. The annual number of sea turtles captured by small-scale set nets in the Mediterranean was estimated to be 23,000 turtles (calculated from total catch estimates from 13 countries). The set nets showed the highest mortality percentage of the four main fisheries presenting 60% of mortality which corresponded to an estimate of 13,800 deaths per year. Libya, Turkey, Tunisia, Cyprus, Greece, Croatia and France were estimated to have more than 1,000 captures per year. Therefore, the North African continental shelf (Tunisia, Libya, Egypt), the Levantine basin, the Aegean and the Adriatic Seas seem to be the regions more affected by set nets. *C. caretta* were captured in all the identified countries but no *C. mydas* captures were explicitly reported by set nets. Demersal longline was estimated to be the fishing gear that captures less sea turtles when compared to the other three main fisheries in the Mediterranean. The fishery was characterized mainly as small-scale, and the annual capture was estimated at 13,000 turtles per year with 40% mortality (5,200 turtles) per year (estimates from 12 countries). The four countries that showed the highest captures with demersal longlines were Turkey, Libya, Tunisia and Greece, hence the marine areas that seem to be affected the most are the North African continental shelf (Tunisia, Libya and Egypt), the Levantine basin and the Aegean Sea. No *C. mydas* were explicitly reported in this fishery, while *C. caretta* seems to be captured in all the identified countries.

Another revision paper for the Mediterranean was presented by Allessandro and Antonello (2010), where the impacts of several fishing gears were assessed for sea turtles, particularly for *C. caretta*. According to these authors, drifting longlines and bottom trawls have the greatest impact on the Mediterranean *C. caretta* populations (respectively in their pelagic and demersal phases), while passive nets (including gillnets and trammel nets) seemed to be responsible for the highest direct mortality rates, mainly due to drowning. In a comparative perspective, these authors compiled information from other sources on the estimated total catches in numbers and direct mortality of sea turtles, that were reported at 50,000-80,000 (direct mortality 0-4%) for drifting longlines, 30,000 (direct mortality of 5%) for bottom trawls, 16,000 (direct mortality of 20-30%) for drift nets, 35,000 (with a potential mortality of 40%) for bottom longlines, 30,000 (with >50% mortality) for set nets. Much of this information comes from Casale (2008).

Álvarez-de-Quevedo et al. (2010) assessed sea turtle by catch in waters off Catalonia (northeastern Spain) with fishing gears other than drifting longlines. The data analysed was collected mainly from questionnaires to fishers, referring to the periods from June 2003 to July 2004. The authors interviewed fishers from 235 vessels, representing 23.3% of the Catalonian fishing fleet (1007 vessels). The number of turtles caught monthly per vessel was estimated at 0.01 for bottom longlines, 0.02 for trammel nets, 0.07 for bottom trawling, and 1.2 for drifting longlines. From these values, a total of 481 (95% CI: 472–491) turtles specimens were estimated to be taken annually as bycatch by the entire fleet, with the largest share taken with bottom trawlers (249 turtles;

51.5% of the total catch) and drifting longlines (124 turtles; 25.7% of the total catch). Turtle mortality seems to be associated mainly with the bottom trawling.

Echwikhi et al. (2010b) analyzed sea turtles (*C. caretta*) captures in artisanal gillnets used in southern Tunisia (Gulf of Gabes) to target sharks (*Mustelus* sp. and *Carcharhinus plumbeus*) and guitarfish (*Rhinobatos cemiculus* and *R. rhinobatos*). The data was collected during the 2007 and 2008 fishing seasons (April to June), by onboard observers on vessels leaving from the ports of Zarzis, Jerba and El Ketf. Overall, a total of 36 *C. caretta* were captured during the 45 monitored fishing sets. CPUEs were estimated in 3 different ways: 0.527 (0.403-0.649) turtles per km^2 of gillnet per day, 0.339 (0.250-0.438) turtles per km of net, and 0.800 (0.654-0.904) turtles per fishing set. The captures consisted mainly of juvenile turtles, and the direct mortality was high, estimated at 69.4% (n=25).

Cambiè et al. (2010) characterized the fishing fleet in the southern coast of Ionian Calabria and its impact in sea turtles as this area is considered the main nesting area of the *C. caretta* in Italy. A total of 11 fishing gears were identified in the area during 2007: drift net "mutualara", pot, seine net, line, surface longline, gillnet, trammel net, purse seine (small pelagic), bottom longline, bottom drift net "bardasciuni", and drift net "ferrettara". During the summer of 2007, observers were placed on vessels operating with driftnets "ferrettara" (n=1), trammel nets (n=2), bottom longlines (n=4) and surface longlines targeting swordfish (n=10), as those were identified as the main gears used during the *C. caretta* nesting season. From these four fisheries, only surface longlines targeting swordfish captured sea turtles (n=17 in 5,960 hooks). The authors alert to the fact that 86.9% of the permanent local artisanal vessels (n = 179, out of 206 total units), were fishing illegally without license and note a vast discrepancy between the official census and the actual number of boats fishing in the area.

Cambiè (2011) analyzed *C. caretta* captures and mortality rates in trammel nets set off the central west coast of Sardinia (Italy) during the summer months. The vessels in this fishery alternate between different fishing gears throughout the year, but all use trammel nets in the summer months to target red mullet and lobsters. The data was collected over 10 years (1992-2001) and was based on interviews for owners of 17 of those small vessels that voluntarily agreed to complete technical specification sheets providing data on sea turtle bycatch and sightings. A total of 52 turtles were recorded during the study, either captured or sighted. The author used a zero-inflated Poisson (ZIP) model to determine the sea turtle bycatch in trammel nets for the fleet, while the probability of immediate survival was assessed using binomial GLMs. Both those approaches are discussed in Coelho et al. (2013). Using the ZIP model, an extrapolation of a total bycatch of 916 sea turtles for the entire fleet and for the considered 10 year period was obtained, considering that the entire fleet uses trammel nets during the summer months. Direct mortality was estimated at a rate of 69%.

4. Data currently available at ICCAT

4.1 ICCAT CPCs datasets

Integrated in the objective of carrying out an evaluation of the impact of ICCAT fisheries on sea turtle populations, the ICCAT CPCs have been requested to submit relevant data from their ICCAT fisheries that can interact with sea turtle populations. A summary of the data, and its characteristics, currently available at the ICCAT Secretariat to carry out his assessment is provided in **Table 14**. This data collection will continue during 2012 and 2013, until the data analysis process is initiated.

4.2 ICCAT meta-database

A bycatch meta-database is currently hold at the ICCAT Secretariat and is continuously being updated with the objective of compiling information on by catches from commercial fisheries, either ICCAT or others, that take place in ICCAT convention area. This database compiles information from different sources, including peer-reviewed papers, technical papers presented to RFMOs (ICCAT and others relevant), technical reports, and other sources of available literature. Most of the information presented in this document is already compiled, or in the process of being compiled, into this bycatch meta-database.

Table 15 summarizes the data available in this database with relevance for impacts of ICCAT fisheries in sea turtle populations, organized by major area and fishing gear. At the time of writing this paper, this database contained information from 102 scientific references on sea turtles for the Atlantic Ocean and Mediterranean Sea. The most focused species is *C. caretta* followed by *D. coriacea*, and the most focused fishing gear is longline followed by purse seines. It should be noted that this meta-database is continuously being updated with new information, and as such the values presented here also need to be continuously updated.

References

Abreu-Grobois, A. and P. Plotkin, 2008. Lepidochelys olivacea. In IUCN 2011. IUCN Red List of Threatened Species, Version 2011.2. URL: www.iucnredlist.org

Achával, F., Y.H. Marin, L.C. Bare,. 2000. Captura incidental de tortugas marinas con palangre pelágico oceánico en el Atlántico Sud- occidental. *In* Arena, G., Rey, M. (Eds.) Captura de grandes peces pelágicos (pez espada y atunes) en el Atlántico Sud-occidental, y su interacción con otras poblaciones, INAPE – PNUD URU/92/003, Montevideo, Uruguay, pp. 83-88.

Aguilar, R., J. Mas, X. Pastor, 1995. Impact of Spanish swordfish longline fisheries on the loggerhead sea turtle *Caretta caretta* population in the western Mediterranean. *In* Richardson, J.I., Richardson, T.H. (Eds.) Proceedings of the 12th annual workshop on sea turtles biology and conservation, NOAA Tech. Mem. NMFS-SEFSC- 361, pp 1–6.

Alessandro, L. and S. Antonello, 2010. An overview of loggerhead sea turtle (Caretta caretta) bycatch and technical mitigation measures in the Mediterranean Sea. Rev. Fish. Biol. Fisheries. 20: 141–161.

Álvarez-de-Quevedo, I., L. Cardona, A. De-Haro, E. Pubill, A. Aguilar, 2010. Sources of bycatch of loggerhead sea turtles in the western Mediterranean other than drifting longlines. ICES J. Mar. Sci., 67: 677–685.

Amandè, M.J., J. Ariz, E. Chassot, A. Delgado-de-Molina, D. Gaertner, H. Murua, R. Pianet, J. Ruiz, P. and Chavance, P. 2010, Bycatch of the European purse seine tuna fishery in the Atlantic Ocean for the 2003–2007 period. Aquat. Living Resour., 23: 353–362.

Anon. 2008. Field study to assess some mitigation measures to reduce bycatch of marine turtles in surface longline fisheries. Final Project Report by MRAG, Lamans & AZTI. Project Ref. No. FISH/2005/28A. pp 215.

Avens, L., J.C. Taylor, L.R. Goshe, T.T. Jones, M. Hastings, 2009. Use of skeletochronological analysis to estimate the age of leatherback sea turtles Dermochelys coriacea in the western North Atlantic. Endang. Species Res., 8 (3): 165-177.

Báez, J.C., R. Real, C. Garcia-Soto, J.M. De-la-Serna, D. Macías, J.A. Camiñas, 2007. Loggerhead sea turtle bycatch depends on distance to the coast, independent of fishing effort: implications for conservation and fisheries management. Mar. Ecol. Prog. Ser., 338: 249-256

Báez, J.C., R. Real, D. Macías, J.M. De-la-Serna, J.J. Bellido, J.A Camiñas, 2010. Captures of swordfish Xiphias gladius Linnaeus 1758 and loggerhead sea turtles Caretta caretta (Linnaeus 1758) associated with different bait combinations in the Western Mediterranean surface longline fishery. J. Appl. Ichthyol., 26: 126–127.

Beerkircher, L.R., C.J. Brown, D.L. Abercrombie, D.W. Lee, 2004. SEFSC Pelagic Observer Program Data Summary for 1992-2002. NOAA Tech. Mem. NMFS-SEFSC-522: 25 pp.

Bjorndal K.A. 1997. Foraging ecology and nutrition of sea turtles. In Lutz, P.L., Musick, J.A. (Eds) The Biology of Sea Turtles, Boca Raton, Florida, CRC Press, pp 199-232.

Bolten, A.B. and K.A. Bjorndal, 2003. Experiment to Evaluate Gear Modification on Rates of Sea Turtle Bycatch in the Swordfish Longline Fishery in the Azores – Phase 2 Final Project Report Submitted to the National Marine Fisheries Service. Archie Carr Center for Sea Turtle Research, University of Florida, Gainesville, FL, USA.

Bolten, A.B. and K.A. Bjorndal, 2004. Experiment to Evaluate Gear Modification on Rates of Sea Turtle Bycatch in the Swordfish Longline Fishery in the Azores – Phase 3 Final Project Report Submitted to the National Marine Fisheries Service. Archie Carr Center for Sea Turtle Research, University of Florida, Gainesville, FL, USA.

Bolten, A.B. and K.A. Bjorndal, 2005. Experiment to Evaluate Gear Modification on Rates of Sea Turtle Bycatch in the Swordfish Longline Fishery in the Azores – Phase 4 Final Project Report Submitted to the National Marine Fisheries Service. Archie Carr Center for Sea Turtle Research, University of Florida, Gainesville, FL, USA.

Bolten, A.B., H. Martins, E Isidro, R. Ferreira, M. Santos, E. Bettencourt, A. Giga, A. Cruz, B. Riewald, K. Bjorndal, 2002. Preliminary results of experiments to evaluate effects of hook type on sea turtle bycatch in the swordfish longline fishery in the Azores. University of Florida contract report to NOAA, National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD, USA.

Bowen, B.W., W.S. Grant, Z. Hillis-Starr, D.J. Shaver, K.A. Bjorndal, A.B Bolten and A.L Bass,. 2007. Mixed Stock analysis reveals the migrations of juvenile hawksbill turtles (Eretmochelys imbricata) in the Caribbean Sea. Mol. Ecol., 16: 49-60.

Bradai, M.N. and A. El-Abed 1998. Presence de la tortue luth Dermochelys coriacea dans les eaux Tunisiennes. Rapp. Comm. int. Mer Médit, 35: 382-383.

Brazner, J.C. and J. McMillan, 2008. Loggerhead turtle (Caretta caretta) bycatch in Canadian pelagic longline fisheries: relative importance in the western north Atlantic and opportunities for mitigation. Fish. Res., 91 (2-3): 310-324.

Bugoni, L., Neves, T.S., Leite, N.O. Jr, Carvalho, D., Sales, G., Furness, R.W., Stein, C.E. Peppes, F.V. Giffoni, B.B., Monteiro, D.S. 2008. Potential bycatch of seabirds and turtles in hook-and-line fisheries of the Itaipava Fleet, Brazil. Fish. Res., 90: 217–224.

Burgess, E., Dimech, M., Caruana, R., Darmanin, M., Raine, H., Harrison, A., Schembri, P.J. 2010. Non-target bycatch in the Maltese bluefin tuna (Thunnus thynnus) longline fishery (central Mediterranean). Collect. Vol. Sci. Pap. ICCAT, 65 (6): 2262-2269.

Caillouet, C.W., Jr., C.T. Fontaine, S.A. Manzella-Tirpak, and T.D. Williams. 1995. Growth of headstarted Kemp's ridley sea turtles (Lepidochelys kempii) following release. Chelonian Conserv. Bi., 1:231-234.

Cambiè, G. 2011. Incidental capture of Caretta caretta in trammel nets off the western coast of Sardinia (Italy): statistical models of capture abundance and immediate survival. Aquatic Conserv: Mar. Freshw. Ecosyst., 21: 28–36.

Cambiè, G., Camiñas, J.A., Franquesa, R., Mingozzi, T. 2010. Fishing activity and impacts along the main nesting area of loggerhead sea turtle Caretta caretta in Italy: overwhelming discrepancy with the official data. Sci. Mar., 74 (2) 275-285.

Camiñas, J.A. 1997. Capturas accidentales de tortuga boba (Caretta caretta, L. 1758) en el Mediterraneo Occidental en la pesquería de palangre de superfície de pez espada (Xiphias gladius L.). Collect. Vol. Sci. Pap. ICCAT, 46 (4): 446-455.

Camiñas, J.A., Baez, X., Valeiras, J.C., Real, R. 2006. Differential loggerhead bycatch and direct mortality due to surface longlines according to boat strata and gear type. Sci. Mar., 70: 661–665.

Camiñas, J.A., Valeiras, J., De-La-Serna, J.M. 2003. Spanish surface longline gear types and effects on marine turtles in the western Mediterranean Sea. In Margaritoulis, D., Demetropoulos, A. (Eds.) Proceedings of the First Mediterranean Conference on Marine Turtles, Nicosia, Cyprus, Barcelona Convention – Bern Convention – Bonn Convention (CMS), pp 88-93.

Caraccio, M.N., Domingo, A., Márquez, A., Naro-Maciel, E., Miller, P., Pereira, A. 2008. Las aguas del Atlantico sudoccidental y su importancia en el ciclo de vida de la tortuga cabezona (Caretta caretta): evidencias através del análisis de ADNmt. Collect. Vol. Sci. Pap. ICCAT, 62: 1831-1837.

Carr, A. 1987. New perspectives on the pelagic stage of sea turtle development. Conserv. Biol., 1: 103.

Carr, A., Meylan, A.B. 1980. Evidence of passive migration of green turtle hatchlings in Sargassum. Copeia, 1980: 366-368.

Carranza A., Domingo A., Estrades A. 2006. Pelagic longlines: A threat to sea turtles in the Equatorial Eastern Atlantic. Biol. Conserv.,131 (2006): 52-57

Carreras, C., Cardona, L., Marco, A., Pascual, M., Aguilar, A., Margaritoulis, D., Rees, A., Castillo, J.J., Tomás J., Raga, J.A., Fernández, G., SanFelix, M., Turkozan, O., Levy, Y., Gasith, A., Aureggi, M., Khalil, M., Rico, C., Roques, S. 2006. Degree of isolation of the Mediterranean nesting populations of the loggerhead sea turtle using nuclear markers. In Frick M., Panagopoulou A., Rees A.F., Williams K. (Eds.) Book of abstracts, 26th Annual Symposium of Sea Turtle Biology and Conservation, Athens.

Carruthers, E.H., Schneider, D.C., Neilson, J.D. 2009. Estimating the odds of survival and identifying mitigation opportunities for common bycatch in pelagic longline fisheries. Biol. Conserv., 142: 2620–2630.

Casale P. 2008. Incidental catch of marine turtles in the Mediterranean Sea: captures, mortality, priorities. WWF Italy, Rome, pp 64.

Casale P. 2011. Sea turtle bycatch in the Mediterranean. Fish Fish, 12: 299–316.

Casale, P., Cattarino, L., Freggi, D., Rocco, M., Argano, R. 2007. Incidental catch of marine turtles by Italian trawlers and longliners in the central Mediterranean. Aquat. Conserv.: Mar. Freshw. Ecosyst., 17: 686–701.

Casale, P., Laurent, L., De-Metrio, G. 2004. Incidental capture of marine turtles by the Italian trawl fishery in the north Adriatic Sea. Biol. Conserv., 119: 287–295.

Chassot, E., Amandè, M.J., Chavance, P., Pianet, R., Dédo, R.G. 2009. Some preliminary results on tuna discards and bycatch in the French purse seine fishery of the eastern Atlantic Ocean. Collect. Vol. Sci. Pap. ICCAT, 64 (4): 1054-1067.

Coelho, R. Fernandez-Carvalho, J., Santos, M.N. 2013, A review of methods for assessing the impact of fisheries on sea turtles. Collect. Vol. Sci. Pap. ICCAT, 69(4):

Dagorn, L., Robinson, J., Bach, P., Deneubourg, J.L., Moreno, G., Di-Natale, A., Tserpes, G., Travassos, P., Dufossé, L., Taquet, M., Robin, J.J., Valettini, B., Afonso P., Koutsikopoulos, C. 2009, MADE: Preliminary information on a new EC project to propose measures to mitigate adverse impacts of open ocean fisheries targeting large pelagic fish. Collect. Vol. Sci. Pap. ICCAT, 64(7): 2518-2533.

Deflorio, M., Aprea, A., Corriero, A., Santamaria, N., De-Metrio G. 2005. Incidental captures of sea turtles by swordfish and albacore longlines in the Ionian Sea. Fish. Sci., 71: 1010–1018.

Delgado-de-Molina, A., Sarralde, R., Pallarés, P., Santana, C., Delgado-de-Molina, R., Ariz, J. 2005. Estimación de capturas de las especies accesorias y de los descartes en la pesquería de cerco de túnidos tropicales en el Océano Atlántico Oriental entre 2001 y 2004. Col. Vol. Sci. Pap. ICCAT, 58 (1): 385-404.

Diez, C.E. and van Dam, R.P. 2002. Habitat effect on hawksbill turtle growth rates on feeding grounds at Mona and Monito Islands, Puerto Rico. Mar. Ecol-Prog. Ser., 234: 301-309.

Di-Natale, A. 1995. Drift net impact on protected species: observer data from the Italian fleet and proposal for a model to assess the number of cetaceans in the bycatch. Col. Vol. Sci. Pap. ICCAT, 44 (1): 255–263.

Dobbs, K.A., Miller, J.D., Limpus, C.J. and Landry Jr, A.M. 1999. Hawksbill turtle, Eretmochelys imbricata, nesting at Milman Island, northern Great Barrier Reef, Australia. Chelonian Conserv. Bi, 3 (2): 344-361.

Domingo A., Bugoni, L., Prosdocimi, L., Miller, P., Laporta, M., Monteiro, D.S., Estrades, A., Albareda, D. 2006a. The impact generated by fisheries on sea turtles in the southwestern Atlantic. WWF Progama Marino para Latinoamérica y el Caribe, San José, Costa Rica. pp71.

Domingo, A., Sales, G., Giffoni, B., Miller, P., Laporta, M., Maurutto, G. 2006b. Captura incidental de tortugas marinas com palangre pelágico en el Atlantico Sur por las flotas de Brasil e Uruguay. Col. Vol. Sci. Pap. ICCAT, 59(3): 992-1002.

Domingo, A., Barceló, C., Swimmer, Y., Pons, M. and Miller, P. 2009. Anzuelos circulares vs. anzuelos “J” en la flota palangrera uruguaya. Collect. Vol. Sci. Pap. ICCAT, 64(7): 2427-2442

Dutton, P., Bowen, B., Owens, D., Barragán, A., Davis. S. 1999. Global phylogeography of the leatherback turtle (Dermochelys coriacea). J. Zool., 248: 397-409.

Eckert, K.L. and Abreu Grobois, F.A. (Eds.) 2001. Proceedings of the Regional Meeting: “Marine Turtle Conservation in the Wider Caribbean Region: A Dialogue for Effective Regional Management,” Santo Domingo, 16-18 November 1999. WIDECAST, IUCN-MTSG, WWF, and UNEP-CEP. xx + 154 pp.

Echwikhi, K., Jribi, I., Bradai, M.N., Bouain, A. 2010a. Effect of type of bait on pelagic longline fishery–loggerhead turtle interactions in the Gulf of Gabes (Tunisia). Aquat. Conserv.: Mar. Freshw. Ecosyst., 20 (5): 525-530.

Echwikhi, K., Jribi, I., Bradai, M.N., Bouain, A. 2010b. Gillnet fishery: loggerhead turtle interactions in the Gulf of Gabes, Tunisia. Herpetol. J., 20: 25-30.

Encalada S.E., Lahanas P.N., Bjorndal K.A., Bolten A.B., Miyamoto M.M., Bowen, B.W. 1996. Phylogeography and population structure of the Atlantic and Mediterranean green turtle (Chelonia mydas): a mitochondrial DNA control region sequence assessment. Mol. Ecol., 5: 473-483.

Epperly, S.P. and Boggs, C. 2004. Post-Hooking mortality in pelagic longline fisheries using "J" hooks and circle hooks: application of new draft criteria to data from the Northeast Distant Experiments in the Atlantic. NOAA/NMFS/SE Fisheries Science Center: 8pp.

Fairfield-Walsh, C. and Garrison, L.P. 2006. Estimated bycatch of marine mammals and turtles in the U.S. Atlantic Pelagic Longline Fleet during 2005. NOAA Tech. Mem. NMFS-SEFSC-539: 52pp.

Fairfield-Walsh C and Garrison, L.P. 2007. Estimated bycatch of marine mammals and turtles in the U.S. Atlantic Pelagic Longline Fleet during 2006. NOAA Tech. Mem. NMFS-SEFSC-560: 54pp.

Fairfield-Walsh, C. and Garrison, L.P. 2008. Estimated bycatch of marine mammals and turtles in the U.S. Atlantic Pelagic Longline Fleet during 2007. NOAA Tech. Mem. NMFS-SEFSC-572: 62pp.

FAO. 2001. International Plan of Action to prevent, deter and eliminate illegal, unreported and unregulated fishing. Rome, FAO, 24pp.

Ferreira, R.L., Martins, H.R., da Silva, A.A., Bolten, A.B. 2001. Impact of swordfish fisheries on sea turtles in the Azores. Arquipelago, 18A:75-79.

Fiedler, F.N., Sales, G., Giffoni, B.B., Monteiro-Filho, E.L.A., Secchi, E.R., Bugoni, L. 2012. Driftnet fishery threats sea turtles in the Atlantic Ocean. Biodivers. Conserv., 21: 915–931.

Finkbeiner, E.M., Wallace, B.P., Moore, J.E., Lewison, R.L., Crowder, L.B., Read, A.J. 2011. Cumulative estimates of sea turtle bycatch and mortality in USA fisheries between 1990 and 2007. Biol. Conserv., 144: 2719–2727.

Fossette, S., Girard, G., López-Mendilaharsu, M., Miller, P., Domingo, A., Evans, D., Kell, L., Plot, V., Prosdocimi, L., Verhage, S., Gaspar, P., Georges, J-Y. 2011. Atlantic leatherback migratory paths and temporary residence areas. PLoS ONE, 5(11): e13908. doi:10.1371/journal.pone.0013908.

Fromentin, J.M. and Farrugio, H. 2005. Results of the 2003 observer program on-board the French purse seiner targeting Atlantic bluefin tuna in the Mediterranean Sea. Col. Vol. Sci. Pap. ICCAT, 58 (2): 779-782.

Garrison, L.P. 2003. Estimated bycatch of marine mammals and turtles in the US Atlantic Pelagic Longline Fleet during 2001-2002. NOAA Tech. Mem. NMFS-SEFSC-515: 52pp. (with erratum).

Garrison, L.P. 2005. Estimated bycatch of marine mammals and turtles in the US Atlantic Pelagic Longline Fleet during 2004. NOAA Tech. Mem. NMFS-SEFSC-531: 57pp.

Garrison, L.P., and Richards, P.M. 2004. Estimated bycatch of marine mammals and turtles in the US Atlantic Pelagic Longline Fleet during 2003. NOAA Tech. Mem. NMFS-SEFSC-527: 57pp.

Garrison, L.P., Stokes, L., Fairfield-Walsh, C. 2009. Estimated bycatch of marine mammals and turtles in the US Atlantic Pelagic Longline Fleet during 2008. NOAA Tech. Mem. NMFS-SEFSC-591: 63pp.

Garrison L.P. and Stokes L. 2010. Estimated bycatch of marine mammals and turtles in the U.S. Atlantic Pelagic Longline Fleet during 2009. NOAA Tech. Mem. NMFS-SEFSC-607: 63pp.

Giffoni, B., Domingo A., Sales G., Niemeyer Fiedler F., Miller P. 2008. Interacción de tortugas marinas (Caretta caretta y Dermochelys coriacea) con la pesca de palangre pelágico en el Atlántico sudoccidental: una perspectiva regional para la conservación. Col. Vol. Sci. Pap. ICCAT, 62(6): 1861-1870.

Gilman, E., Gearhart, J., Price, B., Eckert, S., Milliken, H., Wang, J., Swimmer, Y., Shiode, D., Abe, O., Peckham, S.H., Chaloupka, M., Hall, M., Mangel, J., Alfaro-Shigueto, J., Dalzell, P., Ishizaki, A. 2010. Mitigating sea turtle bycatch in coastal passive net fisheries. Fish Fish., 11: 57–88.

Groombridge, B., Luxmoore, R. 1989. The Green Turtle and Hawksbill (Reptilia: Cheloniidae): World Status, Exploitation and Trade. Secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, United Nations Environment Programme, Lausanne, Switzerland, 601 pp.

Hirth, H.F. 1997. Synopsis of the biological data on the green turtle, Chelonia mydas (Linnaeus 1758). United States Fish and Wildlife Service Biological Report 97-1, 120 pp.

Honig, M.B., Petersen S.L., Duarte A. 2008. Turtle bycatch in longline fisheries operating within the Benguela current large marine ecosystem. Col. Vol. Sci. Pap. ICCAT, (6): 1757-1769

Huang, H.W. 2011. Bycatch of high sea longline fisheries and measures taken by Taiwan: Actions and challenges. Mar. Policy, 35: 712–720.

Huang, H.W., Chou, S.C. Dai, J.P., Shiao, C.H. 2009. Overview of the Taiwanese Observers Program for large-scale tuna longline fisheries in the Atlantic Ocean from 2002 to 2006. Col. Vol. Sci. Pap. ICCAT, 64 (7): 2508-2517.

Johnson, D.R., Yeung, C., Brown, C.A. 1999. Estimated bycatch of marine mammals and turtles in the U.S. Atlantic Pelagic Longline Fleet in 1992-1997. NOAA Tech. Mem., NMFS-SEFSC-418: 70pp.

Jribi, I., Echwikhi, K., Bradai, M.N., Bouain, A. 2008. Incidental capture of sea turtles by longlines in the Gulf of Gabès (South Tunisia): a comparative study between bottom and surface longlines. Sci. Mar., 72 (2): 337–342.

Kerstetter D.W. and Graves, J.E. 2006. Effects of circle versus J-style hooks on target and non-target species in a pelagic longline fishery. Fish. Res., 80: 239-250.

Kopitsky, K., Pitman, R.L., Plotkin, P.T. 2000. Investigations on at-sea mating and reproductive status of olive ridleys, Lepidochelys olivacea, captured in the eastern tropical Pacific. In: Kalb, H.J., Wibbels, T. (Eds.), Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation, NOAA Tech. Mem., NMFS-SEFSC-443, pp. 160-162.

Kotas, J.E., Santos S., Azevedo V.G., Gallo B.M.G, Barata P.C.R. 2004. Incidental capture of Loggerhead (Caretta caretta) and Leatherback (Dermochelys coriacea) sea turtles by the pelagic longline fishery off southern Brazil. Fish. B-NOAA., 102: 393-399

Laurent, L., Camiñas, J.A., Casale, P., Deflorio, M., De-Metrio, G., Kapantagakis, A., Margaritoulis, D., Politou, C.Y., Valeiras, J. 2001. Assessing marine turtle bycatch in European drifting longline and trawl fisheries for identifying fishing regulations. Project-EC-DG Fisheries 98-008. Joint project of BIOINSIGHT, IEO, IMBC, STPS and University of Bari. Villeurbanne, France, pp 267.

Lewinson, R.L., and Crowder, L.B. 2007. Putting longline bycatch of sea turtles into perspective. Conserv. Biol., 21 (1): 79–86.

López-Mendilaharsu, M., Sales, G., Giffoni, B., Miller, P., Fiedler, F.N., Domingo, A. 2007. Distribuición y composición de tallas de las tortugas marinas (Caretta caretta y Dermochelys coriacea) que interactuam con el palangre pelagico en el Atlantico Sur. Col. Vol. Sci. Pap. ICCAT, 60(6): 2094-2109

Marçalo, A., Nicolau, L., Hirofumi, M., Vingada J. 2012. Interações de cetáceos e tartarugas marinhas com a armação fixa para a pesca de atum ao largo da costa Algarvia. Relatório inter-anual interno, Sociedade Portuguesa de Vida Selvagem: 11 pp. (In Portuguese).

Marcovaldi, M.A., Sales, G., Thomé, J.C.A., Dias-da-Silva, A.C.C., Gallo, B.M.G., Lima, E.H.S.M., Lima, E.P., Bellini, C. 2006. Sea turtles and fishery interactions in Brazil: identifying and mitigating potential conflicts. Marine Turtle Newsletter, 112: 4-8.

Margaritoulis, D., Argano, R., Baran, I., Bentivegna, F., Bradai, M.N., Caminas, J.A., Casale, P., De Metrio, G., Demetropoulos, A., Gerosa, G., Godley, B., Houghton, J., Laurent, L., Lazar, B. 2003. Loggerhead turtles in the Mediterranean Sea: present knowledge and conservation perspectives. In Bolten, A.B., Witherington, B.E. (Eds.) Loggerhead Sea Turtles, Smithsonian Books, Washington, D.C., pp. 175-198.

Margaritoulis, D. and Teneketzis, K. 2001. Identification of a developmental habitat of the green turtle in Lakinikos Bay, Greece. In Margaritoulis, D., Demetropoulos, A. (Eds.) Proceedings of the First Mediterranean Conference on Marine Turtles, Nicosia, Cyprus, Barcelona Convention – Bern Convention – Bonn Convention (CMS), pp. 170-175.

Marquez, R.M. 1994. Synopsis on the biological data on the Kemp's ridley turtle, Lepidochelys kempii (Garman, 1880). NOAA Tech. Mem., NMFS-SEFSC- 343, 91pp.

Mejuto, J., García-Cortés B., Ramos-Cartelle, A. 2008. Trials using different hook and bait types in the configuration of the surface longline gear used by the Spanish swordfish (Xiphias gladius) fishery in the Atlantic Ocean. Col. Vol. Sci. Pap. ICCAT, 62 (6): 1793-1830.

Moore, J.E., Cox, T.M., Lewison, R.L., Read, A.J., Bjorkland, R., McDonald, S.L., Crowder, L.B., Aruna, E., Ayissi, I., Espeut, P., Joynson-Hicks, C., Pilcher, N., Poonian, C.N.S:, Solarin, B., Kiszka, J. 2010. An interview-based approach to assess marine mammal and sea turtle captures in artisanal fisheries. Biol. Conserv., 143: 795–805.

Moore, J.E., Wallace, B.P., Lewison, R.L., Zydelis, R., Cox, T.M., Crowder, L.B. 2009. Review of marine mammal, sea turtle and sea bird bycatch in USA fisheries and the role of policy in shaping management. Mar. Pol., 33: 435-451.

Morreale, S.J., Plotkin, P.T., Shaver, D.J. and Kalb, H.J. 2007. Adult migration and habitat utilization. In Plotkin, P.T. (ed.) Biology and Conservation of Ridley Sea Turtles, Johns Hopkins University Press, Baltimore, MD.

Mortimer, J. and Bresson, R. 1999. Temporal distribution and periodicity in hawksbill turtles (Eretmochelys imbricata) nesting at Cousin Island, Republic of Seychelles, 1971-1997. Chelonian Conserv. Bi., 3 (2): 318-325.

Mortimer, J.A., Carr, A. 1987. Reproduction and migration of the Ascension Island green turtle (Chelonia mydas). Copeia, 1987: 103-113.

Mortimer, J.A. and Donnelly, M. 2008. Eretmochelys imbricata. In IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. <www.iucnredlist.org>.

Mortimer, J.A., and Portier, K.M. 1989. Reproductive homing and internesting behaviour of the green turtle (Chelonia mydas) at Ascension Island, South Atlantic Ocean. Copeia, 1989: 962.

Murray, K.T. 2009a. Characteristics and magnitude of sea turtle bycatch in US mid-Atlantic gillnet gear. Endang. Species Res., 8: 211-224.

Murray, K.T. 2009b. Proration of estimated bycatch of loggerhead sea turtles in U.S. mid-Atlantic sink gillnet gear to vessel trip report landed catch, 2002-2006. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 09-19: 7 p.

Musick, J.A. and Limpus, C.J. 1997. Habitat utilization and migration in juvenile sea turtles. In Lutz, P.L., Musick, J.A. (Eds.) The Biology of Sea Turtles, Boca Raton, Florida, CRC Press, pp. 137-164.

Nada, M.A. 2001. Observations on the trade in sea turtles at the fish market of Alexandria, Egypt. Zool. Middle East, 24: 109-118.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1991. Recovery Plan for U.S. population of Atlantic Green Turtle. National Marine Fisheries Service, Washington, D.C.

National Marine Fisheries Service and U.S. Fish and. Wildlife Service. 1993. Recovery Plan for Hawksbill Turtles in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. National Marine Fisheries Service, St. Petersburg, Florida.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 2008. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (Caretta caretta), Second Revision. National Marine Fisheries Service, Silver Spring, MD.

National Marine Fisheries Service, U.S. Fish and Wildlife Service, and SEMARNAT. 2011. Bi- National Recovery Plan for the Kemp's Ridley Sea Turtle (Lepidochelys kempii), Second Revision. National Marine Fisheries Service. Silver Spring, Maryland 156 pp. + appendices.

Oruç, A. 2003. Interactions between marine turtles and trawl fisheries in the eastern Mediterranean, Turkey. In Margaritoulis, D., Demetropoulos, A. (Eds.) Proceedings of the First Mediterranean Conference on Marine Turtles, Nicosia, Cyprus, Barcelona Convention – Bern Convention – Bonn Convention (CMS), pp. 197-201.

Pacheco, J.C., Kerstetter, D.W., Hazin, F.H., Hazin, H., Segundo, R.S.S.L., Graves, J.E., Carvalho, F., Travassos, P.E. 2011. A comparison of circle hook and J hook performance in a western equatorial Atlantic Ocean pelagic longline fishery. Fish. Res., 107: 39–45.

Panou, A., Tselentis, L., Voutsinas, N., Mourelatus, C., Kaloupi, S., Voutsinas, V., Moschonas, S. 1999. Incidental catches of marine turtles in surface longline fishery in the Ionian Sea (Greece). Contrib. Zoogeograp. Ecol. Eastern Mediterranean Reg., 1: 435–445.

Peristeraki, P., Kypraios, N., Lazarakis, G., Tserpes, G. 2008. Bycatches and discards of the Greek swordfish fishery. Col. Vol. Sci. Pap. ICCAT, 62 (4): 1070-1073.

Petersen, S.L., Honig, M.B., Ryan, P.G., Nel R. and Underhill, L.G. 2009. Turtle bycatch in the pelagic longline fishery off southern Africa. Afr. J. Mar. Sci.31(1): 87–96

Pinedo, M.C. and Polacheck, T. 2004. Sea turtle bycatch in pelagic longline sets off southern Brazil. Biol. Conserv. 119: 335–339.

Piovano, S., Swimmer, Y., Giacoma, C. 2009. Are circle hooks effective in reducing incidental captures of loggerhead sea turtles in a Mediterranean longline fishery? Aquat. Conserv.: Mar. Freshw. Ecosyst., 19 (7): 779-785.

Plotkin, P.T. (Ed). 1995. National Marine Fisheries Service and U. S. Fish and Wildlife Service Status Reviews for Sea Turtles Listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, Maryland.

Plotkin, P.T., Owens, D.W., Byles, R.A., Patterson, R. 1996. Departure of male olive ridley turtles (Lepidochelys olivacea) from a nearshore breeding ground. Herpetologica, 52 (1): 1-7.

Pons, M., Marroni, S., Machado, I., Ghattas, B., Domingo, A. 2009. Machine learning procedures: an application to by-catch of the marine turtles Caretta caretta in the Southwestern Atlantic Ocean. Collect. Vol. Sci. Pap. ICCAT, 64: 2443-2454.

Pons, M., Domingo, A., Sales, G., Fiedler, F.N., Miller, P., Giffoni, B., Ortiz, M. 2010. Standardization of CPUE of loggerhead sea turtle (Caretta caretta) caught by pelagic longliners in the Southwestern Atlantic Ocean. Aquat. Living Resour., 23: 65–75.

Pritchard, P.C.H. 1976. Post nesting movements of marine turtles (Cheloniidae and Dermochelyidae) tagged in the Guianas. Copeia, 1976 (4): 749-754.

Read, A. 2007. Do circle hooks reduce the mortality of sea turtles in pelagic longlines? A review of recent experiments. Biol Conserv., 135: 155-169.

Reichart, H.A. 1993. Synopsis of biological data on the olive ridley sea turtle Lepidochelys olivacea (Eschscholtz 1829) in the western Atlantic. NOAA Tech. Mem. NMFS-SEFSC-336.

Sales, G., Giffoni, B.B., Barata, P.C.R. 2008. Incidental catch of sea turtles by the Brazilian pelagic longline fishery. J. Mar. Biol. Assoc. U.K., 88: 853 864.

Sales, G., Giffoni, B. B., Fiedler, F. N., Azevedo, V. G., Kotas, J. E., Swimmer, Y., Bugoni, L. 2010. Circle hook effectiveness for the mitigation of sea turtle bycatch and capture of target species in a brazilian pelagic longline fishery. Aquat. Conserv.: Mar. Freshw. Ecosyst., 20(4), 428-436.

Santos, M.N, Coelho, R., Fernandez-Carvalho, J., Amorim, S. 2012. Effects of hook and bait on sea turtle catches in an equatorial Atlantic pelagic longline fishery. Bull. Mar. Sci., 88(3), 683-701.

Sarralde, R., Ariz, J., Delgado-de-Molina, A., Pallarés, P., Santana, J.C. 2006. Actividad de los observadores en la flota atunera Española de cerco en el océano atlántico desde 2001 al 2005. Col. Vol. Sci. Pap. ICCAT, 59 (2): 690-700.

Sarralde, R., Delgado-de-Molina, A., Santana, J.C., Delgado-de-Molina, R., Ariz, J. 2007. Estimación de los descartes y de las capturas de especies accesorias en la pesquería española de cerco de túnidos tropicales en el Océano Atlántico, entre 2001 y 2006. Col. Vol. Sci. Pap. ICCAT, 60 (6): 2130-2139.

Sarti-Martinez, A.L. 2000. Dermochelys coriacea. In IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. URL: www.iucnredlist.org

Seminoff, J.A. 2004. Chelonia mydas. In IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. URL: www.iucnredlist.org

Seminoff, J.A., Jones, T.T., Resendiz, A., Nichols, W.J., Chaloupka, M.Y. 2003. Monitoring green turtles (Chelonia mydas) at a coastal foraging area in Baja California, Mexico: multiple indices describe population status. J. Mar. Biol. Assoc. U.K., 83: 1355-1362.

Shaver, D.J. and Rubio, C. 2008. Post-nesting movement of wild and headstarted Kemp's ridley sea turtles Lepidochelys kempii in the Gulf of Mexico. Endang. Species Res, 4:43-55.

Silvani, L., Gazo, M., Aguilar, A. 1999. Spanish driftnet fishing and incidental catches in the western Mediterranean. Biol. Conserv., 90 (1):79–85.

TEWG (Turtle Expert Working Group). 2000. Assessment for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. NOAA Tech. Mem. NMFS-SEFSC-444, 115 pp.

Tudela, S. 2004. Ecosystem effects of fishing in the Mediterranean: an analysis of the major threats of fishing gear and practices to biodiversity and marine habitats. Studies and Reviews. General Fisheries Commission for the Mediterranean, No. 74, Rome, FAO, 44pp.

Tudela, S., Kai-Kai, A., Maynou, F., El Andalossi, M., Guglielmi, P. 2005. Driftnet fishing and biodiversity conservation: the case study of the large-scale Moroccan driftnet fleet operating in the Alboran Sea (SW Mediterranean). Biol. Conserv., 121: 65–78.

Turkozan, O. and Durmus, S.H. 2000. A feeding ground for juvenile green turtles, Chelonia mydas, on the western coast of Turkey. British Herpetological Society Bulletin, 71: 1-5.

van Dam, R.P. and Diez, C.E. 1997. Diving behavior of immature hawksbill turtles (Eretmochelys imbricata) in a Caribbean reef habitat. Coral Reefs, 16: 133-138.

Watson, J.W., Foster, D.G., Epperly, S., Shah A. 2003a. Experiments in the Atlantic northeast distant waters to evaluate sea turtle mitigation measures in the pelagic longline fishery. Report on experiments conducted in 2001 and 2002. NOAA Fisheries. March 5, 2003, 89pp.

Watson, J.W., Hataway, B.D., Bergmann, C.E. 2003b. Effect of hook size on ingestion of hooks by loggerhead sea turtles. Report of NOAA National Marine Fisheries Service, Pascagoula, MS, USA.

Watson, J.W., Foster, D.G., Epperly, S., Shah A. 2004a. Experiments in the Atlantic northeast distant waters to evaluate sea turtle mitigation measures in the pelagic longline fishery. Report on experiments conducted in 2001–2003. NOAA Fisheries: 123pp.

Watson, J.W., Bergmann, C.E., Shah, A., Foster, D.G., Epperly, S. 2004b. Evaluation of 18/0 circle hooks in the Gulf of Mexico tuna fishery. Report on experiments conducted in 2004. National Marine Fisheries Service, Southeast Fisheries Science Center, Pascagoula, MS, USA: 14 pp.

Watson, J.W., Epperly, S., Shah, A., Foster, D.G. 2005. Fishing methods to reduce sea turtle mortality associated with pelagic longlines. Can. J. Fish. Aquat Sci., 62: 965–981.

Witzell, W.N. 1984. The incidental capture of sea turtles in the Atlantic US Fishery conservation zone by the Japanese tuna longline fleet, 1978–81. Mar. Fish. Rev., 46 (3): 56–58.

Witzell, W.N. 1999. Distribution and relative abundance of sea turtles caught incidentally by the U.S. pelagic longline fleet in the western north Atlantic ocean, 1992-1995. Fish. Bull., 97: 200-211.

Yeung, C. 1999. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic Pelagic Longline fleet during 1998. NOAA Tech. Mem. NMFS-SEFSC-430: 26pp.

Yeung, C. 2001. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic Pelagic Longline fleet during 1999-2000. NOAA Tech. Mem. NMFS-SEFSC-467: 42pp.

Zeeberg, J., Corten, A., de Graaf, E. 2006. Bycatch and release of pelagic megafauna in industrial trawler fisheries off Northwest Africa. Fish. Res., 78: 186–195.

Zug, G.R., Chaloupka, M., Balazs, G.H. 2006. Age and growth in olive ridley sea turtles (Lepidochelys olivacea) from the North-central Pacific: a skeletochronological analysis. Mar. Ecol., 27: 263-270.

Zug, G.R., Kalb, H.J., Luzar, S.J.. 1997. Age and growth in wild Kemp's ridley sea turtles Lepidochelys kempii from skeletochronological data. Biol. Conserv., 80:261-268.

Zug, G.R. and Parham, J.F. 1996. Age and growth in leatherback turtles, Dermochelys coriacea (Testudines: Dermochelyidae): A skeletochronological analysis. Chelonian Conserv. Bi., 2: 244-249.

Table 1. List of sea turtle species that potentially interact with ICCAT fisheries, with the FAO 3 letter code, scientific names (with authority), and the English, French and Spanish common names.

FAO code	*Name (scientific)*	*Author*	*Name (EN)*	*Name (FR)*	*Name (ES)*
DKK	*Dermochelys coriacea*	(Vandelli, 1761)	Leatherback	Tortue luth	Tortuga laud
LKV	*Lepidochelys olivacea*	(Eschscholtz, 1829)	Olive ridley	Tortue olivâtre	Tortuga golfina
LKY	*Lepidochelys kempii*	(Garman, 1880)	Kemp's ridley	Tortue de kemp	Tortuga iora
TTH	*Eretmochelys imbricata*	(Linnaeus, 1766)	Hawksbill turtle	Tortue caret	Tortuga de carey
TTL	*Caretta caretta*	(Linnaeus, 1758)	Loggerhead	Caouanne	Cayuma
TUG	*Chelonia mydas*	(Linnaeus, 1758)	Green turtle	Tortue verte	Tortuga verde
TTX	Testudinata		Marine turtles nei	Tortues de mer nca	Tortugas de mar nep

Table 2. Conservation status of the six sea turtle species that can potentially interact with ICCAT fisheries, using the criteria from the IUCN Red list, as well as their inclusion in international treaties such as CITES and CMS.

FAO Code	*Name (scientific)*	*IUCN Red List*	*CITES*	*CMS*
DKK	*Dermochelys coriacea*	Critically Endangered	Appendix I	Appendices I and II
LKV	*Lepidochelys olivacea*	Vulnerable	Appendix I	Appendices I and II
LKY	*Lepidochelys kempii*	Critically Endangered*	Appendix I	Appendices I and II
TTH	*Eretmochelys imbricata*	Critically Endangered	Appendix I	Appendices I and II
TTL	*Caretta caretta*	Endangered*	Appendix I	Appendices I and II
TUG	*Chelonia mydas*	Endangered	Appendix I	Appendices I and II

(*) needs updating according to the IUCN Red List evaluation.

Table 3. Summary of the data collected on sea turtle bycatch interactions with longline fishing gear for the northwest Atlantic region. CPUE is given as N/1000 hooks. On the data source FO = onboard fishery observers, Log = logbooks data, Sci = research cruises or commercial vessels during experimental fishing trials.

Reference	*Species*	*N*	*CPUE*	*Region*	*Period*	*Trips*	*Sets*	*Hooks*	*Data*	*Flag*
Witzell (1984)	*D. coriacea*	2	0.001	Atlantic area	1978-1981			3,651,434	FO, Log	USA
	Sea-turtle nei	25	0.007							
	D. coriacea	12	0.007	Gulf of Mexico				1,662,273		
	Sea-turtle nei	18	0.011							
Witzell (1999)	*D. coriacea*	1,264	0.071	US Atlantic PLF	1992-1995			35,596,325	Log	USA
	C. caretta	1,337	0.075							
* NOAA Reports (several years/authors)	*D. coriacea*	1,162	0.123	US Atlantic PLF	1992-2009		12,578	9,460,594	FO	USA
	C. caretta	1,136	0.120							
	Sea-turtle nei	43	0.005							
Beerkircher et al. (2004)	*D. coriacea*	617	0.15	US Atlantic PLF	1992-2002		5,895	4,138,830	FO	USA
	C. caretta	686	0.17							
	Sea-turtle nei	40	0.01							
Epperly and Boggs (2004)	*C. caretta*	177		NED	2002-2003				Sci	USA
	D. coriacea	250								
Watson et al. (2005)	*C. caretta*	96	0.22	NED	2002		489	427,382	Sci	USA
	D. coriacea	148	0.35							
Kerstetter and Graves (2006)	*C. caretta*	5		mid-Atlantic continental shelf	2003-2004		85		Sci	USA
	D. coriacea	4								
Read (2007)	*C. caretta*	188	0.19	NED	2002-2003		1028	1,005,432	Sci	USA
	D. coriacea	227	0.23							
	C. caretta	3	0.10	Gulf of Mexico	2004		61	29,570		
Brazner and McMillan (2008)	*C. caretta*	701	0.75	Canada's EEZ	1999-2006				FO	CAN
Mejuto et al. (2008)	*C. caretta*	151	1.758	Western Azores	2005-2006			85,876	Sci	EC.ESP
	D. coriacea	30	0.349							
Carruthers et al. (2009)	*C. caretta*	814		Off Canada	2001-2006		859		FO	CAN

*: References by Johnson et al. (1999), Yeung (1999, 2001), Garrison (2003, 2005) and Garrison and Richards (2004), Fairfield-Walsh and Garrison (2006, 2007 and 2008), Garrison et al. (2009) and Garrison and Stokes (2010).

Table 4. Summary of the data collected on sea turtle bycatch interactions with longline fishing gear for the northeast Atlantic region. CPUE is given as N/1000 hooks. On the data source FO = onboard fishery observers, Log = logbooks data, Sci = research cruises or commercial vessels during experimental fishing trials.

Reference	*Species*	*N*	*CPUE*	*Region*	*Period*	*Trips*	*Sets*	*Hooks*	*Data*	*Flag*
Ferreira et al. (2001)	*C. caretta*	60	0.27	Azores	1998	2			FO, Log	EC.PRT
	D. coriacea	3								
Read (2007)	*C. caretta*	437	1.05	Azores	2000-2003		274	416,199	Sci	EC.PRT
	D. coriacea	13	0.03							
Mejuto et al. (2008)	*C. caretta*	4	0.104	Azores	2005-2006			38,385	Sci	EC.ESP
	D. coriacea	15	0.391							
	C. caretta	16	0.421	Eastern tropical	2005-2006			38,028		
	D. coriacea	24	0.631							

Table 5. Summary of the catch data collected on loggerhead (*Caretta caretta*) for the northwest Atlantic region, by the US Atlantic Pelagic Longline fleet. The nominal CPUEs were estimated based on the catch numbers and effort information in the NOAA Reports by Johnson et al. (1999), Yeung (1999, 2001), Garrison (2003, 2005), Garrison and Richards (2004), Fairfield-Walsh and Garrison (2006, 2007, 2008), Garrison et al. (2009) and Garrison and Stokes (2010).

Year	*Johnson et al. (1999)*	*Yeung (1999)*	*Yeung (2001)*	*Garrison (2003)*	*Garrison and Richards (2004)*	*Garrison (2005)*	*Fairfield-Walsh and Garrison (2006)*	*Fairfield-Walsh and Garrison (2007)*	*Fairfield-Walsh and Garrison (2008)*	*Garrison et al. (2009)*	*Garrison and Stokes (2010)*
1992	0.017										
1993	0.043										
1994	0.209										
1995	0.253										
1996	0.058										
1997	0.084										
1998		0.083									
1999			0.220								
2000			0.152								
2001				0.332							
2002				0.187							
2003					0.149						
2004						0.099					
2005							0.042				
2006								0.107			
2007									0.091		
2008										0.093	
2009											0.027

Table 6. Summary of the catch data collected on leatherback (*Dermochelys coriacea*) for the northwest Atlantic region, by the US Atlantic Pelagic Longline fleet. The nominal CPUEs were estimated based on the catch numbers and effort information in the NOAA Reports by Johnson et al. (1999), Yeung (1999, 2001), Garrison (2003, 2005), Garrison and Richards (2004), Fairfield-Walsh and Garrison (2006, 2007, 2008), Garrison et al. (2009) and Garrison and Stokes (2010).

Year	*Johnson et al. (1999)*	*Yeung (1999)*	*Yeung (2001)*	*Garrison (2003)*	*Garrison and Richards (2004)*	*Garrison (2005)*	*Fairfield-Walsh and Garrison (2006)*	*Fairfield-Walsh and Garrison (2007)*	*Fairfield-Walsh and Garrison (2008)*	*Garrison et al. (2009)*	*Garrison and Stokes (2010)*
1992	0.079										
1993	0.123										
1994	0.100										
1995	0.126										
1996	0.044										
1997	0.034										
1998		0.022									
1999			0.155								
2000			0.097								
2001				0.268							
2002				0.284							
2003					0.147						
2004						0.166					
2005							0.073				
2006								0.093			
2007									0.094		
2008										0.102	
2009											0.058

Table 7. Summary of the data collected on sea turtle bycatch interactions with longline fishing gear for the southwest Atlantic region. CPUE is given as N/1000 hooks. On the data source FO = onboard fishery observers, Sci = research cruises or commercial vessels during experimental fishing trials, Itv = fishers interviews.

Reference	*Species*	*N*	*CPUE*	*Region*	*Period*	*Trips*	*Sets*	*Hooks*	*Data*	*Flag*
Achaval et al. (2000)	*C. caretta*	73	0.81	Uruguay (EEZ)	1993 / 1996	9	99	90,194	FO	URY
	D. coriacea	32	0.35							
Kotas et al. (2004)	*C. caretta*	145	4.31	South Brazil (EEZ) & Int. waters	Mar/Oct 1998	3	34	33,660	FO	BRA
	D. coriacea	20	0.59							
Pinedo and Polacheck (2004)	*C. caretta*	14	1.09	South Brazil	Nov 1996 / Aug 1999		41	12,870	Sci	BRA
	D. coriacea	1	0.08							
	L. olivacea	1	0.08							
	Sea turtle nei	3	0.23							
Domingo et al. (2006b)	*C. caretta*	1,128	0.13-1.71	Brazil & Uruguay	1998 / 2004		2,077	3,149,638	FO	BRA, URY
	D. coriacea	259	0.04-0.41							
	L. olivacea	29	0.01							
	C. mydas	28	0.01							
López-Mendilaharsu et al. (2007)	*C. caretta*	1,693	0.42-2.45	Brazil & Uruguay	1998 / 2005		1,729	2,643,851	FO	BRA, URY
	D. coriacea	238	0.05-0.70							
Bugoni et al. (2008)	Sp. comb. (DOL fishery)	44	1.08	Brazil	2001 / 2006		40	40,717	FO, Itv	BRA
	Sp. comb. (SWO fishery)	1	0.08				31	11,974		
Giffoni et al. (2008)	*C. caretta*	1,965	0.53	Brazil & Uruguay	Jan 2005 / Jul 2007		2,614	3,730,655	FO	BRA, URY
	D. coriacea	312	0.08							
Sales et al. (2008)	*C. caretta*	789	0.07	Brazil	2001 / 2005	311	7,385	11,348,069	FO	BRA
	D. coriacea	341	0.03							
	C. mydas	45	0.00							
	L. olivacea	81	0.01							
	Sea turtle nei	130	0.01							
Domingo et al. (2009)	*C. caretta*	69	0.73-1.05	Uruguay (EEZ) & Int. waters	Jan / Nov 2007	3	165	77,628	Sci	URY
Pons et al. (2010)	*C. caretta*	3,778	0.38-1.78	Brazil & Uruguay	1998 / 2007		4,276	6,272,344	FO	BRA, URY
Sales et al. (2010)	*C. caretta*	170	0.73-1.61	South Brazil (EEZ) & Int. waters	2004 / 2008	22	229	145,828	Sci	BRA
	D. coriacea	27	0.10-0.27							
	C. mydas	2	0.014							
Pacheco et al. (2011)	*D. coriacea*	16	0.16-0.48	Equatorial West Atl.	Aug 2006 / Jan 2007	6	81	50,170	Sci	BRA
	L. olivacea	4	0.04-0.12							
	C. mydas	10	0.16-0.24							

Table 8. Summary of the data collected on sea turtle bycatch interactions with longline fishing gear for the southeast Atlantic region. CPUE is given as N turtles / 1000 hooks. On the data source FO = onboard fishery observers, Sci = research cruises or commercial vessels during experimental fishing trials.

Reference	*Species*	*N*	*CPUE*	*Region*	*Period*	*Trips*	*Sets*	*Hooks*	*Data*	*Flag*
Carranza et al. (2006)	*D. coriacea*	40	0.39	Gulf of Guinea & St. Helena	May/Sep 2003	1	79	102,700	FO	URY
	L. olivacea	9	0.09							
Honig et al. (2008)	Sp. comb.	118	0.23	South Africa	2000 / 2005		375	520,000	FO	ZAF
Anon (2008)	*C. caretta*	36	0.08	SE Atlantic	Feb/Apr 2007	1	70	44,705	Sci	EC.ESP
	D. coriacea	9	0.02							
Petersen et al. (2009)	*C. caretta*	78	0.018	South Africa	1998 / 2005		2,256	4,400,000	FO	ZAF, ASIAN
	D. coriacea	44	0.010							
	E. imbricata	5	0.001							
	C. mydas	3	0.001							
	Sea turtle nei	51	0.011							
Santos et al. (2012)	*L. olivacea*	161	0.527	Equatorial	Jan-2009 / Mar-2011		221	305,352	Sci	EC.PRT
	D. coriacea	58	0.190							
	C. caretta	10	0.033							
	L. kempii	2	0.007							

Table 9. Summary of the collected on sea turtle hooking mortality rates after interactions with longline fishing gear for the South Atlantic region. On the data source FO = onboard fishery observers, Sci = research cruises or commercial vessels during experimental fishing trials.

Reference	*Species*	*N*	*Region*	*% Alive*	*% Dead*	*Source*
Achaval et al. (2000)	*C. caretta*	73	Uruguay (EEZ)	100.0	0.0	FO
	D. coriacea	32		93.8	6.3	
Pinedo and Polacheck (2004)	*C. caretta*	14	South Brazil	92.9	7.1	Sci
Honig et al. (2008)	Sp. comb.	118	South Africa	18.0	82.0	FO
Sales et al. (2008)	*C. caretta*	789	Brazil	95.9	4.1	FO
	D. coriacea	341		97.7	2.3	
	C. mydas	45		93.5	6.5	
	L. olivacea	81		76.1	23.9	
	Sea turtle nei	130		86.8	13.2	
Anon (2008)	*C. caretta*	36	SE Atlantic	94.4	5.6	Sci
	D. coriacea	9		100.0	0.0	
Sales et al. (2010)	*C. caretta*	170	South Brazil (EEZ) & Int. waters	92.9	7.1	Sci
	L. olivacea	27		94.7	5.3	
Pacheco et al. (2011)	*D. coriacea*	16	Tropical East Atlantic	91.7-100	0-8.3	Sci
	L. olivacea	4		100.0	0.0	
	C. mydas	10		100.0	0.0	
Santos et al. (2012)	*L. olivacea*	161	Equatorial	68.3	31.7	Sci
	D. coriacea	58		96.6	3.4	
	C. caretta	10		90.0	10.0	

Table 10. Summary of the data collected on loggerhead (*Caretta caretta*) CPUE time series for the South Atlantic region. "NomCPUE" refers to nominal (non-standardized) CPUE series, and "StdzCPUE" refer to a standardized series.

	Domingo et al. (2006b)	*López-Mendilaharsu et al. (2007)*	*Pons et al. (2010)*	
Year	*NomCPUE*	*NomCPUE*	*NomCPUE*	*StdzCPUE*
1998	1.71	1.71	1.50	0.63
1999	0.85	0.90	0.70	1.13
2000	0.57	0.64	0.58	0.45
2001	1.40	2.45	1.47	0.81
2002	1.03	1.66	1.43	0.61
2003	0.34	0.44	0.54	0.39
2004	0.13	0.42	0.49	0.57
2005		0.58	0.31	0.38
2006			0.74	0.70
2007			2.25	1.78

Table 11. Summary of the data collected on leatherback (*Dermochelys coriacea*) CPUE time series for the South Atlantic region. "NomCPUE" refers to nominal (non-standardized) CPUE series.

	Domingo et al. (2006b)	*López-Mendilaharsu et al. (2007)*
Year	*NomCPUE*	*NomCPUE*
1998	0.19	0.19
1999	0.10	0.08
2000	0.09	0.21
2001	0.41	0.70
2002	0.16	0.21
2003	0.08	0.05
2004	0.04	0.05
2005		0.08

Table 12. Summary of the data collected on sea turtle bycatch interactions with longline fishing gear for the Mediterranean Sea. CPUE is given as N/1000 hooks. On the data source FO = onboard fishery observers, Sci = research cruises or commercial vessels during experimental fishing trials, Log = logbooks, Port = port sampling.

Reference	*Species*	*N*	*CPUE*	*Region*	*Period*	*Trp*	*Sets*	*Hooks*	*Data*	*Flag*
Aguilar et al. (1995)	*C. caretta*	1,098		W. Med	Jun/Sep 1990/1991		131		FO	EC.ESP
	D. coriacea	2								
Panou et al. (1999)	*C. caretta*	157		Ionian (E Med)	1989/1995	785			Port	EC.GRC
Laurent et al. (2001)	*C. caretta*	22	0.63	Greece	1999/2000		255		FO	EC.GRC
	D. coriacea	1								
	C. caretta	218	0.22-0.71	Ionian (E Med)	1999/2000		443		FO	EC.ITA
	C. mydas	2								
	C. caretta	2,125	1.15-3.27	Gulf of Lion & Alboran	1999/2000		798	2,210,797	FO	EC.ESP
	D. coriacea	2								
Camiñas et al. (2003)	*C. caretta* (ALB)	354	1.05-3.27	W. Med	May 1999 / Dec 2000		798		FO	EC.ESP
	C. caretta (BFT)	391	0-1.74							
	C. caretta (SWO)	1,380	0.29-1.15							
	D. coriacea	2								
Deflorio et al. (2005)	*C. caretta* (SWO)	30	0.08-0.22	N Ionian	May/Sep; 1999/2000		145		FO	EC.ITA
		85	0.29-0.71	S Ionian			159			
	C. caretta (ALB)	57	1.13-0.50	N Ionian	Oct/Dec; 1999/2000		71		FO	EC.ITA
		28	0.20	S Ionian			50			
	C. mydas	2		S Ionian	May/Dec; 1999/2000		209		FO	EC.ITA
Camiñas et al. (2006)	*C. caretta* (BFT)	746	1.41	W Med	Apr/Dec; 1999/2004		276	525,020	FO	EC.ESP
	C. caretta (BFTr)	54	1.057				31	51,090		
	C. caretta (SWA)	125	0.69				145	180,510		
	C. caretta (SWB)	1837	0.74				800	2,496,181		
	C. caretta (SWBr)	354	1.36				211	261,165		
	C. caretta (ALB)	354	1.18				70	298,970		
Báez et al. (2007)	*C. caretta*	675	1.16	Balearic (W. Med)	Jul/Sep; 2000/2003		179	581,666	FO	EC.ESP
Casale et al. (2007)	*C. caretta*	91	0.977	Strait of Sicily	Summer 2005			93,100	Log	EC.ITA
Jribi et al. (2008)	*C. caretta* (Surface LL)	33	0.823	Gulf of Gabes	Jun/Sep; 2004/2005	47	62	40,106	FO	TUN
	C. caretta (Bottom LL)	24	0.278			33	49	86,230		
Anon (2008)	*C. caretta*	2	0.03	Ionian (E Med)	May/Sep 2007		120	60,000	Sci	EC.GRC
	C. caretta	77	1.083	Balearic Isl (W Med)	Jul/Sep 2007		120	71,100	Sci	EC.ESP
Peristeraki et al. (2008)	Sea turtle nei	22	0.2		2004/2006		196	139,710	FO	EC.GRC
Piovano et al. (2009)	*C. caretta*	26	0.41-1.37	Strait of Sicily	Jul/Oct; 2005/2007	7	30	30,000	Sci	EC.ITA
Báez et al. (2010)	*C. caretta* (squid+fish bait)	1,759		W. Med			619		FO	EC.ESP
	C. caretta (fish-only bait)	176					176			
Burgess et al. (2010)	*C. caretta*	321*	2.94*	Central Med.	Apr/Jun 2008		85	109,155	FO	EC.MLT
Echwikhi et al. (2010a)	*C. caretta*	29	0.806	Gulf of Gabes	Jul/Sep; 2007/2008	21	48	35,950	FO	TUN

* Estimated based on the proportions of the total catch in numbers presented in the paper.

Table 13. Summary of the collected on sea turtle hooking mortality rates after interactions with longline fishing gear for the Mediterranean Sea. On the data source FO = onboard fishery observers, Sci = research cruises or commercial vessels during experimental fishing trials.

Reference	*Species*	*N*	*Region*	*% Alive*	*% Dead*	*Source*
Aguilar et al. (1995)	*C. caretta*	1,098	Western Med	99.996	0.004	FO
Laurent et al. (2001)	Sp comb.	23	Greece	95.7	4.3	FO
	Sp comb.	214	Ionian Sea	100	0	
	Sp comb.	676	Spain (W. Med)	97.4	2.6	
Camiñas et al. (2003)	*C. caretta*	2,125	Western Med	96.6	3.4	FO
Camiñas et al. (2006)	*C. caretta* (BFT)	746	Western Med	98.26	1.74	FO
	C. caretta (BFTr)	54		98.15	1.85	
	C. caretta (SWA)	125		98.4	1.6	
	C. caretta (SWB)	1837		99.46	0.54	
	C. caretta (SWBr)	354		95.76	4.24	
	C. caretta (ALB)	354		98.59	1.41	
	C. caretta (All)	3,480		98.68	1.32	
Jribi et al. (2008)	*C. caretta* (Surface LL)	33	Gulf of Gabes	100	0	FO
	C. caretta (Bottom LL)	24		87.5	12.5	
Anon (2008)	*C. caretta*	77	Balearic Isl (W Med)	92.2	7.8	Sci
	C. caretta	2	Ionian Sea (E Med)	100	0	
Echwikhi et al. (2010a)	*C. caretta*	29	Gulf of Gabes	79.3	20.7	FO

Table 14. Summary and characteristics of the data submitted by CPCs in response to the request made by the ICCAT Secretariat regarding interactions between sea turtles and ICCAT fisheries. On the fishing gears LL = longline, PS = purse seine and BT = bottom trawl. CPCs are sorted by alphabetical order.

CPC	*Gear*	*Target Species*	*Time Series*	*Format*	*Information provided*					*Data characteristics*
					Date	**Location**	**Effort**	**Fate**	**Source**	
Belize										CPC has no reports with sea turtle interactions
Brazil	LL	Not specified	2011	Excel	Yes	Yes	Yes	No	FO	Catches (N) in positive fishing sets
Canada	LL	Swordfish, yellowfin, bigeye tuna	2002/2011	Excel	Yes	Yes	No	Yes	FO	Individual specimen information
China	LL	Bigeye tuna	2010/2011	Excel	Yes	Yes	Yes	Yes	FO	Individual specimen information
China Taipei*	LL	Albacore, bigeye tuna	2009/2011	Excel	Yes	Yes	Yes	Yes	FO	Catches (N) per set with information on fate and estimates on sizes
Colombia										No FO program recording sea turtle interactions
EC-France	PS	Tropical tunas	2005/2011	Excel	Yes	Yes	Yes	Yes	FO	Individual specimen information
EC-France	BT	Demersal fishes	2011/2012	Excel	Yes	Yes	Yes	Yes	FO	Individual specimen information
EC-Portugal	LL	Swordfish	2003/2011	Excel	Yes	Yes	Yes	Yes	FO	Catches (N) in positive sets and individual specimen information
EC-Spain	PS	Tropical tunas	2003/2007	PDF	No	No	No	No	FO	SCRS and ALR docs reporting data from purse seines (EC.ESP and EC.FRA)
Egypt										CPC reports that no significant interactions with ICCAT fisheries occur
Iceland										CPC reports that no significant interactions with ICCAT fisheries occur
Japan	LL	Not specified	2010	Excel	Yes	No	No	Yes	FO	Individual specimen information
Korea	LL	Not specified	2011/2012	Excel	Yes	Yes	No	Yes	FO	Individual specimen information
Lybia	LL	Bluefin tuna	2006	Excel	Yes	Yes	No	Yes	FO	Individual specimen information
Mexico	LL	Yellowfin tuna	1993/2010	Excel	Yes	Yes	No	Yes	FO	Individual specimen information
South Africa	LL	Bigeye, yellowfin tuna	2002/2011	Excel	Yes	Yes	No	Yes	FO	Individual specimen information
Tunisia										List of species recorded
US	LL	Not specified	1999/2011	Excel	Yes	Yes	Yes	Yes	FO	Bycatch and individual specimen information

* Data that had been submitted to ICCAT previously to this data request.

Table 15. Summary of the available data from scientific references (including peer-reviewed papers, technical reports, etc) currently listed in the ICCAT meta-database for fisheries in ICCAT waters. The data in this summary Table is organized by species, major region and fishing gear (LL = longline and PS = purse seine). Most of the reporting information compiled in this paper refers to data from these references. It should be noted that this database is continuously being updated with new information relevant for bycatch in ICCAT fisheries.

Species	*Atlantic*			*Mediterranean*			
	LL	*PS*	*Other / Several*	*LL*	*PS*	*Driftnet*	*Other / Several*
C. caretta	52	3	1	21	1	2	3
C. mydas	13	4		1			
D. coriacea	49	3	3	4		1	1
E. imbricata	8	3					
L. kempii	7	4					1
L. olivacea	11	4					
Sea turtle nei	18	1	2	2			7