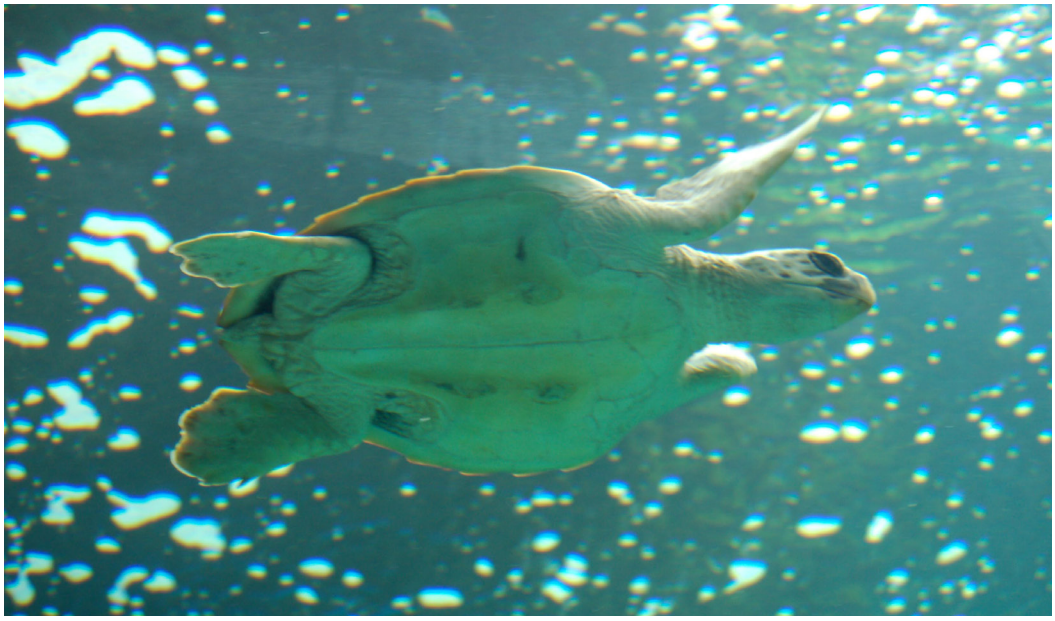
OSPAR COMMISSION

Background Document for Loggerhead turtle *Caretta caretta*



Biodiversity Series

2009

OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the “OSPAR Convention”) was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain.

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, la Finlande, la France, l’Irlande, l’Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d’Irlande du Nord, la Suède et la Suisse et approuvée par la Communauté européenne et l’Espagne.

Acknowledgement

This report has been prepared by Ms Amelia Curd (France). Thanks are also due for the contributions of Rod Penrose, Tom Doyle, Francesca Marubini, Pierre Morinère, Corinne Martin, Ricardo Serrão Santos, Marco Santos, Helen Martins.

Photo acknowledgement:

Cover page: Loggerhead turtle©J Pinnegar/Cefas Photo Library

Contents

Background Document for Loggerhead turtle *Caretta caretta*

Executive Summary

This background document on the Loggerhead turtle (*Caretta caretta*) has been developed by OSPAR following the inclusion of this species on the OSPAR List of threatened and/or declining species and habitats (OSPAR other agreement 2008-6). The document provides a compilation of the reviews and assessments that have been prepared concerning this species since the agreement to include it in the OSPAR List in 2003. The original evaluation used to justify the inclusion of *C.caretta* in the OSPAR List is followed by an assessment of the most recent information on its status (distribution, population, condition) and key threats prepared during 2008-2009. Chapter 7 provides proposals for the actions and measures that could be taken to improve the conservation status of the species. In agreeing to the publication of this document, Contracting Parties have indicated the need to further review these proposals. Publication of this background document does not, therefore, imply any formal endorsement of these proposals by the OSPAR Commission. On the basis of the further review of these proposals, OSPAR will continue its work to ensure the protection of *C.caretta*, where necessary in cooperation with other competent organisations. This background document may be updated to reflect further developments or further information on the status of the species which becomes available.

Récapitulatif

Le présent document de fond sur la caouanne a été élaboré par OSPAR à la suite de l'inclusion de cette espèce dans la liste OSPAR des espèces et habitats menacés et/ou en déclin (Accord OSPAR 2008-6). Ce document comporte une compilation des revues et des évaluations concernant cette espèce qui ont été préparées depuis qu'il a été convenu de l'inclure dans la Liste OSPAR en 2003. L'évaluation d'origine permettant de justifier l'inclusion de la caouanne dans la Liste OSPAR est suivie d'une évaluation des informations les plus récentes sur son statut (distribution, population, condition) et des menaces clés, préparée en 2008-2009. Le chapitre 7 fournit des propositions d'actions et de mesures qui pourraient être prises afin d'améliorer l'état de conservation de l'espèce. En se mettant d'accord sur la publication de ce document, les Parties contractantes ont indiqué la nécessité de réviser de nouveau ces propositions. La publication de ce document ne signifie pas, par conséquent que la Commission OSPAR entérine ces propositions de manière formelle. A partir de la nouvelle révision de ces propositions, OSPAR poursuivra ses travaux afin de s'assurer de la protection de la caouanne, le cas échéant avec la coopération d'autres organisations compétentes. Ce document de fond pourra être actualisé pour tenir compte de nouvelles avancées ou de nouvelles informations qui deviendront disponibles sur l'état de l'espèce.

1. Background Information

Name of species

Caretta caretta Loggerhead turtle

2. Original Evaluation against the Texel-Faial selection criteria

List of OSPAR Regions and Dinter biogeographic zones where the species occurs

OSPAR Regions IV & V

Dinter biogeographic zones: Warm-temperate waters, Warm-temperate pelagic waters, Azores shelf, Lusitanean (Cold/Warm)

List of OSPAR Regions and Dinter biogeographic zones where the species is under threat and/or in decline

All where it occurs

Original evaluation against the Texel-Faial criteria for which the feature was included on the Initial OSPAR List

C.caretta was selected for inclusion on the OSPAR list on the basis of an evaluation of their status according to the Criteria for the Identification of Species and Habitats in need of Protection and their Method of Application (the Texel-Faial Criteria) (OSPAR 2003). The nomination for inclusion on the list cited the criteria decline and sensitivity, with information also provided on threat. It has been nominated for OSPAR Regions IV & V. Table 1 provides an update on this evaluation. The main threats to this species are linked to ingestion of anthropogenic debris and fishing by-catch.

Table 1: Summary assessment of *C.caretta* against the Texel-Faial criteria.

Criterion	Comments	Evaluation
Global importance	Loggerheads breed on NW Atlantic, Gulf of Mexico and Caribbean coasts. Apparently, the limit of distribution is waters of about 10°C; if they encounter colder waters, they may become stunned, drift helplessly and strand on nearby shores. Records are quoted from New England and eastern Canada, Labrador and Nova Scotia, especially between July and October of warm years. The northern limit of distribution is a summer capture of a live young turtle entangled in a fishing line off Murmansk, Barents Sea (68º 55'N). They are also the most common Mediterranean species with most nesting at sites in Lybia, Greece, Turkey and Tunisia. The majority of loggerhead turtles found in the OSPAR maritime area are thought to originate from NW Atlantic populations. After hatching, young turtles of about 5 cm carapace length swim offshore where the Gulf Stream/Azores current carries them to the eastern Atlantic, including the areas around the Azores, Madeira, and Canary Islands (Carr, 1986; Bolten *et al.*, 1998 in Santos, 2007)	Not likely to qualify
Regional importance	This species is known to occur in large numbers around the Azores and in the seas north of these islands, as well as along the Atlantic coast of southern Spain in late summer (Brongersma, 1995). Its occasional presence in Irish, British and French waters is considered a result of winter storms, where winds and currents overwhelm the swimming abilities of post-hatchling and mutilated loggerhead turtles, transporting them to habitats which cannot sustain them (Hays, 1997 in Bolten *et al.*, 2003). Spatially, there is an inverse relationship between number of records and latitude. Migratory fluxes of loggerhead turtles near and through the strait of Gibraltar has been reported in both directions. Thanks to this connection, the Atlantic and Mediterranean loggerhead populations share developmental habitats in	Not likely to qualify

	the western Mediterranean and in the northeastern Atlantic. There are no loggerhead nesting beaches in the OSPAR maritime area.	
Rarity	A highly mobile species, with a small total population size	Qualifies
Sensitivity	The loggerhead turtle is a long-lived, late-maturing (~20 years) animal with growth rates dependant on temperature, food quantity and food quality.	Qualifies – rated as Very Sensitive
Keystone species	Has no controlling influences on communities within the OSPAR region	Not applicable within OSPAR area
Decline	Detailed information on population sizes and trends is difficult to obtain and interpret, especially as loggerhead turtle can spend several years adrift in the North Atlantic. The most suitable index to marine turtle population stability remains the number of females nesting at a given rookery from year-to-year. Loggerhead turtle nesting populations are given to important natural inter-annual variations which make it difficult to assess trends in population size, unless studies are carried out over several decades. Nevertheless it is believed that there has been a historical decline in the numbers of loggerheads linked to anthropogenic impacts (OSPAR 2006a), and numbers of adults returning to breed at sites in Georgia, South Carolina and North Carolina for example, are in severe decline (Pierpoint, 2000). In the last 20 years, the Pacific nesting populations of loggerheads have suffered an 80–86% decline (Kamezaki *et al.* 2003).	Potentially threatened

Worldwide, this species is particularly susceptible to by-catch from shrimp trawlers; ingestion of marine debris, and predation on eggs. Bycatch and debris ingestion are considered to be the most important anthropogenic mortality factors known within the OSPAR maritime are. Ingestion of plastics and tar by sea turtles is common and is believed to contribute to their mortality.

Loggerhead hatchlings and juveniles are frequently associated with sea fronts (oceanic current convergences), downwellings and eddies, where floating epipelagic animals and floatsam are gathered. The elapsed time, usually more than a year - during which the small turtles remain in those places feeding and growing - is called the “lost year”. The duration of this oceanic phase is thought to be highly variable. Growth models suggest the oceanic phase from hatching to recruitment to neritic habitats may range between 6.5 and 11.5 years, with individuals attaining curved carapace lengths of 46–64 cm (Bjorndal *et al*. 2000).

During this first period of life there is evidence that these turtles lead a pelagic-nectonic existence, feeding on organisms usually associated with sargassum mats (Marquez, 1990).Young pelagic loggerheads seem to be especially susceptible to anthropogenic-debris ingestion, perhaps because loggerheads forage on novel items that stand out most against the backdrop of Sargassum and because floating plastics and tar concentrate within the downwellings inhabited by turtles (Barstow 1983 in Witherington 2002). This pelagic life-stage makes the loggerhead the species of hard-shelled turtle that is most susceptible to surface longline by-catch.

3. Current status of the species

Distribution in OSPAR maritime area

During their first years of life, North Atlantic loggerhead sea turtles inhabit extremely stochastic environments. The duration and path of the journey undertaken by loggerhead hatchlings from western Atlantic nesting beaches (principally eastern Florida) to eastern Atlantic foraging areas are determined largely by chance (Witherington, 2002). Hatchling loggerheads swim actively for the first

24h after entering the ocean and maintain a straight line course that will carry them away from shore. This “swimming frenzy” helps the hatchlings traverse the inshore waters, reach offshore currents, and become incorporated into the North Atlantic Gyre (Bjorndal, 2003). Younger age classes then spend several years associated with Sargassum drift lines, convergences, eddies and rings in the North Atlantic gyre (Pierpoint, 2000). In consequence juvenile loggerheads are commonly observed in OSPAR Region V (reported from around Madeira, the Canary Islands and especially the Azores). These turtles apparently originate in the Western Atlantic rookeries, from which hatchlings enter the Gulf Stream and are carried to these islands. These oceanic gyres and eddies are considered as feeding grounds and developing habitats, where the loggerheads reach the last juvenile stages (Marquez, 1990).

In contrast to *Dermochelys coriacea*, *C. caretta* strandings are more abundant in the winter than in the summer along Europe’s coastline. Figure 1 depicts loggerhead observations in OSPAR Regions III & IV, recorded via several national sightings schemes (www.strandings.com (UK and Republic of Ireland); www.cornwallwildlifetrust.org.uk (Cornwall & Devon Wildlife Trust, UK; www.aquarium-larochelle.com (France)). The coastal bias probably reflects the ‘distribution of observers rather than turtles’ as it is very probable that loggerheads occur further offshore. The vast majority of loggerhead turtles observed in these waters are cold-stunned juveniles recorded during the winter and spring, during or following periods of stormy weather. Both French and English researchers have noted that, when loggerhead turtles over 30 cm carapace width are stranded, the majority had their swimming ability impaired due to lesions and amputations resulting from either predation or entanglement with different types of fishing gears. This impeded movement is what causes them to be more affected by the currents (Penrose, pers.comm), and their presence in low water temperatures supports the North Atlantic Gyre-mediated dispersal mechanism theory, where individuals are shunted off towards Europe's coast after heavy storms. These results are taken as evidence that the presence of loggerheads in the temperate waters of OSPAR Regions III & IV results from the displacement of animals from their normal habitat by adverse current or weather conditions and that these areas do not constitute a viable part of the species range. This assessment will therefore focus on the threats and subsequent actions and measures encountered in the OSPAR Region V.

Population (current/trends/future prospects)

A study by Bowen *et al.* (2005) concludes that the complex life history of loggerhead turtles may include two homing migrations. Loggerhead turtles have two distinct juvenile stages, the first being an oceanic stage after hatching. For posthatchling turtles departing the nesting beaches of the western Atlantic, this oceanic habitat includes waters around the Azores and Madeira, and the Grand Banks (Newfoundland, Canada), as well as the Mediterranean Sea. Subsequent to the oceanic stage, which may span a decade, most older juveniles enter a neritic (benthic feeding) stage, in which they consume hard-shelled invertebrates in shallow habitats of the western Atlantic (Bolten 2003). Whereas the journey from nesting beaches to oceanic juvenile habitat is largely mediated by passive transport, the return trip may include active orientation and swimming (Bolten 2003).

All lines of evidence supported the hypothesis of juvenile homing in loggerhead turtles. While not as precise as the homing of breeding adults, this behaviour nonetheless places juvenile turtles in the vicinity of their natal nesting colonies. Therefore the coastal hazards that affect declining nesting populations may also affect the cohort of benthic-feeding turtles in nearby habitats. A study by Bowen et al. (2005) clearly illustrates how at each life history stage loggerhead turtles, due to their complex population structure, encounter different threats, different responsibilities, and different prospects (figure 2).

Condition (current/trends/future prospects)

The future prospects of highly-migratory species such as *C.caretta* are a function of a number of pressures worldwide. Population numbers in the OSPAR maritime area depend on nesting populations on both sides of the Atlantic Ocean, each with their share of anthropogenic impacts (egg harvesting, shrimp trawlers and gill nets to name a few of the most common).

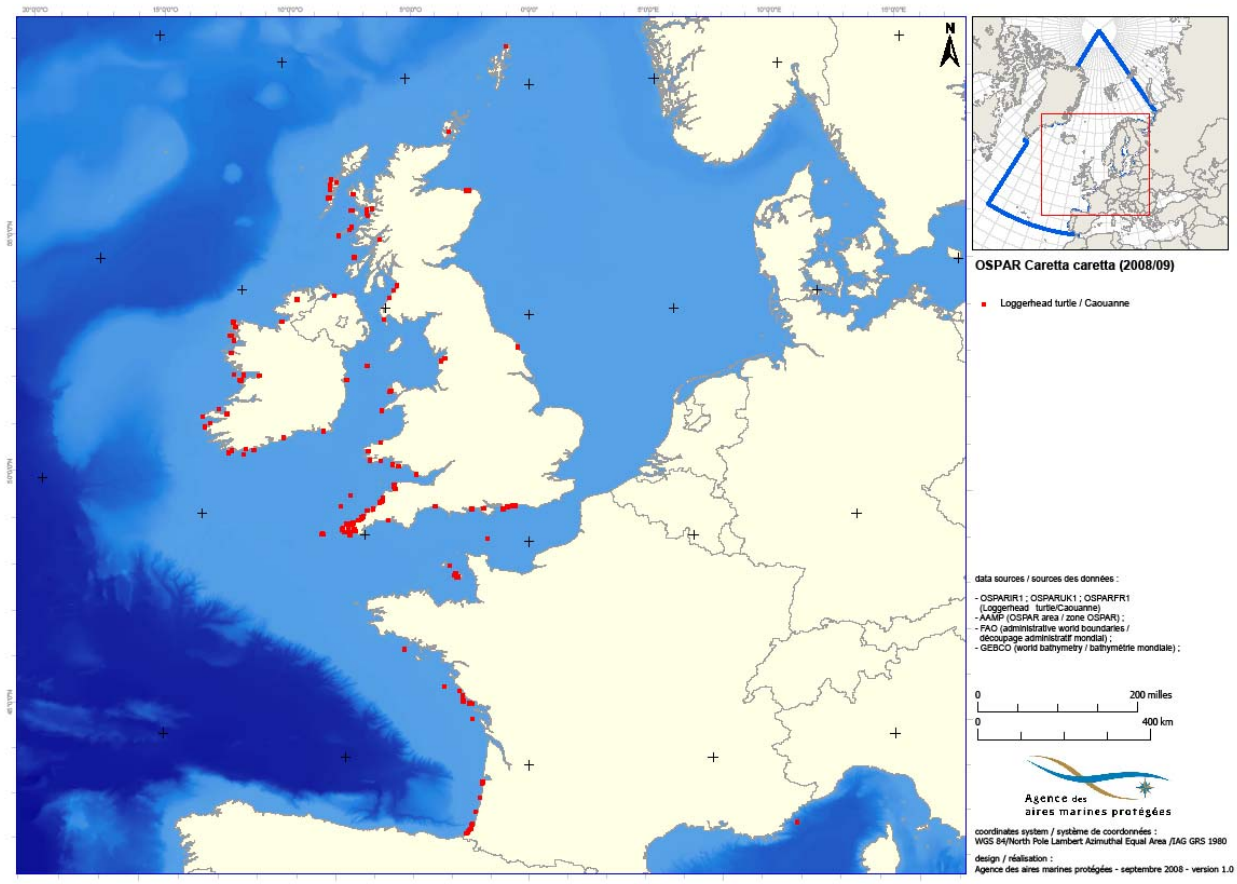


Figure 1: Loggerhead turtle sightings data made available across the OSPAR maritime area. Data sources: La Rochelle Aquarium (FR), 'TURTLE' database (UK & RoI), Cornwall & Devon Wildlife Trusts (UK)

Sea surface temperature is likely to be the factor determining the incidence of hard-shell turtles in the British Isles and France (Witt *et al.*, 2007). For the majority, sightings and strandings of loggerhead turtles in the North-east Atlantic increase during seasonally inclement water temperature (winter to spring). During this period sea surface temperatures around the British Isles are within the range reported to induce floatation (Schwartz 1978). It is widely predicted that sea surface temperatures will increase and storm surges become more frequent as a result of climate change, which may lead to increased accidental presence of juvenile and maimed sub-adult loggerhead turtles along the Atlantic coast of the OSPAR Region.

Of major concern is the development of long-line fisheries in the North-East Atlantic and Mediterranean in the last twenty years. The best estimates are that about 20 thousand loggerhead turtles a year are taken in these fisheries (Lewson *et al.*, 2004), and that between twenty-five and fifty percent of those turtles perish (Bowen, pers. comm.). With the twenty year generation time of loggerhead turtles, the impact of the bycatch has not been felt yet on the nesting beaches which are

currently the only means of assessing population size. If these numbers, which do not account for by-catch from IUU (illegal, unreported and unregulated) fishing are anywhere close to correct, it could lead to a catastrophic loss of breeding turtles.

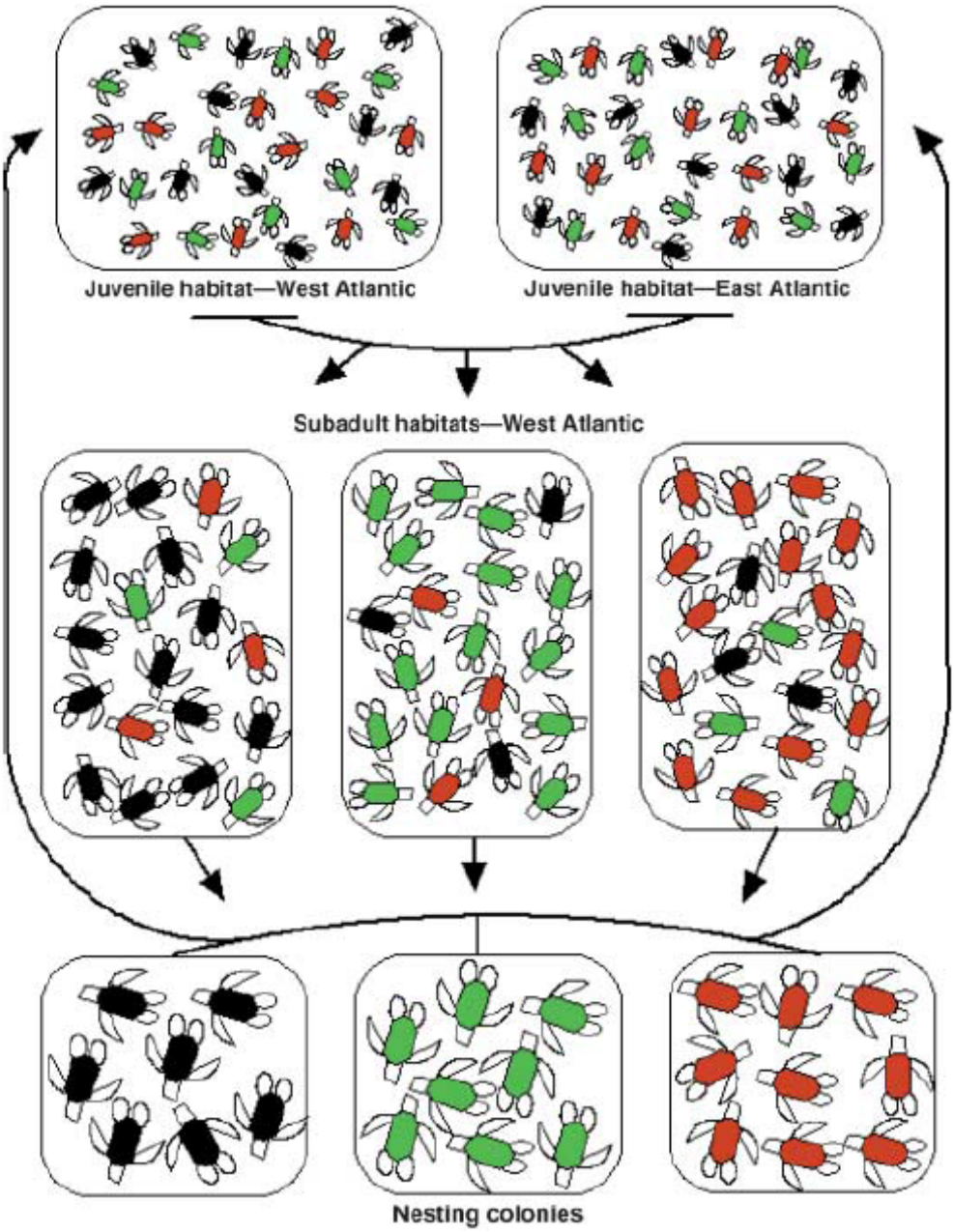


Figure 2: A study by Bowen *et al*. (2005) of the mtDNA haplotypes distribution of loggerhead turtles indicates three levels of population structure, corresponding to three life stages. This variability in genetic structure at different life stage illustrates the need for several different management regimes adapted to the loggerhead's complex population structure.

Limitations in knowledge

Research on nesting populations of loggerhead sea turtles has been focused on the beaches of the western Atlantic. Little is known about the African nesting populations the hatchlings of which are thought to also make their way into the North Atlantic Gyre.

Annual marine turtle sightings reported each year vary considerably. This is due in part to the efficiency of reporting networks, but the influence of biological factors (*e.g.* prey density) on their abundance is not yet well understood (Pierpoint, 2000). It is important to recognise the limitations of the data available on by-catch in OSPAR waters. The majority of both turtle sightings and strandings records are reported haphazardly via a number of informal networks. As a result it is difficult to ascertain whether occasional years of heavy depredation of loggerhead eggs and hatchlings is a normal or abnormal occurrence in a particular area, but it is believed that sustained levels of heavy predation on these early life stages can severely threaten loggerhead populations if, as a result of human induced mortality, the adults and larger juveniles are not experiencing their typically high natural survival (Crouse *et al.*, 1987 in OSPAR 2006a).

4. Evaluation of threats and impacts

A summary of the key activities which can cause impacts to *C. caretta* within the OSPAR Regions is given in Table 2. Worldwide, anthropogenic threats to which nesting populations are subjected also include: beach development/nesting habitat destruction; disorientation of hatchlings by beachfront lighting; directed take; nest destruction by beach vehicles; nest destruction by feral dogs; dredging.

In the waters beyond national jurisdiction in OSPAR Region V, approximately 150 active Japanese pelagic longline vessels operating over the wider Atlantic Ocean target species such as bluefin tuna *Thunnus thynnus* and bigeye tuna *Thunnus obesus* in the remaining regions (ICES 2008). The gear used has not changed recently and the longline systems used by these vessels are still labour intensive. Up to 50 km of 2500 hooks is shot and hauled per day. By-catch statistics for these fleets are inexistant.

In Azorean waters, most loggerheads are between 10 and 65 cm curved carapace length (Fig. 3) and are primarily epipelagic, spending 75% of their time in the top 5 m of the water column, but occasionally diving to over 200 m (Bolten *et al.* 2003). The fishery that targets swordfish, present around the Azores, sets hooks at depths of 5 – 50 m primarily baited with squid and mackerel. Both loggerheads and leatherbacks are captured on the baited hooks as well as entangled in lines. The largest size classes of loggerheads present in the eastern Atlantic are impacted by this fishery. Turtles are usually released alive by the longline fishermen, but in general the hook is left in the turtle. The fate of released turtles is not known.

Table 2. Summary of key threats and impacts to *C. caretta*

Cause of threat	Comment	Scale of threat
By-catch in long-line fishery	The pelagic life-stage makes the loggerhead the species of hard-shelled turtle that is most susceptible to surface longline bycatch. Aguilar *et al.* (1995), based on observations in captivity of turtles with internal hooks, estimated that 20 to 30% of sea turtles might die after being captured by the Spanish longline fishery. These mortality rates are difficult to extrapolate to turtles released back into the sea by the longline fishery. Data on the survival of sea turtles after being caught by a hook and released are needed for the estimate of the impact of the swordfish longline fishery (Ferreira *et al*., 2001). By-catch in other types of fishing gear such as fixed engine nets, trawlers, baited lines, and entanglement in pot and creel ropes can also occur. Many fisheries do not individually have much impact, but collectively contribute to a significant overall challenge to recovery.	High

Cause of threat	Comment	Scale of threat
Waste: litter and debris	A study by Witherington (2002) revealed that 20% of post-hatchling turtles had ingested tar, and 15% plastic debris, with consequences on their growth and agility. Loggerheads are unable to distinguish between plastic flotsam from their natural prey, and as a result often ingest them. Such elements frequently block the digestive tract of turtles	High
Pollution: oil/tar/chemicals	In their juvenile and sub-adult pelagic phases, loggerhead turtles are particularly sensitive to oil pollution, which has been observed in the mouth and stomachs of both size classes. The relationship between pollutants and alteration in *C. caretta* reproductive process as well as their hormonal system activity have been linked *inter alia* to the presence of industrial waste and pesticides. Heavy metals and PCB's have also been detected in turtles and eggs, but the effects on them are unknown (OSPAR, 2006b).	High
Uses: shipping Recreation: boating/yachting/water sports	In areas where recreational boating and ship traffic is intense, propeller and collision injuries are not uncommon. Marina and dock development leads to increased boat traffic, increasing the risk of turtle/vessel collisions.	Low
Climate change: Increase in sea temperature and storm surges	Oceanographic conditions added to some environmental factors often cause strandings, sometimes on a massive scale. Due to the fall of body temperature and diseases caused by bacteria and fungi infections the species loses its mobility (OSPAR, 2006b).	Low

The sizes of the loggerheads captured in the longline fishery are significantly larger than those of the general population in the waters around the Azores. The conservation implications of these results are serious as Crouse *et al.* (1987) reported these size classes as being the most important for the recovery of the North Atlantic loggerhead populations.

Evidence from the pelagic longline swordfish fishery in the Azorean Exclusive Economic Zone (EEZ) and from satellite telemetry suggests that seamounts may affect loggerhead turtle distribution. Seamounts appear to be important habitats for juvenile oceanic loggerhead turtles (Santos *et al*., 2007). More information on the ecological role of this habitat can be found in the parallel OSPAR background document on Seamounts (in press).

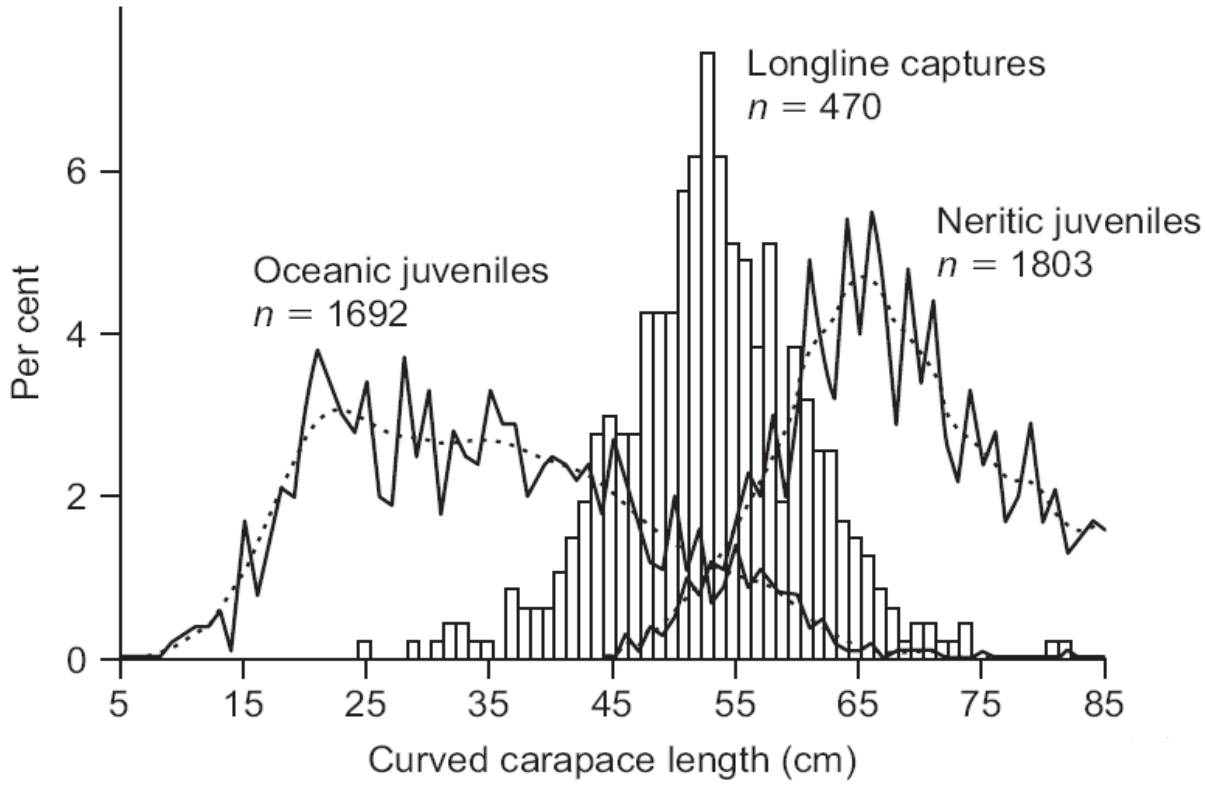


Figure 3 (Santos *et al.*, 2007): Size distributions of loggerhead turtles: left curves are oceanic loggerheads in Azorean waters;histogram shows loggerheads caught in longline fisheries in Azorean waters; right curves are neritic loggerheads in western Atlantic along east coast of USA (modified from Bolten et al. 2003)

5. Existing management measures

In OSPAR Regions III and IV a major development within the static net fisheries was the development and subsequent banning of a driftnet fishery for albacore tuna *Thunnus alalunga*. This fishery straddled the wider Atlantic region. This fishery developed in the early 1990s and at its peak involved around 120 Irish and French vessels working 5 – 10 km of gear in line with the UN Resolution 44/225 of 22 December 1989, which called for a moratorium on the use of large-scale driftnets to protect cetacean species. Following protracted negotiations this fishery was closed in 2002 on the basis of reported marine mammal by-catches. Following these measures, Irish and French fishers converted to other forms of fishing, including the use of pair pelagic trawls. Research trials with this method showed that by-catch of marine mammals and reptiles was as high as in the driftnet fisheries, although in later years this by-catch has reduced considerably. Anecdotally this has been put down to the fact that fishers have tended to drop the headline of these trawls to well below the surface to target bigger tuna (ICES 2008).

Surface longline fisheries for tunas, swordfish, and others often have a by-catch of sea turtle, pelagic sharks, and seabirds. ICCAT is currently engaged in assessing all of the fisheries that it manages to

determine the scale and significance of seabird by-catch. Management measures for loggerhead turtles could therefore be linked with those of the seabirds and pelagic sharks, notably the Porbeagle (*Lamna nasus*), featuring on the OSPAR List. Results from Baez (2005) imply that retrieving longline fishing gear before the morning, or at least reducing daylight soak time, could help diminish substantially loggerhead turtle by-catch, whilst not significantly affecting fish captures. Watson *et al.* (2005) and Gilman *et al.* (2006) already proposed this management measure, but based on inconclusive results.

It should be noted that *Caretta caretta* is indicated in Annex II of the Habitats Directive with an asterisk, meaning it is a priority species for which conservation requires the establishment of protected zones.The CMS report (Fretey, 2001) on the biogeography and conservation of marine turtles of the Atlantic Coast of Africa advises that the regional priority for conservation should essentially focus on the immature individuals in northern Macaronesia, *i.e* The Azores, Madeira & the Canary Islands. A programme to monitor demersal longline fisheries around the Azores placed three observers on board vessels in 2005–2007 over periods between 6 and 9 months. Surface longline fisheries for tunas, swordfish, and others often have a by-catch of sea turtle, pelagic sharks, and seabirds. ICCAT is currently engaged in assessing all of the fisheries that it manages in order to determine the scale and significance of seabird by-catch (ICES, 2008).

A number of programmes and workshops are underway or have taken place in the Azores over the last 10 years:

- A workshop to design an experiment to determine the effects of longline gear modification on Sea Turtle Bycatch Rates was held in Horta, Azores 2-4 September 1998. Funded by the National Marine Fisheries Service, USA. (Bolten *et al.* 2000) The experiment was initiated in 2000 and terminated in 2004, the results from Phase 1 and 2 were published in NOAA Tecnical Memorandum (Bolten *et al*. 2004), while the *Final Project Report* is available for download at the SEFSC/NOAA website (Bolten & Bjorndal 2005). During these experiments fishermen were informed of how to handle hooked turtles and made aware of turtle conservation in general.
- The POPA (Programme for Observation of the Fisheries in the Azores), which until now only observed the tuna fleet (www.horta.uac.pt/projectos/popa) – started recently a programme directed at the surface longline fishery operating in the Azorean EEZ. The objective of this programme is to monitor catches, by-catches and discards, including turtles. Observers also have a role in the education of the crew, showing best practices and offering tools for safe handling of hooked turtles.
- -Project MADE (Mitigating Adverse Ecological Impacts of Open Ocean Fisheries) (FP7), started May 2008, aims to devise mitigation strategies to open-ocean fisheries, focusing on by-catch species. Surface longline is one of the targeted fisheries, and spatial measures emerge as the main tool to be proposed. It is anticipated that marine turtles will be the subject of some of this research.
- Collaborative projects are currently underway in the Azores region between DOP/IMAR (Department of Oceanography and Fisheries at the University of the Azores, Horta and the Instituto do Mar, University of the Azores) and NOAA (past and present) using satellite telemetry to evaluate the post-release lethal and sub-lethal effects of deep-hooking on turtles.

6. Conclusion on overall status

The complex population structure of loggerhead turtles mandates a different management strategy at each life stage (Bowen *et al*., 2005). Disturbance to pelagic juveniles will have a diffuse impact on Atlantic nesting colonies, mortality of sub-adults will have a more focused impact on nearby breeding

populations, and disturbance to adults will have pinpoint impact on corresponding breeding populations. These findings demonstrate that surveys of multiple life stages are desirable to resolve management units in migratory marine species (Bowen *et al*., 2005).

Conservation efforts, which are often focused on eggs and nesting beaches, would be more effective if refocused to reduce by-catch. In a declining population, adult and large immature turtles make the greatest contribution to the survival of the population (Crouse *et al.,* 1987). Laurent *et al.* (1992) showed that the main factor affecting population growth rate for the Mediterranean loggerhead population is adult survival and considered fecundity to be less important. Thus, the reduction of natural or anthropogenic mortality of eggs is not sufficient as a conservation measure to assure the survival of the species. It is of high priority to concentrate efforts on the protection of large sub-adults and adults (Panout *et al.* 1995 in Ferreira *et al*. 2001).

One of the most promising advances in marine conservation is the development of marine protected areas (MPAs) on an ecosystem scale. Studies have confirmed the efficacy of MPAs for these ecological goals, but do not fully address the needs of migratory species. The genetic surveys of juvenile loggerhead turtles confirm suspected links between nesting colonies in the North-west Atlantic and distant feeding populations in the North-east Atlantic and Mediterranean Sea (Carr 1987; Bolten *et al*. 1998; Laurent *et al*. 1998). These ocean-wide connections raise doubts about protecting specific ecosystems as a comprehensive management option for loggerhead turtles and other migratory species (Bowen *et al.*, 2005).

In the case of migratory species, the solution is not ecosystem protection alone, but taxon-specific protection of vulnerable life stages (Bowen & Roman 2005). The specific management strategy will depend on the idiosyncratic life histories of the target species. In sea turtles this clearly includes nesting beaches and juvenile-feeding habitats, which in OSPAR Region V should focus on seamounts.

The discovery of the importance of seamounts for sea turtles raises the possibility of protecting these animals by establishing marine protected areas around seamounts which, combined with other fishery management options (*e.g*., gear modifications, line retrieval times, time/area closures) in these critical areas, would reduce incidental capture of turtles (Santos *et al.*, 2007).

7. Action to be taken by OSPAR

Action/measures that OSPAR could take, subject to OSPAR agreement

As set out in Article 4 of Annex V of the Convention, OSPAR has agreed that no programme or measure concerning a question relating to the management of fisheries shall be adopted under this Annex. However where the Commission considers that action is desirable in relation to such a question, it shall draw that question to the attention of the authority or international body competent for that question. Where action within the competence of the Commission is desirable to complement or support action by those authorities or bodies, the Commission shall endeavour to cooperate with them.

The loggerhead turtle's pan-oceanic movements and shallow diving are doubly disadvantageous, in that they both increase their interaction with longline fisheries. It is therefore crucial that new methodology and fishery management procedures be applied to reduce leatherback turtle bycatch (Hays *et al.,* 2004). In order to facilitate the implementation of international conservation measures, a greater understanding of the relative importance of the OSPAR maritime zone to marine turtles is needed. The establishment of a common, regularly updated and readily accessible database is a first step towards achieving this.

It is proposed that OSPAR should recommend that relevant Contracting Parties take into account the need for the protection of *Caretta caretta* in the development and application of fisheries policies and plans with a view to:

a. incorporating loggerhead turtles into existing systems of stranding response that are already in place for cetaceans (EC No 812/2004)

b. routinely recording the information provided by fishermen on fisheries inspection visits

c. encouraging voluntary reporting of turtle by-catch.

d. encouraging localised scientific efforts to pool their findings

OSPAR should require that Contracting Parties report back to the OSPAR Commission on the implementation of the above recommendations so that the development of the necessary measures can be evaluated. As a first step Contracting Parties should make an assessment of the effectiveness of the regulations they already have in place for the protection of *Caretta caretta*, consider how those regulations might be made more effective through improved monitoring, control and surveillance and report the results to the OSPAR Commission.

To complement these actions, the OSPAR Commission should:

a. communicate to the EC and other relevant fishing authorities the need for increased transparency in non-commercial by-catch statistics;

b. work with the EC to clarify conservation objectives in relation to fishing regulations

c. emphasise to relevant scientifc funding bodies the following research needs with respect to *Caretta caretta:*

(i). Further tracking of individuals using satellite telemetry will help address key questions regarding homing migrations, foraging behaviour, residence times, surface behaviour, and behavioural plasticity of the species.

(ii) Further monitoring in pelagic fisheries. Dedicated observers on ships of opportunity (ShOps) in conjunction with targeted aerial surveys and concerted 'coastal observatories' may provide an important tool for assessing leatherback abundance.

(iii) Further evaluation of fisheries impacts, as information on sea turtles and fisheries related mortality must be urgently collected.

(iv) Implement reliable data collection on fisheries/sea turtle interactions and other sources of mortality in order to enable quantitative risk assessments to be carried out; and where data collection exists, improve its quality, reliability and above all accessibility.

Table 3: Summary of the key priority actions and measures which could be taken for Loggerhead turtle (*Caretta caretta*). Where relevant, the OSPAR Commission should draw the need for action in relation to questions of fisheries management to the attention of the competent authorities. Where action within the competence of the Commission is desirable to complement or support action by those authorities or bodies, the Commission shall endeavour to cooperate with them

Key threats	Interactions with fisheries, especially pelagic longliners (overfishing, by-catch,) Loss of habitat Sea temperature Boat collisions Marine Pollution – debris and oil spills in particular
Other responsible authorities	UNCLOS, EU, FAO, NEAFC, NASCO, ICCAT, fishery authorities of non-EU countries
Already protected? Measures adequate?	Habitats & Species Directive Annex II & IV Bern Convention Annex II CMS Appendices I & II CITES Appendix I IUCN Red List EN (Endangered) A1abd EU LIFE/Interreg projects
Recommended OSPAR Actions and measures	**By the OSPAR Commission** • Ensuring policy coordination across agencies/authorities • Encourage contracting countries that are also EU Member States to make use of EC n°812/2004 to place observers aboard fishing vessels who monitor the bycatch of all non-commercial species, and include loggerhead turtles in the reporting • Work in partnership with RFMOs • Work with Contracting Parties and the European Commission to clarify conservation objectives and the links to management actions in MPAs particularly in relation to measures to regulate effects of fishing that compromise conservation objectives (ICES, 2008) • Support a regional sightings database • Increasing the number of MPAs focused on the conservation of loggerhead turtles, which would also provide protection and encompass a number of other OSPAR-listed species (sharks in particular) and the seamounts habitat • Continue to work in partnership with NGO's striving to reduce marine litter (eg KIMO International)

	By the Contracting Countries • Include loggerhead turtles into existing systems of stranding response for cetaceans • Increasing the collaboration between national Sea Turtle Strandings Networks • Support efforts to decrease plastic marine debris • Support marine turtle satellite-tracking research programs • Strengthen port-state control to reduce oil pollution from ships
	By the responsible authorities to whom the OSPAR Commission can make its concerns known • Recommend mitigation measures (i.e. reduced daylight soak time for longline gear) to appropriate fishing authorities • Record information provided by fishermen on routine fisheries inspection visits • Encourage voluntary reporting of turtle bycatch • Encourage the public availability of fishing boat, gear type and VMS data in order to correctly evaluate and situate accidental CPUE.

Brief Summary of proposed monitoring system (see annex 2)

It is strongly recommended that observer programmes be continued to monitor sea turtle by-catch rates, as capture rates may vary between years and between fishing boats.

Article 5(3) of the European Union Council Regulation EC n°812/2004, of 26.4.2004 laying down measures concerning incidental catches of cetaceans in fisheries and amending Regulation (EC) No 88/98, reads as follows:

> "Independent observations of fishing activities are essential to provide reliable estimates of the incidental catch of cetaceans. It is therefore necessary for monitoring schemes with independent on-board observers to be set up and for the designation of the fisheries where such monitoring should be given priority to be coordinated. In order to provide representative data on the fisheries concerned, the Member States should design and implement appropriate monitoring programmes for vessels flying their flag engaged in these fisheries. For small-sized fishing vessels less than 15 m overall length, which sometimes are unable to allow an additional person permanently on board as an observer, data on incidental catches of cetaceans should be collected through scientific studies or pilot projects. Common monitoring and reporting tasks also need to be set.
> The task of observers is to monitor incidental catches of cetaceans and to collect the data necessary to extrapolate the by-catch observed to the whole fishery concerned. In particular, the observers shall:
>
> (a) monitor the fishing operations of the vessels concerned and record the appropriate data on fishing effort (gear characteristics, location and timing of beginning and end of effective fishing operation)
>
> (b) monitor incidental catches of cetaceans.

> **Observers may also carry out such other observations, as may be determined by Member States, for the purposes of contributing to the scientific understanding of the catch composition of the vessels concerned and the biological status of fishery stocks.**"

This article is considered by researchers as being a key piece of EU environmental legislation, which can be used as a basis with which to justify the presence of observers on board shipping vessels who officially monitor all by-catch of marine mammals, reptiles and birds.

Annex 1: Overview of data and information provided by Contracting Parties

Contracting Party	Feature occurs in CP's Maritime Area	Contribution made to the assessment (e.g. data/information provided)	National reports References or weblinks
Belgium	N		
Denmark	N		
European Commission	Y		
France	Y	Y	http://www.aquarium-larochelle.com/index.php?id_page=63&id_site=1
Germany	N		
Iceland	N		
Ireland	Y	Y	www.strandings.com
Netherlands	N		
Norway	N		
Portugal	Y (Azores)		http://www.arquipelago.info/
Spain	Y	Y	http://www.mapa.es/fr/pesca/pags/sostenibilidad_p/tortugasypesca/reduccmortandad/estudio2.htm
Sweden	N		
UK	Y	Y	Pierpoint, C., 2000.Bycatch of marine turtles in UKand Irish waters. JNCC Report No 310. JNCC, Peterborough. http://www.jncc.gov.uk/page-2330 http://www.jncc.gov.uk/article17 www.strandings.com

The Loggerhead turtle was nominated for inclusion in the OSPAR List in 2001 in a joint submission from Iceland, Portugal, UK for OSPAR Area V and from Portugal for OSPAR Area IV. Contact persons for Portugal: Fátima Brito, Direcção Geral do Ambiente, Rua Murgueira-Zambujal, 2720-865 Amadora, Portugal and Ricardo Serrão Santos, DOP-Universidade dos Açores, Cais de Santa Cruz, 9901 862 Horta, Portugal.

Summaries of country-specific information provided

UK and Republic of Ireland: Data for these two countries are grouped together as they share a common database: Rod Penrose of Marine Environmental Monitoring, and Gabriel King in Ireland have painstakingly gathered records of turtle sightings from around Ireland and the UK that date back over 100 years.

In addition to European and international agreements, legislative coverage for loggerhead turtles in the UK is provided by the Conservation Regulations 1994 (Schedule II) and the Wildlife and Countryside Act 1981, as amended (Schedule 5). It is the oceanic stage of life that results in the greatest proportion of animals being recorded in UK and Irish waters (Witt *et al*, 2007). The average size for *C. caretta* recorded is approximately 30 cm (range 13.5 – 110 cm). By far, the majority are 'first-passage' turtles and their arrival is most likely mediated by North Atlantic current that flows adjacent to the continental shelf of Europe. While individuals have been reported every month of the year, the majority are found between November and March. At this time of the year, sea water temperatures are low and often below the threshold of 9.5 reported to induce floatation in this species (Schwartz 1978). Witt *et al.* (2007) found that the temperature distribution for *C. caretta* reported dead was significantly lower than the temperature distribution for those reported alive. Spatially, there is an inverse relationship between number of records and latitude and most sightings and strandings occur on west facing aspects. On the whole these results are taken as evidence that UK and Irish waters do not constitute a viable part of this species range.

France: Loggerhead turtles are only present in French waters as juveniles or sub-adults (3 – 7yrs of age). Research on marine turtles in the French territory has primarily been focused on the nesting populations of leatherback turtles in French Guiana, therefore the origins of the loggerhead turtles present are not fully understood, but are suspected to originate from the Cape Verde Islands and the West African coast. Inter-annual variation in loggerhead turtle strandings and sightings is linked to fluctuations in the intensity of the Portugal coastal counter current (P. Morinière, pers.comm.), suggesting loggerheads present along France's Atlantic coast first pass through African waters.

On 29 July 2008, a juvenile (8 kg) loggerhead turtle, "Antioche", was tagged with a satellite-linked transmitter and released after receiving specialist rehabilitative care for several months at la Rochelle aquarium. Contrary to expectations, Antioche did not immediately head for the North Atlantic Gyre but made her way up the coast of France. At the time of writing she had travelled 800 km and was located off the southern coast of Brittany. This is the first juvenile loggerhead turtle equipped with an Argos tag on Europe's Atlantic coast (http://www.seaturtle.org/tracking/index.shtml?project_id=297)

Portugal (Azores & Madeira): The Azores seem to be a regular transit area for young loggerhead turtles coming from SE United States and Mexico (Fretey, 2001). Between 1984 and 2004, the Department of Oceanography and Fisheries (DOP) of the Univerisity of Azores tagged 2672 turtles, 16 of which have been recaptured (Azores - 9, Nicaragua -1, North Carolina -2, Florida-2, Cuba-1, Morocco -1 Spain - 1, Sicily -1). A collaboration between the University of the Azores and the University of Florida equipped 6 turtles with a longline hook inside them and 12 without with satellite transmitters. The hooked turtles all followed the currents to the east, made shallower dives and stayed down longer.

From 1994 to 1997 the University of Madeira marked and measured a large number of juvenile loggerhead turtles. A "LIFE" project has identified the turtle's favoured zones within a radius of 200nm with the goal of creating a marine reserve protecting this pelagic stage. The archipelago includes six protected coastal areas. Another project (Praxis) began at the end of 1998, and established the population's feeding habitats and composition (skeletochronology, hormonal analysis) (Fretey, 2001). Loggerhead sea turtles begin to leave oceanic habitats around the Azores and recruit to neritic habitats at 7 years of age, at ~46 cm curved carapace length (Bjorndal *et al*., 2003). Mortality from

incidental capture in longline fisheries in the Azores does increase with size, with the 2 to 6 year age classes experiencing very little mortality (Bjorndal *et al*., 2003). The loggerhead also used to be collected for human consumption/ sale to tourists in the Azores and Madeira during the late 1960s-70s (Brongersma, 1995).

Spain: Hatchlings are found along the Atlantic coast of southern Spain in late summer, and are thought to stem from nesting beaches along the coast of Morocco.

The "Conservación y Recuperación de Animales Marinos (CRAM)" Foundation (http://www.cram.org) has a number of on-going loggerhead turtle research and awareness-raising programmes. One programme in particular, "Proyecto G", co-financed by the Ministerio de Medio Ambiente, Medio Rural y Marino, carried out a survey on the effectiveness of circle-hooks in reducing loggerhead by-catch on longline fishing vessels:

http://www.cram.org/index.php?page=doc_fix&id2=http://cram.org/redcms/index.php?p=docfix_preview&id2=73&ptit=Proyecto%20G&pop=1&taxn=251.

Annex 2: Description of proposed monitoring and assessment strategy

Rationale for the proposed monitoring

Serious data deficiencies in sea turtle fisheries interactions exist and it is recommended that information on sea turtles and fisheries related mortality must be urgently collected.

Use of existing monitoring programmes

Union Council Regulation EC n°812/2004 is a proposed legislative tool with which to place observers onboard national fishing fleets.

Synergies with monitoring of other species or habitats.

Other OSPAR species and habitats with which synergies could be made during monitoring programmes are as follows:

Species: pelagic sharks, sea birds and marine mammals.

Habitats: seamounts

A number of ship-based observation methodologies, usually devised for cetaceans but applicable to marine turtles, already exist. Techniques/approaches, percentage of fishing effort observed, monitoring locations, timing and frequency are very much dependent on the activities of national fishing fleets. Given the wide variety in fishing fleet size, gears, timing, frequency and size of area fished, it was not felt that a detailed description of the recommended monitoring and assessment strategy would be useful at this stage of the assessment.

Annex 3: References

Aguilar R., Mas J. and Pastor X., 1995. Impact of Spanish swordfish longline fisheries on the loggerhead sea turtle Caretta caretta population in the western Mediterranean. Pp. 1-6 in: J.I. Richardson & T.H. Richardson (Eds). *Proceedings of the Twelfth Annual Workshop on Sea Turtle Biology and Conservation*. NOAA Technical Memorandum NMFS-SEFSC-361. 274 pp.

Baez J.C., Raimundo, R., and Caminas, J. A., 2007. Differential distribution withing longline transects of loggerhead turtles and swordfish captured by the Spanish Mediterranean surface longline fishery. *Journal of the Marine Biological Association* **87**: 801-803.

Barstow S. F., 1983. The ecology of Langmuir circulation: a review. *Marine Environmental Research* **9**:211–236.

Bolten A.B, Martins H.R, Isidro E, Santos M.R, Ferreira R.L, Bettencourt E, Giga A, Cruz A, Bjorndal K, 2004. Experiment to evaluate gear modification on rates of sea turtle bycatch in the swordfish longline fishery in the Azores – Phase1 and Phase 2. In: Long KJ, Schroeder BA (eds) *Proceedings of the international technical expert workshop on marine turtle bycatch in longline fisheries.* NOAA Technical Memorandum NMFS-OPR-26: 139 -153.

Bolten, A.B., 2003a. Variation in sea turtle life history patterns: neritic vs. oceanic developmental stages. In: *The Biology of Sea Turtles* (eds. Lutz, P.L., Musick, J. and Wyneken, J.), Vol. II, pp. 243–57. CRC Press, Boca Raton.

Bolten, A.B,. 2003b. Active swimmers passive drifters: the oceanic juvenile stage of loggerheads in the Atlantic system. In: *Loggerhead Sea Turtles* (eds. Bolten A.B. and Witherington B.E.), pp. 63–78. Smithsonian Institution Press, Washington, DC.

Bolten A., Martins H., Isidro E., Ferreira R., Santos M., Bettencourt E., Giga A., Riewald B. and Bjorndal K., 2002. Preliminary Results of Experiments to Evaluate Effects of Hook Type on Sea Turtle Bycatch in the Swordfish Longline Fishery in the Azores. Azores Project Summary. 9pp.

Bolten, AB, Martins HR, Bjorndal KB (eds)., 2000. Workshop to design an experiment to determine the effects of longline gear modifications on sea turtle bycatch rates: Horta, Faial, Azores, Portugal, 2-4 September 1998. NOAA Technical Memorandum: 50pp.

Bowen B.W. and Roman J., 2005. Gaia's handmaidens: the Orlog model for conservation. *Conservation Biology* **19(4):** 1037-1043.

Bowen B.W., Bass A.L., Soares L. and Toonen R.J., 2005. Conservation implications of complex population structure: lessons from the loggerhead turtle (*Caretta caretta*). *Molecular Ecology* **14:** 2389-2402.

Bjorndal K.A., Bolten A.B., Dellinger T., Delgado C. and Martins H.R., 2003. Compensatory Growth in Oceanic Loggerhead Sea Turtles: Response to a Stochastic Environment. *Ecology* **84**: 1237-1249.

Bjorndal K. A., Bolten A.B., and Martins H.R., 2003. Estimates of survival probabilities for oceanic-stage loggerhead sea turtles (*Caretta caretta*) in the North Atlantic. *Fishery Bulletin* **101(4)**: 732-736.

Bowen B.W., Bass A.L., Chow S-M., Bostrom M., Bjorndal K.A., Bolten A.B., Okuyama T., Bolker B.M., Epperly S., LaCasella E., Shaver D., Dodd M., Hopkins-Murphy S.R., Musick J.A., Swingle M., Rankin-Baransky K., Teas W., Witzell W.N. and Dutton P.H., 2004. Natal homing in juvenile loggerhead turtles (*Caretta caretta*). *Molecular Ecology* **13**: 3797-3808.

Brongersma L., 1995.Marine Turtles of the Eastern Atlantic Ocean. In: Bjorndal, K.A. (Ed) (1995) Biology and Conservation SeaTurtles. Proceedings of the World Conference on Sea Turtle Conservation,Washington 26-30 November, 1979 with contributions on Recent Advances in SeaTurtle Biology and Conservation 1995.

Second Edition. Smithsonian Institute. Pp 407-416.

Carr A.F.,1987. New perspectives on the pelagic stage of sea turtle development. *Conservation Biology* **1**:103–121

Carr A.F., 1986 Rips, FADS, and little loggerheads. *Bioscience* **36**:92–100

Crouse D.T., Crowder L.B. & Caswell H. (1987). A stage-based population model for loggerhead sea turtles and implications for conservation. *Ecology* **68**: 1412-1423.

Eckert K. L., Bjorndal K.A., Abreu-Gobois F.A. and Donnelly, M., 1999. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4. 235pp.

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

Fretey J., 2001. Biogeography and Conservation of Marine Turtles on the Atlantic Coast of Africa/ Biogéographie et conservation des tortues marines de la côte atlantique de l'Afrique. CMS Technical Series Publication No6, UNEP/CMS Secretariat, Bonn, Germany, 429pp.

Gilman E., Zollet E., Berverly S., Nakano H., Davis K., Shiode D., Dalzell P. and Kinan I., 2006. Reducing sea turtle by-catch in pelagic longline fisheries. *Fish and Fisheries* **7:** 2-23.

Hays G.C and Marsg R., 1997. Estimating the age of juvenile loggerhead sea turtles in the North Atlantic.*Canadian Journal of Zoology* **75**: 40-46.

ICES, 2008a. New Advice. 1.5.5.9 Assessment of the impact of fisheries on the marine environment of the OSPAR maritime area. 78pp.

ICES, 2008b. Report of the Working Group on Ecosystem Regional Description (WGRED). ICES Document CM 2008/ACOM:47, 203 pp.

Kamezaki N., Matsuzawa K., Abe O., Asakawa H., Fujii T., Goto K., 2003. Loggerhead turtles nesting in Japan. In: Loggerhead Sea Turtles (eds Bolten, A.B. & Witherington, B.E.). Smithsonian Institution Press, Washington, DC, pp. 210–217.

Laurent L., Lescure J., Excoffier L., Bowen B., Domingo M., Hadjichristophorou M., Kornaraki L. and Trabuchet G., 1993. Genetic studies of relationships between the Mediterranean and Atlantic populations of loggerhead turtle Caretta caretta with a mitochondrial marker. Compte Rendu de l'Académie des Sciences de Paris, Life sciences 316: 1233-1239.

Laurent L, Clobert J. and Lescure J., 1992. The demographic modeling of the Mediterranean loggerhead sea turtle population: First results. Rapports et process verbaux des reunions - Commission international pour l'exploration de la mer Méditerranée. Monaco 33:300

Lewison R.L., Freeman S.A. and Crowder L.B., 2004. Quantifying the effects of fisheries on threatened species: the impact of pelagic longlines on loggerhead and leatherback sea turtles. Ecology Letters, 7: 221-231

Márquez M., R., 1990. FAO species catalogue. Vol.11: Sea turtles of the world. An annotated and illustrated catalogue of sea turtle species known to date. FAO Fisheries Synopsis No. 125, Vol. 11. Rome, FAO. 81 pp.

Mejuto J., García-Cortés B., and de la Serna J. M., 2002. Preliminary scientific estimations of bycatches landed by the Spanish surface longline fleet in 1999 in the Atlantic Ocean and Mediterranean Sea. ICCAT Collective Volume of Science Papers, SCRS/2001/049.

OSPAR, 2003. Criteria for the identification of species and habitats in need of protection and their method of application (the Texel-Faial Criteria). OSPAR Commission, London (Reference Number: 2003-13).

OSPAR, 2008 Case Reports for the Initial List of Threatened and/or Declining Species and Habitats in the OSPAR Maritime Area (OSPAR publication 2008/358)

Panou A., Voutsinas N. & Voutsinas V., 1995.Incidental catches of loggerhead turtles, Caretta caretta, in swordfish long lines in the Ionian Sea, Greece. Archipelagos - Marine and Coastal Management: 1-5.

Santos M.A., Bolten A.B., Martins H.R., Riewald B. and Bjorndal K.A., 2007. Air-breathing visitors to seamounts: sea turtles. In Pitcher T.J., Morato T., Hart P.J.B., Clark M.R., Haggan A. and Santos R. (Eds): Seamounts: Ecology Fisheries and Conservation (Fish & Aquatic Resources). University of Azores: Blackwell publishing: 239-243.

Schwartz F., 1978. Behavioural and tolerance responses to cold water temperature by three species of sea turtles (Reptilia, Cheloniidae) in North Carolina. Florida Marine Research Publication 33:16–18

Watson J.W., Epperly S.P., Shah A.K. and Foster D.G., 2005. Fishing methods to reduce sea turtle mortality associated with pelagic longlines. *Canadian Journal of Fisheries and Aquatic Sciences* **62**: 965-981.

Witt M., Penrose R. and Godley B. (2007) Spatio-temporal patterns of juvenile marine turtle occurrence in waters of the European continental shelf. *Marine Biology* **151(3):** 873-885(13).

Witherington B.E., 2002. Ecology of neonate loggerhead turtles inhabiting lines of downwelling near a Gulf Stream front. *Marine Biology* **140**:843–853.

OSPAR COMMISSION

New Court
48 Carey Street
London WC2A 2JQ
United Kingdom

t: +44 (0)20 7430 5200
f: +44 (0)20 7430 5225
e: secretariat@ospar.org
www.ospar.org

OSPAR's vision is of a healthy and diverse North-East Atlantic ecosystem

ISBN 978-1-906840-62-4
Publication Number: 422/2009