Regional Bycatch of Long-lived Species (Sea Birds, Marine Mammals, and Sea Turtles) in the Mediterranean and Black Seas

by

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The Mediterranean and Black Seas region includes twenty-two countries, three continents, and 26,000 kilometers of coast. About 80%, or 32,950 vessels, are less than 12 meters in length, and thus characterized as small-scale artisanal fisheries that include trawls, drift nets, purse seines, longlines, and gillnets. According to the IUCN Red List of threatened species, one seabird, 18 marine mammals, and four sea turtles are species of importance. The region provides important habitat for air-breathing marine vertebrates, many of which are imperiled, including the nearly extinct Mediterranean monk seal. Bottom and surface longline fishing in the region primarily cause seabird mortality. Dolphin populations have declined due to a variety of factors, including entanglement in gill nets. Various other mammals are critically endangered. Sea turtle bycatch mortality rates range from 10%-50% in a variety of fisheries. Thus, collaboration from the variety of Mediterranean countries will be required to reduce bycatch by fishers.

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Abstract

The Mediterranean region includes 22 countries, three continents, and 26,000 kilometers of coast. About 80%, or 32,950 vessels, are <12 meters in length, and thus characterized as small-scale artisanal fisheries that include trawls, drift nets, purse seines, longlines, and gillnets. The region provides important habitat for air-breathing marine vertebrates, many of which are imperiled, including the nearly extinct Mediterranean monk seal. Bottom and surface longline fishing in the region primarily cause seabird mortality. Dolphin populations have declined due to a variety of factors, including entanglement in gill nets. Various other mammals are critically endangered. Sea turtle bycatch mortality rates range from 10%-50% in a variety of fisheries. Thus, collaboration from the variety of Mediterranean countries will be required to reduce bycatch by fishers.

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Mediterranean and Black Seas Regional Assessment

I. Regional Overview

Twenty-six countries border the Mediterranean and Black Seas coastline (Payne 2004). Bycatch of long-lived species consists of sea birds, marine mammals, and sea turtles. This assessment focuses on marine mammals and sea turtles, as these taxa make up the majority of bycatch in this region.

Mediterranean fishing grounds are close to shore where biodiversity peaks. Key threats to the region are diminishing biodiversity and habitat damage (Communities 2002). Overall, far less information is available on the Eastern Mediterranean.

In Mediterranean fisheries, seabird mortality is primarily caused by bottom and surface longline fishing (Valeiras and Caminas 2003).

Various dolphin populations have declined due to accidental killings, destruction of habitat, pollution, and gill net fishing. Various other mammals are critically endangered, and the Mediterranean monk seal is nearly extinct (Mee 04 May 2004).

More than 60,000 sea turtles are caught annually due to Mediterranean fishing practices. The mortality rates are 10%-50% (Tudela 2000).

II. Study Area

Figure 1: The Mediterranean and Black Seas region (CIA 2007).

III. Habitat

Mediterranean

The Mediterranean's 26,000 kilometers of coast is characterized by temperate climate and remarkably high biodiversity. The inflow into the Mediterranean is nutrient-poor, oxygenated water from the Atlantic, which flows through the Strait of Gibraltar. The bottom waters are usually well oxygenated. The primary driving force is intensive fishing, followed by eutrophication (Office 17 October 2003). The southern coast of the Mediterranean is found to be primarily a downwelling area (Bakun 2001).

The continental shelf is narrow in this region. Territorial waters are close to coasts, and due to various political considerations, the Mediterranean does not have an Exclusive Economic Zone (EEZ) in place. Spain declared 49 miles of Fisheries Protection Zones, and Malta claimed 25 miles. In the Alboran Sea, Gulf of Lions, Northern Tyrrhenian Sea, Adriatic Sea, Ionian Sea, Aegean Sea,

the Sicily Strait, and the Gulf of Gabes the number of shared fisheries has increased (Communities 2002).

Historical wind observations from maritime weather reports are summarized to identify the characteristic seasonal distributions of wind-induced Ekman upwelling and downwelling in the Mediterranean Sea (Bakun 2001). Upwelling gyres are the source of high phytoplankton productivity in the Adriatic Sea. The Mediterranean overall is considered a low productivity ecosystem, (<150gC/m2-yr). Temperature stratification occurs with warmer, less saline surface water and colder, saline deeper water, ensuing autumnal algal blooms and extended hypoxia or anoxia(Office 2003).

Coastal pollution and eutrophication have been the principle threats to marine mega-fauna in the Adriatic Sea. Noxious phytoplankton blooms and anoxic conditions have killed fish in the northern Adriatic (Office 2003). Untreated sewage and increased toxic blooms result from anthropogenic activities. Fish kills have been caused by anoxia, a result of phytoplankton blooms and high numbers of benthic diatoms. Other major threats to the biodiversity include: uncontrolled development, urbanization and pollution, human sewage, and agriculture. These sources enter the Mediterranean through runoff, discharge, and river transport (Office 2003).

Black Sea

The Black Sea Large Marine Ecosystem (LME) is 330 miles North to South, 630 miles East to West, surrounded by six countries (Romania, Bulgaria, Turkey, Georgia, Ukraine, Russia) and known for a temperate climate. The Black Sea opens to the Mediterranean Sea through the Turkish Straights and receives fresh water from rivers (the Danube, Kuban, Don, Dniestr, and Dniepr Rivers)(Mee 2004).

Ecosystem threats in the Black Sea are eutrophication and intensive fishing. This is a highly productive region (>300gC/m^2) influenced greatly by river runoff and scarce exchange with the Mediterranean Sea. Eutropication is accelerated from extreme nitrogen loading from pollution, which has lead to increased beach closures, litter, and decreased transparency of the water (Mee 2004).

The Black Sea has a narrow continental shelf as well as a large drainage basin. Clupeoids (sardines, anchovies, and herrings) are the most important species in shelf catches. The Black Sea reaches over 2,200 meters in depth. Below 250-300 meters, oxygen is virtually non-existent. This region is home to the world's largest volume of anoxic water, with 90% anoxia (Mee 2004).

IV. Seabird, marine mammal, sea turtle taxa, occurrence, and populations

Table 1. Seabird (B), marine mammal (M), and sea turtle (T) species that occur in the Mediterranean and Black Seas region and IUCN Red List status (CR=critically endangered, EN=endangered, VU=vulnerable, NT=near threatened, LR=lower risk, DD=data deficient) (IUCN Red List). Assessment of bycatch threats to each species and the gear type(s) with which each species most commonly interacts.

Taxa	Species	Common Name	IUCN Status	Bycatch Major Threat
B	*Puffinus mauretanicus*	BALEARIC SHEARWATER	CR	Hooking (long lines)
M	*Balaenoptera acutorostrata*	MINKE WHALE	LR	Netting, Entanglement
M	*Balaenoptera borealis*	SEI WHALE	EN	--
M	*Balaenoptera physalus*	FIN WHALE	EN	Collision
M	*Delphinus delphis*	SHORT-BEAKED COMMON DOLPHIN	LR	n/a
M	*Feresa attenuata*	PYGMY KILLER WHALE	DD	n/a
M	*Globicephala macrorhynchus*	SHORT-FINNED PILOT WHALE	LR	Netting, Entanglement
M	*Globicephala melas*	LONG-FINNED PILOT WHALE	LR	n/a
M	*Megaptera novaeangliae*	HUMPBACK WHALE	VU	Collision, Entanglement
M	*Mesoplodon densirostris*	BLAINVILLE'S BEAKED WHALE	DD	Netting, Entanglement
M	*Monachus monachus*	MEDITERRANEAN MONK SEAL	CR	--
M	*Orcinus orca*	KILLER WHALE	LR	--
M	*Phocoena phocoena*	HARBOR PORPOISE	VU	Netting, Entanglement
M	*Physeter macrocephalus*	SPERM WHALE	VU	Netting, Entanglement
M	*Pseudorca crassidens*	FALSE KILLER WHALE	LR	n/a
M	*Stenella coeruleoalba*	STRIPED DOLPHIN	LR	Netting
M	*Steno bredanensis*	ROUGH-TOOTHED DOLPHIN	DD	Netting, Entanglement

M	*Tursiops truncatus*	BOTTLENOSE DOLPHIN	DD	Netting, Entanglement
M	*Ziphius cavirostris*	CUVIER'S BEAKED WHALE	DD	Netting, Entanglement

T	*Caretta caretta*	LOGGERHEAD	EN	n/a
T	*Chelonia mydas*	GREEN TURTLE	EN	Fisheries-related
T	*Dermochelys coriacea*	LEATHERBACK	CR	Netting
T	*Eretmochelys imbricata*	HAWKSBILL TURTLE	CR	n/a

Seabirds

Balearic Shearwater

Mortality occurs largely due to accidental captures, particularly from unselective fishing methods (Tudela 2000). The Action Plans designed by BirdLife International, approved by the Ornis Committee (EU DG Environment) and endorsed by the Bern Convention Standing Committee, covers three Mediterranean specific seabird species: Audouin's gull (*Larus audouinii*), the Balearic shearwater (*Puffinus mauretanicus*) and the Mediterranean shag (*Phalacrocorax aristotelis desmaresti*). Protection of the Balearic shearwater is of utmost importance as it is listed on the IUCN Red List of Endangered Species (Tudela 2000).

According to the IUCN Red List, the Balearic Shearwater is the only threatened or endangered seabird greatly affected by fisheries in the region. If the population continues to decline at the current rate, population models predict an 80-98% decline of the species within three generations. (IUCN Species Survival Commission 1994; International 2004).

The Balearic Shearwater has both a small population (1,650 breeding pairs), and a small breeding range (less than 100 square-km) that is limited to the Balearic Islands of Spain (International 2004). Balearic Shearwaters are also found on the Atlantic, Galician, and Cantabrian coasts (Mourino).

The Balearic Shearwaters are the rarest Mediterranean seabird and their biology is not well studied (Arcos 2002). In 1991, there were 3,300 breeding pairs of Balearic Shearwaters, and presently the population has drastically declined to less than half.

Audouin's Gull

While not listed on the IUCN list, in 2004, the Audouin's Gull was estimated to have 18,000-19,000 breeding pairs. The population increased significantly

between 1970 and 1990, but now the species suffers a localized threat. The overall 2004 Pan-European Conservation Status and the EU25 Conservation status both ranked the condition of the Audouin's Gull as unfavorable (BirdLife 2004). The Greek Red Book of Threatened Vertebrates lists the Audouin's gull as endangered (Portolou 2000).

The Audouin's Gull population is concentrated (90%) in Spain. The threats to this species include changes in fishing practices and alteration of breeding habitats. Audouin's Gulls are also known to occur in Greece, Italy, and Turkey (Gallo-Orsi 2001, Portolou 2000), and in Morocco, Tunisia, France, Algeria and Cyprus. Specifically, gulls are affected by the decline of fish stocks and drowning in fishing gear. Few areas Audouin's Gulls exist are protected. The two "Monk Seal Protection Areas" in Turkey also serves the gulls (Portolou 2000).

Their breeding population is endemic to the Mediterranean basin and feeds primarily on sardines, squid, and anchovies (Castilla 1995). These seabirds also feed on small surface-fish (Portolou 2000).

Marine Mammals

The IUCN lists the following threatened or endangered marine mammal species at high risk of bycatch: sei whale, fin whale, humpback whale, Mediterranean monk seal, harbor porpoise, and sperm whale. The following species are "data deficient," thus their status cannot be determined: pygmy killer whale, Blainville's beaked whale, rough toothed dolphin, bottlenose dolphin, and Cuvier's beaked whale (IUCN Species Survival Commission 1994).

Historically, Mediterranean small-scale commercial fisheries have had interactions with the bottlenose dolphin, the short-beaked common dolphin, and the Mediterranean monk seal (Reeves 2001). The Mediterranean monk seal is critically endangered and has had a decreasing population since 1965 (IUCN Species Survival Commission 1994). The bottlenose dolphin and the short-beaked common dolphin are two species that are abundant worldwide, however the Mediterranean populations are believed to be isolated from the Atlantic Ocean populations (Reeves 2001).

Cetaceans

Cetacean diversity and abundance are higher in the Western Basin (Tudela 2000). Regarding marine mammals, the Agreement on the Conservation of Cetaceans of the Black and Mediterranean Seas (ACCOBAMS) has concluded that the species of primary importance in the Black Sea include the sperm whale, long-finned pilot whale, striped dolphin, and harbor porpoises. In both the Mediterranean and Black Seas, the marine mammal species of secondary concern include bottlenose dolphins and short-beaked common dolphins. There

is insufficient information about Cuvier's beaked whales and harbor porpoises in the Mediterranean to determine known or presumed impacts. The fin whale was also researched, but the impacts of fishing were likely insignificant (Notarbartolo di Sciara 2006).

Through the 1950's, an average of 200,000 dolphins were taken each year from the Black Sea. The dolphin population was estimated to be 800,000 individuals. In 1966, after the number of dolphins drastically declined, dolphin fishing was banned in the Black Sea.

The Mediterranean and Black Seas are home to twenty-four cetacean species, some species that live in the region year-round and some migratory. The Black Sea is home to only four species: short-beaked common dolphin, harbor porpoise, bottlenose dolphin, and only rarely the Minke whale. The Mediterranean Sea is home to the fin whale, short-beaked common dolphin, long-finned pilot whale, Risso's dolphin, orca, harbor porpoise, sperm whale, striped dolphin, bottlenose dolphin, Cuvier's beaked whale, minke whale, humpback whale, and false killer whale, along with a number of visitor and vagrant species (Giuseppe Notarbartolo di Sciara 2006).

The striped dolphin is the most abundant cetacean species in the western Mediterranean. In 1991, an estimated population of 117,880 was reported. The Ligurian Sea, Provenzal Basin, and Alboran Sea, particularly near the Strait of Gibraltar, hold significant populations of the striped dolphin(Tudela 2000).

The Contrary to its name, the common dolphin is currently rare in the Mediterranean. From 1991-1992, population estimates were 14,736 individuals. The largest remaining population is located in the Alboran Sea. Morocco and Algeria are important areas for the common dolphin(Tudela 2000).

Harbor porpoises (*Phocoena phocoena)* are rare in the Mediterranean, and their population surrounding the Black Sea has declined to the verge of extinction. Harbor porpoises are sporadically present in North African waters(Tudela 2000).

Fin whales in the Mediterranean are most commonly found in the Ligurian-Provenzal Basin. In 1992, the population was estimated at 1,012 individuals (Tudela 2000). It is estimated that a few hundred sperm whales are still found in the Mediterranean.

Mediterranean Monk Seals

Since 1966, the Mediterranean monk seal (*Monachus monachus*) has been listed as critically endangered. They are the sixth most threatened mammal in the world, whose population is limited to 300-500 individuals (Tudela 2000, FAO 2.4, Dendrinos 1999; Ali Cemal Gucu 2004). Local extinction has occurred for this

species in the Black Sea and Croatia (UNEP 31 2004; Johnson). While monk seals live 20-30 years in the wild, and reach sexual maturity between 5-6 years, additional scientific research about the species is critical for future conservation goals (Johnson, 2007).

In Greece, from 2003-2004, 16 monk seal births were recorded in three study areas (UNEP 31 March-3 April 2004). In Turkey, nine new pups were recorded, with the population total then growing to 24 individuals (Ali Cemal Gucu 2004). Today the Mediterranean monk seal habitat is patchy and fragmented. The majority of Mediterranean monk seals now live in the Eastern Mediterranean and the Mauritian coast, while some, though declining, have been spotted occasionally in Cyprus (Dendrinos 1999). At least one Mediterranean monk seal was observed at Cape Yeronissos, Ayia Napa, Limassol, Cape Gata, and Polis Dasoudi in 1998 (Dendrinos 1999).

Sea Turtles

The following four sea turtle species are critically endangered or endangered and affected by fisheries-related mortality: Loggerhead (*Caretta caretta*), Green (*Chelonia mydas*), Leatherback (*Dermochelys coriacea*), and Hawksbill turtles (*Eretmochlys imbricata*) (IUCN Species Survival Commission 1994). Loggerhead turtles are the most abundant sea turtles species in the Mediterranean, followed by green and leatherback turtles (Casale, Mazaris et al. 2007). Partial isolation between the Mediterranean and Atlantic loggerhead females is genetically supported (Casale, Mazaris *et al.* 2007).

Sea turtles are long-lived and have a high mortality rate in the first period of life as hatchlings and early juveniles and a long immature phase. However,But sea turtles usually have a high probability of survival in the adult phase (Casale, Mazaris et al. 2007). While most turtles do not breed every year, both loggerhead (2,000 annually) and green turtles (300-400 annually) nest on Mediterranean beaches (Tudela 2000). Green sea turtles nest on few beaches. Approximately 350 to 1,750 clutches are laid per year. Broderick *et al.* found 2.9-3.1 green turtle clutches per female, per season. They also estimate 2,280-2,787 loggerheads nesting each year in the Mediterranean waters (Caminas 2005). Nesting and neritic (part of the sea over the continental shelf <200m deep), habitats are essentially constrained to the Eastern Mediterranean (Casale, Mazaris et al. 2007)

Green turtles reach sexual maturity at approximately thirty years. Green turtle nesting in the Central and Western Mediterranean has not been confirmed, as of 2005. The population is at risk of collapse because the recruitment rates are likely lower than the number of fishing-related deaths (Caminas 2005).

Green turtles are known to nest in Turkey and Cyrpus. Loggerheads are more abundant and nest in Turkey, Cyprus, Egypt, Greece, Israel, Italy, Lebanon,

Libya, Syria, and Tunisia. Leatherbacks are distributed across the region as well as occasional Kemp's Ridley turtles (Caminas 2005).

There are turtle nesting sites in Greece, Turkey and Cyprus, and the Libyan coast may be an important nesting site specifically for loggerheads, (Gerosa and Casale 1999). Green turtles are reported to nest only in Turkey and sporadically in Israel. Groombridge (Reeves 2001) reported the annual nesting population of green turtles to be as few as 300-400 females in the entire Mediterranean. However, this population is not deemed functionally independent of the Atlantic population (Godley 1998).

The endangered sub-tropical Nile soft-shelled turtle (*Tryonix triunguis*), which is not strictly marine, lives in the Eastern Mediterranean coastal wetlands. Because their populations are extremely low, additional protection for this species was recommended by the Bern Convention of European Wildlife and Natural Habitats. Fishermen catch the Nile soft-shelled turtles and deliberately kill them, according to fishermen in the Karatas harbor (Tudela 2000).

V. FISHERIES

Approximately 80% of Mediterranean vessels (or 32,950 vessels) are smaller than 12 meters in length. Thus, the fleet is characterized as a small-scale artisinalartisanal fishery. However, larger, non-artisinalartisanal vessels take much of the catch. Furthermore, the number of landings and the diversity of catches quantify constitute the economic value of catches. Small quantities of valuable small size and short-lived species can yield a higher price for the catch. Different gear types (e.g.., trawler, seines, small-scale fishing) catching that catch the same species are common in this area (Communities 2002).

The FAO reports a stable 10-year capture trend (1990-1999). A moderate increase in shelf catch has occurred (less than 1 million tons in 1990, to 1.1 million tons in 1999). Clupeoids, such as herrings, anchovies and sardines make up 28% of the catch, thus the mostconstituting important species in the region.

Technological improvements in the fishing fleet and fishing capabilities have resulted in a decline in catch rate per boat. High fish prices have subsequently increased the fishing effort. Fisheries production has increases increased in many areas, as it is a source of economic importance (Office 2003).

Black Sea catch trends have been irregular, with a peak of nearly 600,000 tons (1995), and an average catch of 500,000 tons annually. Uncontrolled fisheries and eutrophication have altered the structure and dynamicdynamics of the Black Sea. In the 1970's, most of the resources were fished close to Maximum Sustainable Yield. As Caddy (1993) established, landings of turbot, pelagics, and anadromous species (e.g. sturgeon) have declines declined recently, and the anchovy fishery has collapsed locally (Mee 2004).

Vessel data was were submitted by Albania, the European Community (Cyrpus, France, Greece, Italy, Malta, Portugal, and Spain), Greece, Italy, Lebanon, Malta, Spain, Tunisia, and Turkey to the GFCM (General 2006). The GCFM white list database lists 6,969 reported vessels reported (General 2006). Approximately half of the vessels are 18 meters to 24 meters (mid-size); the remaining are less than 18 meters (small) or more than 24 meters (large). Most gear of the fleets is trawlsTrawls predominate in these fleets (General 2006). One study sampled 31 ports in the Western western and Central central Mediterranean, namely Spain and Italy, to record number of [trawl] hauls, towing duration, and fishing locations. The Italian fleet had 332 vessels in the study area, and Spain had 143 vessels (Sarda 2000).

Italy (Adriatic) has the most trawlers; and Italian (Tyrrhenian) waters has also have the most longest liners. ; Greece leads with the largest total fleet (~21,000 vessels); Greece and has the most gill nets. ; and Greece and France tie for total fleets with highest gross registered tonnes (~115,000 each) (Gerosa and Casale 1999). In 1999, the Italian trawl fishing fleet "consisted" of 584 bottom trawlers, 115 midwater trawlers, and 1,051 vessels using more than one gear type. (IREPA 2001, Lazar 1995).

Multi-species fisheries in the Tyrrhenian Sea are known to catch a wide range of species. Conversely, the Western western Mediterranean consists of virtually mono-specific fisheries (Sarda 2000). The Black Sea Turbot (*Psetta maxima* and *P. maxima maeotica*) is one of the most valuable commercial species in the Black Sea. The turbot fishery opens in April and ends the last week of June. The fisheries utilize use 160-200mm mesh for the bottom gill nets. There are 185 boats operating 19,000 bottom gill nets from six ports in western Turkey (Oztürk 2001).

Fishing along the coast of Georgia is accomplished by the use primarily consists of passive gear, such as traps, beach-seines, and gillnets 5-20m long, along with mid-water trawls on the sea bed (Payne 2004).

While pelagic driftnets were banned in the EU in January 2002, non-EU countries are increasingly using this gear. in the Mediterranean. The Moroccan Mediterranean driftnet fleet had 177 active boats in a recent study. Most of these boats use driftnets year- round, inducing producing large amounts of bycatch (Caminas 2004).

Long line daily catch rates of longlines vessel's daily catch rates have decreased significantly over the decades, in lieu of more powerful and efficient fishing vessels. Long life-span-lived and larger species and bigger species have nearly disappeared from demersal fishing and in other areas. Anchovy in Northern northern Spain is in risk danger of collapse. Black spots seabream in the Alboran Sea, and hake in the Gulf of Lions are also at risk of collapse. Illegal

trawls fish due to poorPoor enforcement of regulations. has allowed illegal trawl fishing to occur. These trawl fisheries have reduced the “refuge” effect, by fishing the shallow, coastal areas (less than 50 meters; less than 3 miles from coast). Fishing effort and use of small mesh sizes in towed gears harvest all life spans stages of species, thus defying sustainablewhich thwart sustainability or long-term profitability of fisheries (Communities 2002).

Table 2: Number of Vessels and Fishing Gear Type (General 2006).

Fishing Gear Class	#	% of Total
Trawls	2920	41.90%
Not Specified	2036	29.22%
Surrounding Nets	1613	23.15%
Hooks and Lines	214	3.07%
Dredges	105	1.51%
Gillnets and Entangling Nets	70	1.00%
Seine Nets	9	0.13%
Traps	2	0.03%
TOTAL:	6969	--

As illustrated in the table above, nearly 42% of the vessels used trawls, with surrounding nets used on approximately 23% of vessels. However, 29% of gear classes were “not specified.” There are many illegal fishers in the region that have not been investigated for fishing effort or bycatch (General 2006).

The International Commission for the Conservation of Atlantic Tunas (ICCAT) is mainly concerned with the bluefin tuna, albacore, swordfish, dolphinfish, and three species of shark (Payne 2004).

According to a 2001 FAO report, 36% of landings in the Mediterranean were the demersal group of fishes, 52% small pelagics, 8% medium-sized pelagics, and 4% large pelagics the majority of landings in the Mediterranean (52%) were of small pelagics. The remaining were of demersal fish (36%), mid-sized pelagics (8%), and large pelagics (4%) (Payne 2004).

According to a 2002 report by the Subcommittee of Stock Assessment for General Fisheries Commission for the Mediterranean (SAC-GFCM), the Mediterranean shared stocks include the following species: Hake, Anchovy, Sardine, Sprat hake, anchovy, sardine, sprat, Red red mullet, Blue blue whiting, Norway lobster, Bluefin bluefin tuna, Swordfish, Albacore, Dolphinfish, swordfish, albacore, and dolphinfish. Small pelagics (Anchovy, Sardine, Sardinella, Sprat, anchovy, sardine, sardinella, sprat) dominate the region, consisting constituting of over 50% of landings by weight (Payne 2004). The gear used for small-pelagic catches primarily are largely purse-seines and pelagic trawls with a mesh size of 20mm in most countries (Payne 2004).

Each year, an estimated 2.3 million pelagic longline hooks and 1.8 million bottom longline hooks are set in the Mediterranean (Belda and Sanchez 2001). The Spanish trawlers fleet numbers 1,175, while the number of purse seines is unreported, but understood believed to be lower (Lostado i Bojó 1997).

Countries with deep-sea shrimp fisheries include Spain, Italy, Tunisia, Morocco, and Algeria. Two species of deep sea shrimps are targeted in the region. The two species, rose shrimp and red shrimp (*A. antennatus* and *A. foliacea,* respectively) yield approximately 50 kg/day. *A. antennatus* is more frequently caught in the westernmost Mediterranean, yet the Eastern eastern Mediterranean has both species (Sarda 2000). The number of shrimpers versus total trawlers was recorded. In Spain and Italy, numbers of shrimp trawlers varied from 7% to 73%. In the Tunisian and Moroccan ports sampled, 100% of trawl activity was from shrimpers (Sarda 2000).

Sea Turtles: Opportunistic Takes

The presence of turtles constitutes a hindrance to normal fishing activities when. When on the boat, they are also seen as bad luck in some Italian areas and Albania, and are rarely recognized as an endangered species (Gerosa and Casale 1999).

Turtles caught and found stranded are often killed due to fishermen ignorance or prejudice. In Albania, sea turtles have been reported killed and made into feed for pigs and chickens. If fishermen keep turtles for personal or commercial use, this may signify 100% mortality. Some turtles are killed and eaten on board Greek and Italian vessels; particularly when foreign crews that consider turtles a delicacy. Other traditions include consuming the meat and blood of turtles, and using the ornamental use of the carapace for ornamentation. In Egypt, thousands of turtles are believed to be killed each year. The demand and the black market raises the value of turtles, allowing fishermen to use illegal profits for income. This is complicated to control because most interactions takes are in secret or between friends (Gerosa and Casale 1999).

V. BYCATCH OF SEA BIRDS, MARINE MAMMALS AND SEA TURTLES

Bycatch is often defined as any unintentional catch.

Table 3. Number of species affected by specific gear types used by ICCAT area tuna fisheries.

# species affected (total species in region recorded)	LONG LINE	GILL NET	PURSE SEINE	HARPOON	TRAP	HANDLINE/ RECREATIONAL
Sea Turtles (4)	3	4	4	2	1	1
Marine Mammals (16)	5	11	11	5	5	0

Note: The Balearic Shearwater was not included in the recorded data, thus there is no table for seabird bycatch from this ICCAT data.

Sea Bird Bycatch

A study on the Columbretes colony found a strong relationship between gulls and fishing boats. It is suggested that the gulls in the northern Mediterranean (Delta del Ebro) depend heavily on fishing offal and in the absence of that resource, reproductive output would decrease (Castilla 1995). In addition, Castella (1995) reported that commercial fishery modification has negatively affected the reproductive output of sea birds (Castilla 1995).

Balearic Shearwaters are gregarious birds that can be attracted fishing boats, which can make them susceptible to bycatch (International 2004). However, information on Balearic Shearwater biology (Arcos 2002) and mortality rates are is lacking (Belda and Sanchez 2001; Sanchez and Belda 2003) and additional fisheries impact data are needed to determine population level impacts of fishing bycatch (Belda and Sanchez 2001; Baccetti 2003).

Long Lines

Sea birds can dive up to 30 meters, often to attack prey [or baited hooks] (Arcos 2002). Belda and Sanchez (2001) found that seven species of birds are susceptible to bycatch in longlines. The most commonly caught seabirds in longlines are the Cory's shearwater, Audouin gull, yellow-legged gull, northern gannet, Mediterranean shearwater, and Balearic shearwater (Belda and Sanchez 2001; Baccetti 2003). In 1998, seabird mortality in bottom longlines was 0.69 birds per 1,000 hooks and 0.25 birds per 1,000 hooks in pelagic long lines. In 1999, bottom longline vessels averaged 0.16 birds per 1,000 hooks. Incidental capture occurred from swallowing a hook (50%) and being hooked on the wing (41%). The remaining were unobserved mortalities.

Hooked seabirds act as a buoy on longlines, altering the depth of the nets and negatively affecting the catch (Barnes, Ryan *et al.* 1997). A study of eight vessels reported 114 to 2,000 hooks per set. Between zero and 24.9 baits were lost per 1,000 hooks. In 1998, pelagic and bottom longline vessels recorded 22 seabird deaths. In 1999, bottom longline vessels reported a seabird mortality of five individuals around the Columbretes Islands (Sanchez and Belda 2003).

Tudela found seabird bycatch was higher in bottom longlining (0.72 birds caught/ 1,000 hooks) than surface longlining (0.22/ 1,000 hooks). However, this may reflect periodic large catches that occur in bottom longlines. For example, a single bottom longline set in 1997 caught 200 Balearic shearwaters (Tudela 2000). From 1998-1999, four Balearic Shearwaters were reported as incidentally caught (in the absence observers). According to Cooper et al. (2003), France, Italy, and Spain are the only countries with record of incidentally caught Balearic Shearwaters.

The northwest Mediterranean uses modern longliners (Payne 2004). This longline fishery is estimated to affect 4-6% of the local breeding seabird population (Cooper 2003, Belda and Sanchez 2001). Balearic Shearwaters are particulary interesting because of their susceptibility to longline bycatch and their declining population size (Belda and Sanchez 2001). Consequently, additionaladditonal research of this species is warranted. Audouin's gulls become more susceptible to longline bycatch when trawls are not operating because of increased scavenging behavior when temporary fishing discards are unavailable (Tudela 2000).

Spain is currently the only country with quantitative data (Tudela 2000, Cooper, Baccetti et al. 2003) on Balearic Shearwater bycatch. During on-board observations, both Balearic Shearwaters and Audouin's gulls preyed on baited hooks (Tudela 2000). Bycatch was recorded most frequently at sunrise and from mid-afternoon to dusk. On average, 0.16 to 0.69 birds were caught per 1,000 hooks. Monitoring 557 fishing operations from 1999-2000, the Spanish surface longline fleet (western Mediterranean) found Cory's shearwaters and yellow-legged gulls accounted for nearly all bycatch. Audouin's gulls have also entangled in nylon mesh near the small Spanish archipelago off Morocco (Tudela 2000).

From 1998-1999, the mortality for Balearic Shearwaters was not recorded. The Cory's shearwater, which is in the same Family as the Balearic Shearwater, suffered a mortality of 18 birds in two years from eight long line vessels (Sanchez and Belda 2003). From 1999-2000, an estimated 50 Balearic Shearwaters were killed due to "mass mortality" when a longline fishing boat was close to a flock. Additionally, this species increasingly depends on the fish waste from trawl fishing vessels, as other sources of food in the Mediterranean has declined (International 2004).

Purse Seines

Seabirds feed on fishery waste, which can lead to injury and death. They capture discards after dawn and after dark, consume live fish close to the surface, near the purse seine light. The Balearic Shearwater was associated with purse seine fisheries, suggesting heavy reliance on purse seine discards, particularly when trawlers are not operating. The species was recorded near trawler discards and purse seine vessels, during daylight hours (Arcos and Oro 2002). Shearwaters are not known for nighttime feeding and also are less commonly associated with fishing vessels in the winter (Arcos 2002).

Seabirds opportunistically consume the discards from and prey associated with fishing activities (Tudela 2000). For example, the Audouin's gull has been known to associate with purse seine fleets and capture small pelagic fish attracted to the lights or concentrated by the fishing vessels. Balearic shearwaters depredate discards from purse seines (Tudela 2000).

Trawls

Auduin gull colonies are sensitive to nearby fishing activities. Gulls were flushed from colonies when nearby trawlers were hauling their nets. On non-fishing days, however, the majority of gulls stayed at the colony. Castilla (1995) documented Audouin’s gulls foraging from commercial fishing activities. Arcos (1996) confirmed the belief among trawl fishers that breeding Audouin’s gulls travel long distances to obtain trawler offal as a food source. Between 1991 and 1992, a moratorium on trawling was implemented in eastern Spain to mitigate the impacts of fishery discards to Audouin’s gulls. However, fishing threats to this species are still largely unknown (Castilla 1995).

Bioenergetic models found that, with much variability, the Balearic Shearwater derives approximately 40% of its energy from trawler discards during breeding season, March to June (Arcos 2002). This species obtains food from capturing fishing discards (38%) and fishing under floating objects (33%) (Arcos 2002). Eight instances of Balearic Shearwaters feeding on trawler offal resulted in the bycatch of 101 individuals (Arcos 2002).

Marine Mammal Bycatch

In the ICCAT area several marine mammal species are incidentally caught in tuna fisheries. Due to high mortality rates, bycatch of common dolphins in the Alboran Sea and Strait of Gibraltar likely contribute to the caused a population decline (Tudela 2000). In the Alboran Sea, annual ‘take rates’ for striped and common dolphins were approximately 10.2% and 12.3% of the respective

population sizes. Take rates of greater than 1-2% are typically unsustainable for small-cetacean populations. Consequently, reported bycatch rates are a threat to the common and striped dolphin populations. Research found inexperienced younger animals entangled in driftnets more often than adults (Tudela 2000).

Historically, small-scale, commercial fisheries in the Mediterranean had interactions with bottlenose dolphins, short-beaked common dolphins, and Mediterranean monk seals (2001). As of 1992, the Mediterranean Sea held 11% of the marine harvest in the region, while the Black Sea dominated with 64% of the harvest Annual dolphin bycatch in the Mediterranean between 1968 and 1982 averaged 43 tons. The average annual dolphin bycatch in the Black Sea between 1968 and1982 was 38,256 tons (Godley 1998).

Driftnets and Fixed Nets

According to Tudela (2000), driftnet fisheries cause the most harm and are responsible for the highest rates of direct human-induced marine mammal mortality. Small-scale fisheries using fixed nets and purse seines have the second-highest rate (Tudela 2000). The bycatch rate of dolphins was 0.1 individuals per km of net set per Spanish fishing operation (Tudela 2000).

A study by Tokac, *et al.* found 50-60 fishing vessels used drift nets in the Turkish Aegean Sea in 2001. Driftnets are a non-selective fishing gear because they can entangle any species larger than the mesh size. In 1999, ten dolphins of three different species were caught incidentally in drift nets in the Aegean Sea. In 2000, nine dolphins of three different species were caught in swordfish driftnets. In both years, the striped dolphin (*Stennalla coeruleoalba*) was the most commonly caught species (Öztürk 2001).

The Ligurian Sea has an estimated bycatch rate of 0.29 cetaceans per fishing day and vessel, while the Tyrrhenian Sea is estimated as 0.08 cetaceans per fishing day and vessel. In 1992, the driftnet-free “Santuario dei Cetacei” was established in Ligurian Sea waters (Tudela 2000). Di Natale and Mangano (1983) reported “the incidence of human activities on the mortality of the sperm whale in the Italian seas is very high.” The box–shaped head of the sperm whale may make this species more susceptible to entanglement in driftnets In the Mediterranean, the Moroccan driftnet fleet catches common dolphins and striped dolphins most often, as well as bottlenose dolphins, pilot whales, sperm whales, fin whales, and minke whales. Four boats of the Moroccan fleet captured 237 dolphins (common and striped) over eight-months (Tudela 2000).

In a two-year study (1997-1998), Black Sea countries recorded 17 dolphins as bycatch, 70% harbor porpoises and 30% common dolphins (Payne 2004). These dolphins were largely killed by fixed nets (turbot fishing) and purse-seines (anchovy fishing). Bottlenose dolphins also are killed as bycatch, though none

were observed during this study. Most dolphin bycatch (~46%) occurred in the spring during the fixed net fishery season. This study found the remaining bycatch occurrences in Summer, followed by Autumn, and Winter with the least bycatch (Payne 2004).

Gill Nets and Trammel Nets

Artisanal gillnets and trammel nets can entangle sperm whales, Risso's dolphins, common dolphins and bottlenose dolphins (Tudela 2000). Gill nets drown hundreds of dolphins each year, primarily between April and June, which is the fishing season for turbot, sole and sturgeon. The marine mammals that have been killed incidentally include harbor porpoises (95.5% of bycatch) and bottlenose dolphins.According to A. Birkun Jr. (year), the turbot fishing season coincides with harbor porpoise gestation and nursing period. An estimated 2,000-3,000 individuals are taken as bycatch in the Turkish Black Sea each year (Oztürk 1999). In a study of 40 harbor porpoises, 77.5% were female (Oztürk 1999).

Despite its name, the Mediterranean population of common dolphin is listed as Endangered in IUCN Red List. Italian driftnets cause striped dolphin bycatch in Balearic waters, where their low population is another concern (Tudela 2000). The Balearic government and fishermen associations are part of a project to prevent dolphin predation from nets (Tudela 2000).

Purse Seines

The Mediterranean bluefin tuna fishery does not set nets around cetaceans. However, pilot whales have been caught infrequently. Purse seines in the Mediterranean are far less damaging than drift nets. Bycatch from purse seines include common and striped dolphins near southern Spain, southern Italy, and northern Africa. In the Alboran Sea, the Spanish purse seine fishery for sardine and anchovy is the most destructive to dolphin populations (Tudela 2000).

Purse seine fleets have a noteworthy impact on the common dolphin in the western Mediterranean in the Alboran Sea, but not the eastern Mediterranean. The Balearic waters are known for conflicts between artisanal fisheries and bottlenose dolphins (Tudela 2000).

Trawls

The Gulf of Gabes is prone to cetacean stranding from the trawling fleet (Mediterranean 2003).

Less Common Gears

Uncommon gears in the region include tuna traps and fishing with explosives. Fishermen off southern Spain have killed killer whales entering tuna traps. A

documented use of explosives killed a sperm whale in Italian waters (Tudela 2000).

The squid fishery uses illuminated handlines that attract striped dolphins, Risso's dolphins, long-finned pilot whales and sperm whales t.Trawl nets were opportunistically preyed upon by striped and bottlenose dolphins. Bottlenose dolphins were observed feeding on artisanal bottom gillnets around the islands of Ventonene and Ischia, causing large cuts on their bodies. Catalan fishermen off southern France, and western Sardinia also reported dolphins feeding around trawlnets and trammel nets with catch (Tudela 2000).

Cetacean Interactions: Retaliation & Deliberate Killing

The small-mesh fishery is the only fishery to exhibit an economic impact from dolphins (Reeves 2001). estimated that four kg of red mullet per km of netting were lost on nights when dolphins were present (average net length was 2.2km per boat).

Table 5. Economic effects of dolphin interactions on various Mediterranean fisheries. Investigation from January 1999-October 2000 (Reeves 2001).

Gear Type	Mesh Size	Target Species	Dolphin Interaction
Large Mesh	64-72mm	Lobster	None Documented
Medium Mesh	32-50mm	Squid, Cuttlefish, rockfish, *Scorpaenidae*	Insignificant Impact
Small Mesh	27mm	Red Mullet	Some Economic Impact

The flounder fishery in north Venice and the anchovy fishery in the Ionian Sea have had unfavorable interactions with dolphins. Notarbartolo-di-Sciara (2001) reported that bullet wounds often are found in stranded dolphins, and fishermen will “feed” dolphins fish laced with poison or needles. Small-scale fishermen in Greece, Turkey (Cilician Basin), and Balearic waters are aggravated by the costs associated with damage to gear caused by dolphins, which often leads to deliberate killing.

Dolphins killed by fishermen also have been documented in Italy and Malta, and dolphins with bullet wounds have been recovered in French waters (Tudela 2000). In the Andalusian ports of Garrucha and Algeciras of the Alboran Sea, dolphin meat is used as bait for shrimp fishing. Humans in a few Italian and Spanish localities consume dolphin meat (Tudela 2000).

The largest bottlenose dolphin population is in the Balearic Islands of Spain. Approximately 30 bottlenose dolphins die annually, largely from deliberate killing by Balearic fishermen and from entanglements. The population there has been reduced to the extent that this mortality rate is not sustainable (Tudela 2000).

Mediterranean Monk Seal: ***Multiple Gear***

The Mediterranean monk seal has recently been recognized as extinct in the Black Sea. It is also considered extinct on the Adriatic coast, Sardinia, Croatia, the Sea of Marmara, and possibly Tunisia (Johnson 2007). The Greek Aegean monk seal population consumes only 750 kg of fish daily, yet fishermen consider seals a major competitor (Tudela 2000). Due to their trusting nature, the Mediterranean monk seals have been an easy target for fishermen with nets, clubs, and spears (Johnson 2007). Industrial fishing has played a role in the monk seal's decline in both population and native range (Johnson 2007).

Anthropogenic mortality (incidental entanglement in fishing gears and deliberate killing by fishermen) and food scarcity (due to overfishing and depletion of fish populations) are the two principle threats affecting this endangered population. Overfished stocks push the monk seals to prey more heavily on fish trapped in nets, which increases their probability of becoming entangled and drowning. According to fishermen, seals attack nets 20-30 meters from the surface. In 1994, six seals were deliberately killed off the Cilician coast of Turkey (Tudela 2000).

The primary cause of pup death is entanglement in fishing gear. Seal vulnerability peaks during their first six months. For example, in one Cilician colony off the coast of Turkey, four of six pups died in one year due to entanglement. One pup was release from the net alive. These events occurred near breeding caves (Gucu 2004). Thus, protected areas are essential for seal pup survival, particularly around breeding caves and coastal waters.

Although historical records show injuries can be caused by many types of fishing gear (Kiraç and Savas, 1996), Monk seals are most vulnerable to stationary nets set on the bottom, abandoned nets, and purse seines. In the Greek Ionian Islands, 23% of deaths were due to entanglements. Out of 38 deaths in the Mediterranean and Black Sea Turkish waters, eight had drowned, 16 were killed by fishermen, and 11 were killed by dolphin hunters. In Morocco during the 1980s, 27 to 40 deaths were due to entanglement. In Turkey, it is suggested that the trammel and gillnets used there may not be strong enough to trap adults. However, four pups in four years were entangled in these nets (Tudela 2000).

Small areas surrounding Mediterranean monk seal breeding caves have special protection as no-fishing zones. Improving fishing nets and techniques to repel seals from fishing equipments are noted in the Action Plan for the Management

of the Mediterranean Monk Seal. Furthermore, areas surrounding breeding caves are designated no-fishing zones (Tudela 2000).

Regional Information

Black Sea

Cetaceans in the Black Sea are vulnerable to hazards such as invasion of non-native species, coastal erosion, eutrophication, heavy pollution, and overfishing (Oztürk 1999). Dolphins in the Black Sea commonly die in fixed nets (Payne 2004).

Bycatch studies in the Black Sea have revealed significant impacts to cetaceans since 1990 (Oztürk 1999). Through the 1950's, an average of 200,000 dolphins were taken each year from the Black Sea. That dolphin population was estimated to be 800,000 individuals. In 1966, dolphin fishing was banned in the Black Sea after the number of dolphins drastically declined.

From 1993 to 1997, along the western coast of the Turkish Black sea (Bulgaria to Istanbul), Oztürk (1999) reported 63 dolphins as bycatch, most of which were immature (≤ 130cm total length)). Only one was a bottlenose dolphin, while the remaining were short-beaked common dolphins (Oztürk 1999). The study also documented 41 dolphins killed in 875 bottom gill nets (4.6%). IOverexploited fish stocks deminish the dolphins' food source which increases competition between dolphins and fishermen (Oztürk 1999).

Turkey & Cyprus

In Turkey, swordfish are caught with gill nets, longlines, and harpoons. Between 1999 and 2000, the swordfish fishery caught 19 cetaceans (Öztürk. 2001). In turbot fishery gill nets, bycatch occurrs between April and June. The mesh size was 22cm, and nets were set as deep as 80m (Oztürk 1999).

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Table 3. Marine mammal species caught in the ICCAT area by major tuna fisheries (historically recorded). This table is not quantitatively significant.

Scientific Name	Common Name	Gear Type Used
Balaenoptera acutorostrata	MINKE WHALE	GILL NET, PURSE SEINE, TRAP
Balaenoptera borealis	SEI WHALE	PURSE SEINE
Balaenoptera physalus	FIN WHALE	LONG LINE, GILL NET, PURSE SEINE, HARPOON,
Delphinus delphis	SHORT-BEAKED	GILL NET, PURSE

	COMMON DOLPHIN	SEINE
Globicephala macrorhynchus	SHORT-FINNED PILOT WHALE	PURSE SEINE
Globicephala melas	LONG-FINNED PILOT WHALE	LONG LINE, GILL NET, HARPOON, TRAP
Megaptera novaeangliae	HUMPBACK WHALE	GILL NET
Mesoplodon densirostris	BLAINVILLE'S BEAKED WHALE	GILL NET
Orcinus orca	KILLER WHALE	PURSE SEINE, TRAP
Phocoena phocoena	HARBOR PORPOISE	GILL NET
Physeter macrocephalus	SPERM WHALE	GILL NET, PURSE SEINE, HARPOON
Pseudorca crassidens	FALSE KILLER WHALE	PURSE SEINE
Stenella coeruleoalba	STRIPED DOLPHIN	LONG LINE, GILL NET, PURSE SEINE, HARPOON, TRAP
Steno bredanensis	ROUGH-TOOTHED DOLPHIN	PURSE SEINE
Tursiops truncatus	BOTTLENOSE DOLPHIN	LONG LINE, GILL NET, PURSE SEINE, HARPOON
Ziphius cavirostris	CUVIER'S BEAKED WHALE	LONG LINE, GILL NET, TRAP

.

Table 4. Cetacean Bycatch (SECTION 2.5.3)(Tudela 2000)

When	Where	Bycatch	Other
Summer 1988	Ligurian Sea	37 Cetaceans	Driftnet
1990-1992	Tyrrhenian Sea	15 Cetaceans	Italian Driftnet: 100 commercial trips
	Ligurian Sea	10 cetaceans	Driftnet for Swordfish
1991	Tyrrhenian and Sardinian Seas	1,682 cetaceans*	Entire Italian driftnet fishery
1990-1991	Tyrrhenian and Sardinian Seas	946 striped dolphins	Driftnet
1986-1989	Italian coasts	24 sperm whales, 126 other	Driftnet-caused stranding

		cetaceans	
1978 - 1982	--	20 sperm whales	Italian driftnets
May 1993 - June 1994	Spanish Iberian and Balearic coasts	12 sperm whales (including 3 calves)	driftnet
Annual Estimation	Alboran Sea	3,647 dolphins	Moroccan driftnet fleet
Annual Estimation	Straits of Gibraltar & adjacent Atlantic	13,358 dolphins	Moroccan driftnet fleet
1993	Not specified	366 dolphins	Spanish fleet (27 boats)
1994	Not specified	289 dolphins	Spanish fleet (27 boats)
	Turkish coast of the Aegean Sea	striped, Risso's, and bottlenose dolphins	
Annual Estimation	Not specified	6 dolphins	Spanish tuna fleet (all released alive)
2 incidents	Ligurian Sea	21 striped dolphins	tuna purse seine
1987	San Remo in the Ligurian Sea	8 striped dolphins	
Annual Estimation	Alboran Sea	300 dolphins	Spanish sardine and anchovy fleet
Annual Estimation	Catalonia & the Gulf of Lions	100 striped dolphins	Spanish purse seine fishery
	France and Italy	striped, common and bottlenose dolphins, fin whales	trawlers
	Italy and Spain	striped dolphin, false killer whale, Risso's dolphin, fin and sperm whale (killed)	surface longlines
	Tyrrhenian waters	1 sperm whale (entangled)	surface longline
Annual Estimation	Mediterranean	12 to 32 cetaceans (mortality rate of 10%)	Spanish surface longline fleet
Annual Estimation	Garrucha and Algeciras, in the Alboran Sea	180-260 dolphins (meat used as bait)	shrimp fishing with traps
	Lebanese waters and Algeria		Dynamite purse seine fishing

*= 1,682 cetaceans taken by the whole Italian driftnet fishery: 1,363 striped dolphins, 132 pilot whales, 62 other delphinids, 79 Risso's dolphins (*Grampus griseus*), 35 bottlenose dolphins (*Tursiops truncatus*), 8 sperm whales, 2 Cuvier's beaked whales and 1 fin whale (Tudela 2000).

Sea Turtle Bycatch

The Mediterranean has a very large amount of human-induced mortality involving sea turtles (Casale, Mazaris et al. 2007; Paolo Casale 2007, Casale 2007)). Entrapment in fishing gear is the chief problem affecting sea turtles (Ayse Oruc 1996). According to Margaritoulis *et al.* (2003), large pelagic fisheries, such as swordfish, bluefin tuna and albacore, are a major threat to Mediterranean marine turtles (2004). Mediterranean sea turtle stranding networks reported a high proportion of anthopogenic impact on turtles, largely comprised of fishery-interactions. Casale *et al.*(2007) calculated human-induced mortality to be responsible for between 10 and 20% of sea turtle deaths.. Hypoxic damage and physical injuries to turtles may cause additional mortality (Godley 1998), which is currently not quantified.

The most frequent sea turtle-fishery interactions are with trawls, which catch all turtle species. Scientists estimate that more turtles are killed by trawls than all other anthropogenic impacts combined. This is because trawls comprise a considerable proportion of fishing effort and have a high mortality rate (Gerosa and Casale 1999; Paolo Casale 2007).

Table 5: Sea Turtle species caught in the ICCAT area by major tuna fisheries (historically recorded). This table is not quantitatively significant.

Scientific Name	Common Name	Gear Type Affecting Species
Caretta caretta	LOGGERHEAD	LONG LINE, GILL NET, PURSE SEINE, HARPOON, TRAP, HANDLINE/RECREATIONAL
Chelonia mydas	GREEN TURTLE	LONG LINE, GILL NET, PURSE SEINE
Dermochelys coriacea	LEATHERBACK	LONG LINE, GILL NET, PURSE SEINE, HARPOON
Eretmochelys imbricata	HAWKSBILL TURTLE	GILL NET, PURSE SEINE

Although prohibited, loggerheads and green turtles are directly exploited and sold in some Mediterranean fish markets (Caminas 2005). Interactions with the green turtles in the Mediterranean is a concern due to their highly endangered status and it is likely much of the bycatch contains juvenile green turtles(Godley 1998).

Driftnets and Fixed Nets

The Ligurian Sea driftnet fishery catches 0.057 loggerheads daily, and the Tyrrhenian Seas catch 0.046 daily (Table 9). Here, 40% of the bycatch occurs in July. In the 1980's, the Italian driftnet fleet was estimated to catch 16,000 turtles annually (Table 9). In 1992 and 1994, loggerhead turtles made up 0.32% and 0.92% of the catch in the Spanish swordfish driftnet fishery (Albronean Sea), respectively. The large-scale driftnet fleet in the southwest Mediterranean (Moroccan fleet) caught 0.21 turtles/haul from December-May(Tudela 2000).

Table 6. Driftnets and effects on sea turtles (Godley 1998)

Fishing Area	Est. # turtle captures annually	Direct mortality
Italy (Ionian Sea)	16,000	29.9%
Italy (Ligurian & Tyrrhenian Seas)	Low	0
Spain (1994)	117-354	3.3%

Turtles also die in fixed nets when they try to feed on fish entrapped in the nets. Turtle captures have been reported along the Spanish Mediterranean coast.

- *Static Nets*

In the Balearic Islands of Spain, surveys of fishermen using static nets, found 77.7% of entangled turtles die. Mortality rates in Corsica (94.4%), continental France (53.7%), and Croatia (54.9%) also were very high (Casale 2005). Tunisia had a much lower rate of 5.2%. Fishermen also provided data that approximately 0.5-2.1 turtles were caught per year, per vessel in Tunisia. In the Balearic Islands, 0.17 turtles were caught per month, per vessel.. Fishermen further report 920 turtles caught by static nets annually in Tunisia, and about 200 annually caught in the Balearic Islands. Di Natale (2002) estimated 200,000 artisanal fishing vessels in the Mediterranean, with approximately half of them using static nets (Casale 2005). These high mortality rates signify a major threat to the species.

Gill Nets and Trammel Nets

Due to advancements in net design, nets are almost species-specific for fish, crustaceans, and mollusks. Gear improvements could prevent non-target species from being caught, such as turtles. Drift-nets are a type of gill net that are fished vertically in the water by set floats. These nets drift freely with the wind or current and have been used since 177 AD in Greece (Gerosa and Casale 1999). Observers found 29 Ionian coastal vessels captured approximately 16,000 turtles with nets up to 12 km, and mortality of 20-30% (Gerosa and Casale 1999).

Drift nets are used chiefly in the open sea, where the number of captures could be low as turtle density is low. Turtles are mostly caught in the upper third of the nets. Yet nets could be dangerous if placed along sea turtle migratory routes between areas of feeding and reproduction. Many states (*e.g.*, Spain) have forbidden the use of drift-nets in the Alboran Sea and are trying to utilize more selective and less damaging fishing practices. Also, the EC (EU regulation 345/92) banned nets longer than 2.5 km (Gerosa and Casale 1999).

The Italian fishery targeting swordfish and Taiwanese vessels in Mediterranean waters primarily use drift nets. In 1989, over 700 boats in Italy were using nets (12- 20 km long) with 180-400 mm mesh and depths of 28-32 meters. See Table 10.

Table 7. Gill nets and effects on sea turtles (Godley 1998).

Fishing Area	Est. # turtle captures annually	Direct mortality
France	10-100	50.0%
Italy	Not Quantified	50.0%

Gill nets can fish passively or actively A criticism of gillnets is their effects on non-commercial or protected species, including turtles (Gerosa and Casale 1999). Algeria, Morocco, France, Turkey, Spain and Greece have been documented using gill nets (Gerosa and Casale 1999). Turtles actively feed on fish entangled in trammel nets, which increases their probability of being captured (Gerosa and Casale 1999). Local parameters such as soak time, time of day, gear differences, and season need to be accounted for when looking at gill net standardizations (Gerosa and Casale 1999).

Mortality in set nets on the bottom and surface vary because turtles are able to breathe if entangled in surface nets, while bottom nets are likely to result in drowning. In addition, death from chronic injuries caused by ropes or nets as well as necrosis can occur after release (Gerosa and Casale 1999).

Table 8. Trammel nets and effects on sea turtles (Godley 1998)

Fishing gear (target catch)	Fishing Area	Impact of turtle captures annually	Direct mortality
Lobster	France	Low	100%
Lobster	Corsica	Low	93.3%
Fish (Sole)	Corsica	Low	75.0%
Fish (Sole)	France	Low	53.1%
Fish	France	Low	28.5%

Long Lines

Spanish swordfish long line bycatch depends on the gear type and hook position. The weight of larger fish catches causes the gear to sink, thus drowning more turtles. Leatherbacks are most often caught in swordfish longlines, comprising most of the entanglements recorded in the western Mediterranean. Caminas and Valeriras found two entangled leatherbacks in approximately 217 fishing operations.

The wide central Mediterranean functions as oceanic and neritic habitat for loggerheads. High turtle catch rates in the central Mediterranean longlines were observed from 2003 to 2005 (Casale 2007).

Turtle bycatch studies in the southwestern Mediterranean (Spanish longline fleet) are estimated to be dramatically higher, 6.5-9.8 turtles per day recorded in 1990-1991.Between 1990 and 1991, turtle bycatch in the southwestern Mediterranean (Spanish longline fleet) was estimated to be dramatically higher than the rest of the Mediterranean, with 6.5-9.8 turtles per day (Tudela 2000). Thus, an estimated bycatch total is was between 22,000-35,000 turtles per yea (with 66% of catches occurring in only two months (July-August). In 1990, 23,888 individuals were caught, and in 1993, 1,953 individuals. Another study of the Spanish albacore and swordfish longline fleets found 280 fishing hauls yielded 496 loggerheads (Tudela 2000). The albacore fishery (deeper set hooks) had higher bycatch rates than the swordfish fishery. The albacore fishery caught with 1.05 turtles per 1,000 hooks, while and 0.33 turtles per 1,000 hooks were caught in swordfish long lining.respectively. Turtles migrate to the western Mediterranean to feed in the spring and summer, and all of the bycatch in this area consisted of juveniles. Adults were caught, but rarely, in winter (Tudela 2000).

Spanish swordfish longline bycatch depends on the gear type and hook position. The weight of larger fish catches causes the gear to sink, thus drowning more turtles. Leatherbacks are most often caught in swordfish longlines, comprising most of the entanglements recorded in the western Mediterranean (Tudela 2000). Caminas and Valeriras found two entangled leatherbacks in approximately 217 fishing operations.

Swordfish longlines are the primary source of leatherback incidental captures in the western Mediterranean. Specifically, in the Spanish swordfish fishery, 15 vessels caught two turtles during two months of summer 1991 (Tudela 2000). The Italian longline albacore fleet bycatch affects the Spanish swordfish driftnet fishery in the Alboran Sea.

World-wide, drifting longlines are a major threat to sea turtles (Casale 2007). The wide central Mediterranean functions as oceanic and neritic habitat for loggerheads. Pelagic longliners in the central Mediterranean target swordfish exclusively and use J-shaped steel hooks baited with mackerel or pilchard. Longlines are usually set in the late afternoon and recovered at dawn. High turtle bycatch rates in the central Mediterranean longlines were observed from 2003 to 2005 (Paolo Casale 2007). Lewinson *et al (*2004*)* cites a high mortality rate from this fishery, comprised mostly of loggerheads. Two Mediterranean studies reported 33-34% mortality for turtles with hooks deep in their digestive tracts. Casale *et al (*2004*)* found bycatch rates in the eastern Mediterranean were 15 times higher than in the west. The Eastern Mediterranean is estimated to have 2,500 captures annually, and 4,300 captures in the western Mediterranean (Table Y, Paolo Casale 2007). Pelagic longlines in the western Mediterranean targeting swordfish, using J-hooks have the high rate of 4.468 turtles per 1,000 hooks (Table Y) and catch rates of this fishery imply significant captures by the Italian fleet alone (Paolo Casale 2007).

Table 9. Drifting longlines and effects on sea turtles (Godley 1998)

Fishing Area	Est. # turtle captures annually	Direct mortality
Spain (1990)	35,837	0.4%
Spain (1991)	22,000-23,637	0.4%
Italy (Ionian Sea)	Not Quantified	Not Quantified

Swordfish lines are the primary source of leatherback incidental captures in the Western Mediterranean. Specifically, in the Spanish swordfish fishery, 15 vessels caught two turtles during two months of summer 1991 (Tudela 2000).

Each year, pelagic long lines used for targeting tuna and swordfish fishing lead to the accidental capture of 25,000 loggerheads each year. Mediterranean fishermen, specifically in Greece, Italy, and Spain, use different surface longlines dependent depending on their target catch. Longlines targeting bluefin tuna are deeper (50m to 100m) than swordfish longlines (50m-60 meters). Spanish longlines caused a 20-30 percent mortality rate in an experimental study of turtles injured by fishing gear Experimental studies by Aguilar *et al.* (2004) found mortality rates of turtles injured by surface longlines was 20-30 percent (Caminas

2004). The regions' highest catch rates occur with bottom longlines, with 23 turtles per boat, per year (Tudela 2000).

Caminas (2004) also found Spanish longlines caused a 20-30 percent loggerhead mortality rate Italy, Tunisia, and Maltese also catch a multiplicity of loggerheads in their longline fleets (*e.g.*, Gulf of Taranto, South Adriate and Aegrean Sea) (FAO 2004). In Tunisian waters, longline fleets annually catch an estimated 4,000 loggerheads (Tudela 2000). During 2005, surrounding the Straight of Sicily, Italian pelagic longliners captured an estimated 2,148 turtles (Paolo Casale 2007).

From 2003 to 2005, pelagic longliners caught turtles with an average curved carapace length of 45.9 cm and bottom longliners 58.6 cm. The most frequently caught size range was from 40-50cm, both in trawls and longlines (Paolo Casale 2007).

The regions' highest catch rates occur with bottom long liners, with 23 turtles per boat, per year (Tudela 2000). Experimental studies by Aguilar, Mas and Pastor found mortality rates of turtles injured by surface longlines was 20-30 percent (2004). Drifting longlines catch more turtles than other gears, yet the associated mortality has not been quantified. Worldwide, approximately 200,000 turtles are caught in drifting longlines annually. Furthermore, post-release mortality is difficult to study. Mortality from drifting longline and associated gear is unknown, yet needed to determine the impact the effects on sea turtle populations (Casale 2007).

The hook and branchline, or piece of line attached to the hook, are major causes of instantaneous and long-term mortality. It is unknown if fishermen remove hooks from the mouth or throat or just cut the branchline. Hook removal requires fishers to bring the turtles onboard which consumes valuable fishing time (Casale 2007). Ingested hooks caused deaths from a perforated heart, blood vessels, or digestive tract. Turtles with hooks in the lower esophagus/stomach have very little chance for survival. Conversely, branchlines disable digestive functions leading to a delayed death (Casale 2007). Necropsies found branchlines cause mortality as well as hooks. It is unknown if fishermen remove hooks from the mouth or throat or just cut the branchline. Hook removal involves the turtles onboard and consume valuable fishing time(Casale 2007).

Drifting longline mortality was estimated to be above 30%. However, without data and understanding on the mortality and hook location, fishery management may be less effective. From 2001-2005, data were collected from 300 of 409 Loggerheads. 300 turtles caught by drifting longlines had hooks caught or ingested. Accounts from fishermen and studies inIn Southern southern Italy report fishermen usually reported cutting the branchline from the deck while the

turtle is in the water. More Consequently, turtles are released then with a potentially lethal branchline of over 1 meter, thus potentially lethal (Casale 2007).

Table10. Drifting longlines and effects on sea turtles (Godley 1998)

Fishing Area	Est. # turtle captures annually	Direct mortality
Spain (1990)	35,837	0.4%
Spain (1991)	22,000-23,637	0.4%
Italy (Ionian Sea)	Not Quantified	Not Quantified

While numerous estimates exist, one study concluded 10% to 50% of turtles incidentally caught in longlines die. See Table Y below for longline data. An experimental study estimated turtle injuries from fishing gear result in death for 20-30% of individuals caught in the Spanish longline fleet. In 1994, approximately 236 animals were caught incidentally and released alive at sea(Tudela 2000)

Loggerhead turtles are more likely to drown in the albacore than the swordfish fishery. It is estimated that 30% of the turtles entangled by the Italian driftnet fleet drown. Also, tagged Loggerhead turtles seem to incur more fishery incidents than non-tagged turtles because the tags increase their chance of entanglement (Tudela 2000).

Table Y. LL bycatch of sea turtles in the Med

Location/Fishery	Rate	Unit	Mortality rate	Comments
Eastern	2500	year	33-34%	swordfish fishery
Western	4300	year	33-34%	swordfish fishery
Western	4.468	per 1000 hooks		swordfish fishery
Surface LL			20-30%	loggerhead
Spanish LL			20-30%	
Bottom LL	23	per boat per year		
Tunisia	4000	year		loggerhead
Strait of Sicily	2148	year (2005)		

- *Surface Longlines*

Surface Longlines have been used since 177 BC in Sicily, based on the method of baited-hook fishing. Turtles in the area are often attracted to the baited longlines. Hook sizes used in this fishery in the Mediterranean vary from 2 to 11 cm; hook numbers vary from 1,000 to 2,400 hooks; type of bait used, from includes mackerel to and shark; times and haul times vary; and the length of the main fishing line ranges from 20 km to 60 km (Gerosa and Casale 1999).

In the Mediterranean, swordfish and albacore are intentionally caught using surface longlines, largely in the western side. However, due to overfishing, the

swordfish stock and sizes of individuals have reduced. Accidental capture of turtles occurs mainly in the central and western Mediterranean(Gerosa and Casale 1999).

The loggerhead turtle is the only species commonly caught in surface longlines. The leatherback is rarely captured in the Mediterranean, suggesting this species is rare in the area and the likelihood of catching one is close to zero.. Green turtles can be carnivorous, making them very vulnerable to longlines (Gerosa and Casale 1999)

Over 35,000 loggerheads are caught each year in the central and western Mediterranean. The Spanish fleet alone, off the Balearic Islands, catches15,000-20,000 turtles annually. Loggerheads are attracted to the bait, particularly mackerel, causing the hook to embed in their tongue, mouth, or oesophagus. Most captures occur between June and August. Longline bycatch studies of loggerheads in the eastern Mediterranean are lacking (Gerosa and Casale 1999).

The southwestern Mediterranean has the highest rate of capture (with 6.5-9.8 turtles per day, per boat. The Greek, Ionian Sea has approximately 0.16 turtle captures per day, per boat. According to Gerosa and Casale (1999), loggerheads have a 61 times greater chance of being caught by the Spanish longlines than by the Greek fleet off the islands in the Ionian Sea (Gerosa and Casale 1999).

Methodological difficulties exist in estimating sea turtle mortality in thatbecause there are two stages of possible damage: harm while in the water with fishing gear and after release if the animal survives capture. Hook injury to loggerheads is not fatal at first is approximately 10% (Gerosa and Casale 1999).

According to NGO campaigns, some fishermen now cut the branchline close to the turtle's mouth if they have already swallowed the hook. Experiments in Spain have estimated the mortality to be nearly 29% for fully ingested hooks. Others report that animals infrequently survive ingesting hook, branch, or surface longline. Loggerheads also may have the ability to survive hooks imbedded over time, and some have been recorded to spontaneously expel the hook with the nylon line attached(Gerosa and Casale 1999).

The Italian and Spanish limit for capture of turtles is under 27cm standard curve carapace length. CCL. The population size most likely caught is between 27 and 50 cm standard curve carapace length. Adults are captured less often, thus only a small percentage of reproducing individuals are present. However, it is not clear how frequently fishers report entanglements of larger individuals. As a result, researchers lack complete data. That said, Gerosa and Casale (1999) recorded that longlines caught more big individuals (> 50 cm) than smaller individuals.(Gerosa and Casale 1999).

- *Bottom Longlines*

Bottom longlines target demersal fish, are placed centimeters from the sea bottom, use smaller hooks than surface longlines, and typically used sliced anchovy for bait. The bycatch caused by this fishing method is largely unknown. The danger to turtles depends on the depth of the longline. Depths between 200 and 700 meters are insignificant, yet shallower depths do result in turtle captures (Gerosa and Casale 1999).

Juvenile turtles are most adversely affected. Unlike smaller individuals, larger turtles are occasionally able to drag the main line and ballast to the surface to breathe(Gerosa and Casale 1999).

- Ghost Gear

Ghost gear entanglement and mortality rates have not yet been studied, but are common in the region. The Italian driftnet fishery has approximately 30% mortality rate of turtles solely due to drowning(Caminas 2004).

Purse Seines

The Spanish tuna purse seine fleet catches approximately 1.5 turtles per year per boat, but they are released alive. Consequently, purse seines are not considered a chief danger (Tudela 2000).

Trawls

Most trawl data are from the eastern basin of the Mediterranean. Major captures are allegedly in Tunisia, Turkey, Egypt, Greece, and the Slovenia-Croatia-Yugoslavia area (Table 14) (Gerosa and Casale 1999). Artisanal trawls in the Mediterranean primarily catch juvenile fish near the coast, where the continental shelf is narrow (Payne 2004). Casale et al. (2004) found midwater nets fish very close to the sea bottom. However, no turtles were caught during midwater trawl observations in this study (Casale, Laurent et al. 2004).

Table 14. Bottom trawl and effects on sea turtles (Godley 1998).

Fishing Area	Est. # turtle captures annually	Direct mortality
Greece (Peloponesus)	Not Quantified	2.6%
Italy	1,000-1,500	Not Quantified
Croatia	2,500	Not Quantified
Tunisia	3,500-4,000	0
Tunisia	2,00-2,500	0
Turkey	High	0.5%
Turkey	High	0
Egypt	High	Not Quantified

France	Low	3.0%
Corsica	Low	3.8%
Spain	Low	Not Quantified

Bottom trawlers fish on the continental slope, continental shelf, and the deep sea. In the Mediterranean, the trawl fleet is the largest in both effort and number of vessels. There was no reliable estimate of trawl fishing in turtle habitats. However, Laurent *et al.* reported trawlers were not as significant to turtle's mortality as surface long liners. Mediterranean trawl hauls are shorter than hauls in other regions(Caminas 2004).

Midwater trawls (usually 11-30 meters deep) cause 87% of total turtle trawl captures. Approximately 95% were captured alive and released back into the sea. Information about delayed mortality has not been established (Caminas 2004).

Onboard observers are considered the only method to provide truly reliable data. This method also depends on good relationships between observers and fishermen (Gerosa and Casale 1999). During observations (1999-2000) in the Adriatic Sea between 1999 and 2000, 62 loggerheads were caught during 55 hauls. Seven hauls caught two turtles, and 48 trawls caught one turtle. Thus, no hauls occurred without catching turtles. The maximum depth of hauls that caught turtles was 74.5 m. Below that, depth had no significant influence on whether turtles were caught (Casale, Laurent et al. 2004).

In 1995, the Coatian bottom trawl fleet was estimated to capture a minimum of 2,500 turtles per year (LAZAR 1995). Additional information on capture rates could provide insight to seasonal movements of turtles and their zones (Gerosa and Casale 1999).

Bottom trawls have long been recognized as a major threat to sea turtle populations, including forced apnea. Turtle captures by Italian trawlers, longliners, and foreign fleets suggest high numbers, specifically for loggerheads. Some trawlers targeted deep, bottom species below 200 meters (Paolo Casale 2007). Dead and comatose Loggerheads resulted from haul durations of 130 minutes versus 72 minutes median time (LAZAR 1995). Trawling less than 60 minutes yielded a mortality rate near 0%, but when fishing time increases to 200 minutes, mortality rises to 50% (Tudela 2000).

The Tunisian small-scale fleet (Gulf of Gabes) estimated taking 5,000 individuals annually. The trawl fleet resulted in 2,000-2,500 sea turtle captures annually. Illegal trawls are believed to take hundreds to thousands of additional turtles annually. Additional information on mortality rates could help determine the parameters influencing direct mortality (Gerosa and Casale 1999).

In the central Mediterranean, observed turtle catch rates of pelagic longline and bottom trawls were the highest in the Mediterranean Basin (Paolo Casale 2007).

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Table 11. Approximation of turtle captures per year, by area(Gerosa and Casale 1999).

Country/Region	Captured/year
Algeria	~200
Egypt	Many
France / Corsica	Few
Greece	Many
Slovenia/ Croatia/ Yugoslavia	2,500
Tunisia	2,000-5,000
Turkey	Many

The north Adriatic has high sea turtle catch rates in bottom trawls. The Adriatic is an important area for juvenile and adult loggerheads, as is the central Mediterranean. In 60 specimens from the Tunisian trawl fleets, one turtle was reported dead and two comatose during 2004.

During ten months of study, 12 boats went on 1,200 fishing trips. Green turtles were caught more than Loggerheads, with 306 and 116 entrapped in trawl nets, respectively. Turtles captured were classified by fishing area. Bycatch (green and loggerhead) varied from 1-193 turtles, per area, per season. The Mouth of Ceyhan yielded 193 turtles: , 158 Greens and 35 Loggerheads. A total of 320 turtles were caught in all ten fishing areas recorded (Ayse Oruc 1996).

A midwater trawl in the Mouth of Ceyhan River was observed during the fishing season. One day (December 16, 1996) the trawl was at 18 m deep and caught 20 Green turtles and 10 Loggerheads. All were alive. The second day (December 17, 1996) the trawl was at 21 m deep and caught 10 Green turtles and 2 Loggerheads, all which were alive (Oruc 1996).

Bottom trawls caught the most turtles in Karates (37 total), Tuzla (13 total), Akyatan (10 total). The 10 month trawling season was broken into 4 “seasons.” Over the 4 seasons, 24 Green turtles and 44 Loggerheads were caught. December 1 to February 28 was the “season” with the most midwater trawl turtle catches: , with 27 greens and 34 Loggerheads. Entrapment in nets occurred between the hours 06:0000h and 18:0000h as those are the hours midwater trawl nets are used (Oruc 1996).

The majority of turtles were caught in trawl nets between 11-and 30 meters deep. Midwater trawls did not catch any turtles below 50 meters.

Bottom trawls caught turtles between 0 and 70 meters. Turtles were most frequently caught in bottom trawls between 11-and 20 meters, 21-and 30 meters, and 31-and 40 meters (Oruc 1996).

During the 1996-1997 fishing season, trawlers caught 338 turtles. Of these, 267 were green turtles and 71 were loggerheads. (See Table 16 below).

Table 12. Status of turtles caught during the 1996-1997 fishing season(Ayse Oruc 1996).

Status	Alive	Weak	Comatose	Wounded	Dead	Total
C. mydas	242	9	14	1	1	267
C. carretta	62	4	5	0	0	71
Both species	304	13	19	1	1	338

In the eastern Mediterranean fishing area between Mersin and Iskenderun, twelve 12 boats from the port of Karatas used trawls. Four boats used midwater trawls and eight used bottom trawls consistently. During the 1996-1997 fishing season, 27 boats were registered to Karatas (Ayse Oruc 1996). Bottom trawls target catch is demersal fish(Gerosa and Casale 1999).

Fishermen are legally required to bottom trawl two miles from shore. Midwater trawls must be 18 meters deep, but; fishermen have been reported close to shore during the fishing season. This increases bycatch risk to sea turtles because they feed close to shore (Oruc 1996).

Studies in the Gulf of Mexico found significant correlations between fishing effort at depths less than 30 meters and turtle stranding. Both loggerhead and green turtles rarely bottom below 50 meters (Gerosa and Casale 1999).

Small specimens (34.5-49.9 cm minimum) are not caught. Mortality from trawling is a result of stress from the tons of catch in the net and apnea from several hours of submersion. Turtles caught can be alive, dead, or comatose. When comatose turtles are thrown back overboard, they will die. Comatose turtles have a chance of survival *if* they are treated with resuscitation techniques. Overall mortality is related to duration of trawl, water temperature, and intensity of fishing effort in that particular zone. Zones with intense fishing result in more comatose turtles (Gerosa and Casale 1999).

In Turkey, fishermen have been reported to release turtles as soon as they were brought up in the trawl nets. Fishermen did not want to cause harm. Sea turtles trapped for a long time, however, have a high probability of drowning when released immediately. Fishermen have limited knowledge of turtle respiratory systems, and unknowingly can cause harm with immediate releases. Two juvenile green turtles were caught (May 2, 1997) with no physical injury, yet

these likely died post-release (Ayse Oruc 1996). A large number of rays and skates (*Raja sp, Dasyatis sp*) are commonly caught in midwater and bottom trawls in this area as well. Green turtles in nets with skates and rays have displayed injury from the skates. Ayse *et al.* (1996) noted the increase in skates and rays may be an indicator of an imbalanced ecosystem.

Henwood and Stunz (1987) found 1% mortality for 60-minute trawls, but large increases in the likelihood of death in trawls when trapped longer than 60 minutes. Given known duration of trawls in the Mediterranean, mean mortality rates would fall between 16% to 28%(Gerosa and Casale 1999).

Trawls changing speeds can cause turtles to swim vigorously. Concentrations of high lactic acids have been found in loggerheads in trawls. Much is unknown about intentional apnea. High water temperatures which increase metabolic rates, reduce apnea resistance in turtles (Gerosa and Casale 1999).

The majority of bycaught turtles in the Mediterranean were of large individuals over 70 cm long. The low mortality in this Mediterranean region may be caused by the low temperatures connected with large individuals. Winter mortality cannot be approximated at this time. Trawling activities also are carried out during summer months when high temperatures may reduce apnea endurance. Smaller individuals are more susceptilbe to apnea. Currently there are no dependable mortality estimates(Gerosa and Casale 1999).

- Italian Trawls

The Adriatic Sea, particularly the north-east portion, is an essential loggerhead foraging and overwintering habitat. The Italian bottom trawl fleet was conservatively estimated to capture 4,273 turtles per year. In the southwestern sub-area, a study by Casale et al. (2004), reported 9.4% of captured turtles Since comatose turtles cannot swim or surface to breathe, it is assumed that comatose turtles would die if released. Therefore, counting the comatose turles as deaths would increase mortality from 9.4% to 43.8% (Casale, Laurent et al. 2004).

The Adriatic Sea has shallow waters to the north, where turtle sightings occur regularly. In 1999, 584 bottom trawlers, 115 midwater trawlers, and 1,051 vessels using more than one gear type fished in the northern Adriatic (Casale 2004).

Adriatic Sea midwater trawls fish close to the sea bottom and haul for shorter periods than bottom trawls (65 minutes compared to 111 minutes for bottom trawls). Midwater trawls use sonar to find fish and implement nets only when on target species (Casale 2004).

The maximum depth, in the Andriatic that involved turtle bycatch, was 74.5 meters. Dead and comatose turtles resulted from longer hauls (with a median of 130 minutes) (Casale, 2004). Recent data suggest higher catch rates and mortality. Casale e*t al.* (2004) documented the Croatian trawl fleet (407 vessels) in the same area incidentally caught approximately 2,500 turtles.

Trawl bycath of turtles in the Adriatic Sea can be reduced by limiting fishing effort. Allowing comatose turtles to recover on the vessel deck and avoiding their immediate release if they seem sluggish also can decrease mortality rates. The fate of comatose turtles is reliant on the goodwill of fishermen (Casale 2004).

Less Common Gears

In France,l100% of entangled loggerheads are killed in lobster nets, and in Corsica, the loggerhead mortality rate in lobster nets is 93.3%. Fish nets in Corsica have a 75% loggerhead mortality rateBottom trawls in Turkey have a high number of annual captures as well, as reported in 1997 (Caminas 2004).

Near-shore fishing and underwater explosives used in fishing impact turtle nesting locations (Caminas 2005). Other threats include destruction of nesting habitat and egg harvesting (FAO 2004).

Multiple Gear

In the swordfish fishery, 77% of turtles caught were immature (Tudela 2000). Numerous turtles, predominantly loggerheads, are caught in pelagic longlines, bottom trawls, and drift nets (Godley 1998, (Paolo Casale 2007). Bottom trawls and drifting longlines cause the greatest number of deaths (Casale 2007).

Leatherbacks are common in the Mediterranean basin. In the 1990's trammel nets, bottom trawls, and driftnets reported catching leatherbacks in Tunisian waters (Tudela 2000). Local fishermen claim to see leatherbacks in the eastern Mediterranean. In 1995 only one Leatherback was killed in fishing nets (Oruc 1996).

Loggerheads are the most abundant turtle species in the Mediterranean and nest in Turkey, Cyprus, Tunisia, Egypt, and Libya. Mediterranean surface longline and driftnet fleets pose the greatest threats to loggerheads, followed by bottom trawls and gillnets. A study from 1989 to 1995 found each vessel caught an average of 7.7 loggerheads each year in the Central and South Ionian Sea. The Greek longline fleet in the Ionian Sea catches approximately 280 turtles per year. The 30-50 driftnets incidentally catch roughly 600 individuals (Tudela 2000).

Table 13. Monitored fishing effort at Lampedusa with fishing gear, turtles per day, per boat, using the minimum number of fishing days from 1 July to 15 September(Casale 2007).

Fishing Gear	Turtles	Turtles/day-	Year

		boat	
Large bottom trawlers	242	1.115	2003
Large bottom trawlers	322	1.126	2004
Large bottom trawlers	76	0.332	2005
Small bottom trawlers	32	0.376	2005
Pelagic longliners	91	1.071	2005
Bottom longliners	11	0.786	2005

The total turtle catch in one fishing season of 916 days was 774 turtles. The fishing effort of all gear types in the fleet during summer 2005 added to a total of 3,998 days. The three main fishing gear types used over 3,254 days and 68 boats, would cause an estimated 1,518 turtle captures. Bottom trawls captured four times as many turtles as bottom and pelagic longliners together (both have similar number of captures)(Paolo Casale 2007).

All vessels used pelagic longlines between 1 July and 15 September. Thus, theses data are considered a conservative estimate of the fishing season for pelagic longlining. In this same area, there were an additional 80 Italian trawlers of similar size. According to Lampedusa's trawler captains, almost all trawlers fish in the summer and about half the fleet fishes year-round (Paolo Casale 2007).

Table 14. Standard catch rates by area in the Mediterranean Sea(Paolo Casale 2007)

Area	Standard catch rate
Central	0.0274-0.0893
North-east	0.0548
North-west	0.0037

Table 15. Gear types affecting marine turtles in the Mediterranean (Caminas 2005).

Gear Type	Countries Using Gear	Bycatch Species
Driftnets (mesh size 18 to 42 cm)	Morocco, Turkey, France, Italy (sporadic in Albania, Algeria, Greece)	Loggerhead, Green turtle, Leatherback
Driftnets	France, Monaco	Loggerhead

(mesh size 18 to 42 cm)		
Driftnets (mesh size 8 to 16 cm)	Italy	Loggerhead,
Driftnets (mesh size 4 to 7 cm)	Numerous coasts	Loggerhead, Green turtle
Bottom-set gill nets	Numerous coasts	Loggerhead
Purse Seine	All	Loggerhead, Green turtle,
Tuna Traps	Spain, Italy, Tunisia, Libya, Morocco, Croatia	Loggerhead
Bottom Trawl	All	Loggerhead, Green turtle
Drifting Longlines	Spain, Italy, Greece, Albania, Turkey, Cyprus, Lebanon, Egypt, Libiya, Tunisia, Algeria, Morocco, Malta	Loggerhead, Green turtle
Drifting Longlines	Spain, Italy, Greece, Albania	Leatherback
Pelagic Pair Trawl	Italy, Croatia	Loggerhead
Pelagic Trawl	France, Italy	Loggerhead

Regional Information-

Sea Turtle Areas of Significance

Adriatic Sea:
The shallow northeastern Adriatic Sea is an important region for overwintering and foraging loggerhead turtles. The southwest area logged the lowest catch rate. Casale *et a*l. (2004) conservatively estimated between 2,000 and 8,000 turtle captures per year occurred in the Italian trawl fishery.

Croatian, Slovenian, and Yugoslavian fisheries trawl during the winter, resulting in a high number of captures. Assessment should be done for every season in this area. Major interactions with adult turtles is assumed, but not known (Gerosa and Casale 1999).

Eastern Mediterranean:
Turtles are often caught as bycatch in this area (Caminas 2005).

Egypt:

Green turtles are caught and sold for human consumption, even if they were caught incidentally (Caminas 2005).

Gulf of Gabès:
Adult turtles frequent this area in winter. In summer, this is a foraging area for juveniles. Tunisian and Italian fishing effort needs to be assessed (Gerosa and Casale 1999). This area is prone to sea turtle bycatch from trawls (Mediterranean 2003).

Karatas-Cyhan fishing region:
This area had by far the most captured turtles, with 143 individuals. From 1995-1996, 186 individuals were captured throughout all six fishing areas. When divided by ”season,” most turtles were caught between December and February (70), while the second highest catch occurred between mid-October-and mid-November 20th, (55) (Oruc 1996).

Lakonikos Bay:
This is likely a feeding and overwintering area in the Aegean Sea with possible impacts on adults. Surveys are needed for the large Greek and Turkish fisheries (Gerosa and Casale 1999).

Levantine basins:
This area is fished by Egyptian and Turkish fleets. Accidental mortality reports are needed for impact assessments. This is a green turtle nesting area and a possible feeding and overwintering area (Gerosa and Casale 1999). Kasparek (2003) found that 78 percent of nesting occurred at only five beaches, particularly in this Basin area (Caminas 2005).

Libyan coasts:
The Libyan coast provides an important nesting area for loggerhead.s. Widespread use of gillnets and longlines. takes place here. These fishing gears could be harmful, but more research is needed(Gerosa and Casale 1999).

Northern Ionian Sea:
This foraging area for immature turtles and the Greek coasts also are important nesting areas. More research on green turtles and Italian fisheries is needed (Gerosa and Casale 1999).

The Western Basin (Alboran Sea, Balearic Islands area, Gulf of Lion, Corisica):
Immature turles feed here in the summer (during their pelagic phase)i. Few adults also have been found in the winter (Gerosa and Casale 1999).

Black Sea

The most recent account for total fish catch in the Black Sea is 523,000 tons per year. This includes Bulgaria, Russia, Georgia, Romania, Turkey, and the Ukraine. As stated previously, the Mediterranean subpopulation of loggerheads is critically endangered. There are no known marine turtle nesting beaches in the Black Sea, and loggerheads are only found in the western Black Sea near river mouths and occasionally in deep water (Caminas 2004).

Turkey & Cyprus

Turkey, due to lack of enforced regulations, has experienced a collapse of the Black Sea fisheries, which may put more fishing pressure on the Mediterranean (Gerosa and Casale 1999). In Turkey and Egypt, turtle captures occur year-round. Those locales have high water temperatures, which may provide overwintering. habitat. Winter captures have been recorded in the Adriatic, but the low water temperatures may prevent turtles from being active. Known benthic feeding grounds include Egypt, Turkey, the Gulf of Gabès, and the Adriatic. In the Adriatic and Aegean, female adults have been found nesting. Summer feeding grounds may include the Gulf of lion, Corsican waters, and the westernmost Mediterranean (Gerosa and Casale 1999).

In Turkey, endangered fish stocks and other endangered species studies are nonexistent. Thus, maintaining policies and planning for endangered species protection does not occur. Threats and those effects facing the Eastern Mediterranean are largely unknown. Protection efforts in the marine environment are absent in Turkey (Ayse Oruc 1996).

Surveys of Turkish fishermen revealed that 2.5 turtles were caught per boat, per year. Cyprus fishermen reported 4 turtles, per boat, per year. Frome these estimates, Godley (1998) calculated approximately 2,000 sea turtles were caught incidentallyper year from Alanya to Mersin.

The Turks use turtle blood and fat for medicinal purposes (e.g.., asthma treatment). In Cyprus, turtles are used for their meat and shell, and the carcasses are discarded (Godley 1998).

A study of green and loggerhead turtle bycatch in artisanal fisheries, calculated 170 fishing vessels in northern Cyprus and 531 in Turkey (between Mersin and Alanya). The statistics also revealed that 96% of the fishing vessels in Cyprus were small; the remaining 4% were large vessels. In Turkey, 77% of vessels were small; the remaining 23% were large. Using a median point estimate of 10% mortality, Godley *et al.* (1998) estimated 202 turtles were killed in this

fishery annually. Fishing effort peaked between May and September (Godley 1998).

According to interviewed fishermen, fishing effort in Turkey increases in the summer months, while effort in Cyprus is relatively stable year-round. In Turkey, bycatch peaks in June, while turtle sightings are highest in August. In Cyprus, bycatch peaks in July and August, and sightings are highest in July (Godley 1998).

According to 77% of surveyed fishermen in Turkey and 97% in northern Cyprus, turtles are thought to damage fishermen's livelihoods. In Turkey, however, turtles were not considered the most problematic species, both dolphins (18%) and monk seals (5%) were cited by respondents. In Cyprus, turtles were considered the main concern (78%) and dolphins were only cited as a problem by 9% of the fishermen (Godley 1998). Some of the turtles caught alive (an estimated 90%) may have been killed onboard by fishermen (Godley 1998).

When surveyed, 91% of the fishermen in Turkey reported the fisheries declining, all blaming overfishing. The trawl fishery was specifically noted by 80% of respondents(Godley 1998). In Cyprus, 78% of fishermen reported declining fisheries, and many of those respondents believed trawlers were the cause (Godley 1998).

Green sea turtles nest on very few beaches in both Cyprus and Turkey. The population is headed for collapse as the recruitment rates is extremely low. Along the Turkish coast, over 1,000 nets are set along more than 40km of beaches, which are crucial turtle nesting sites. Trawlers, longliners, and small-scale boats [nets] fish within the fishing-restricted coastal strip, off Kazanli, Turkey. Trawlers also fish within the three-mile coastal zone limit, which affects the green turtle population. Fishermen from Karatas report turtle captures year-round. Five trawlers reported catching 160 green turtles and 26 Loggerheads, over a 28 week period (Tudela 2000).

Fisheries interactions are significantly affecting the loggerhead population in Cyrpus, Greece, Turkey, and Libya. The green turtle population is significantly affected by fisheries interactions in Turkey and Cyprus. The Spanish and Italian surface longline, the Northern Adriatic Italian trawls, Tunisian trawls, Turkish trawls, Moroccan driftnets, and Italian driftnets are the primary fleets affecting marine turtles. Effects of artisanal fisheries have not been quantified(Caminas 2004).

Lack of Data

There are no published reports on the effects of fisheries in southern Cyprus, Syria, Lebanon, or Israel (Godley 1998).

VII. BYCATCH MITIGATION

The complexity of Mediterranean fisheries, with regard to gear types, fishing practices, species richness, allows fishermen to adapt quickly and work against fisheries management practices.

Coastal fisheries are essential to this region and are often better managed at the local or national level, since the local authorities have the capacity to act more quickly. Community intervention may prove necessary if fisheries are transnational (i.e. conservation, market, environmental reasons)) (Communities 2002). Required actions at the community level include reducing overall fishing pressure, applying catch limits where possible, improving current exploitation patterns, and reducing negative impacts to stocks and the environment. According to the 2002 FAO report, widespread knowledge of the need to reduce fishing mortality does exist (Communities 2002).

Bycatch mitigation of protected species is of importance in the Community Action Plan and the FAO International Plan of Action (Communities 2002). Economic measures, such as limiting boats and time at sea, and creating area closures, have proven more effective than technical management of the Mediterranean (Payne 2004). Improved participation of fishermen is helpful to improve compliance with management (Communities 2002).

For example, one recommendation for sustainability included redesigning the deep-sea shrimping fleet by reducing the size of the fleet and improving the efficiency of the vessels. This will increase their economic fitness (Sarda 2000).

Sea Birds

Proposed conservation measures for the Balearic Shearwater include studying long-line fishing and bycatch, and coordinating bans on trawl fishing to avoid the absence of fishing waste, which is an important food source for the species (International 2004).

Setting nets at night can reduce seabird mortality, while reducing economic losses. In the northwest Mediterranean, an estimated minimum of 11 baits/1,000 hooks were lost due to scavenging birds. Further, 80% of bait scavenging occurs at sunrise or sunset. Sanchez and Belda (2003) suggested fishermen set nets at night to reduce bait loss and seabird mortality. However, night setting may also reduce the target catch. Another technique to reduce bycatch trailing lines with floats designed to scare birds away, or setting nets underwater to prevent birds from attacking bait.

Many areas are not protected. Therefore, environmental impact assessments would be helpful in future conservation efforts as well as determining and quantifying the effects of anthropogenic activities on sea birds (Gallo-Orsi 2001).

Marine Mammals

Cetaceans

The Action Plan for the Conservation of Cetaceans in the Mediterranean Sea was adopted under the Barcelona Convention in 1991. In 2001, the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS) agreeing to the following:

- Prohibit the deliberate taking of cetaceans
- Prohibit driftnets longer than 2.5 km
- Prohibit discarding of fishing gears at sea
- Require the safe release of cetaceans caught accidentally.
- Promote the creation of a network of protected areas and marine sanctuaries
- Create measures to minimize the adverse effects on driftnets (Tudela 2000).

The most qualitatively significant and potentially perilous issue is mortality from fishing bycatch, primarily caused by drift nets (Tudela 2000).

The main provisions included a Conservation Plan which prohibits deliberate taking of cetaceans and implements the precautionary principle for all parties. Parties also were required to adopt the ways to minimize adverse fisheries effects on cetaceans listed above (IGFIL Treaty Database. Guide to Fisheries Law).

To protect cetacean populations, goals include, but are not limited to: rebuilding degraded ecosystems, eliminating dynamite fishing, stopping dolphin kills by small-scale fishermen, implementing educational programs for fishermen, that focus on how to reduce cetacean bycatch and mortality, and ending illegal use of dolphin meat as bait in two Spanish ports. Furthermore, since the tuna purse seine fishery is growing quickly, monitoring will become essential to avoid adverse effects to the dolphin populations. Currently, the French tuna fishery is responsible for the leading tuna catches in the region (Tudela 2000).

ICCAT (Recommendation 03-04) and the European Union require the complete eradication of Mediterranean driftnet fishing in the most timely manner possible. The Alboran Sea is home to the final remaining healthy population of common dolphins in the Mediterranean. This population is threatened, however, by high bycatch rates from the Moroccan driftnet fleet (Tudela 2000).

As suggested in the Institute Centrale per la Ricerca Scientifica e Tecnologica Applicata al Mare (ICRAM) report, research on the overlap between fishing activities and the ranges of individual dolphins, maps of areas where negative interactions take place between dolphins and fisheries, map of areas where negative interactions do not take place, and characterization of local fishing techniques would be vital to creating mitigation solutions. In order to quantify effects on dolphin populations, the region must establish networks to facilitate communication and response to strandings/entanglements, and identify experts who can supervise necropsies and provide advice about releases. Further recommendations include: implementing clear strategic goals in the Mediterranean;, gathering quantitative data on the interactions of dolphins and Mediterranean small-scale commercial fisheries, including costs and effects of interactions to the dolphin populations, and creating a long-term management program to record dolphin mortality, including determining if fishermen are taking retaliatory measures against dolphins (Reeves 2001). Currently, 26 Odontocete species have been reported ingesting plastic or marine debris. Thus, when creating management plans, protection measures for these species also must take into account marine debris (Tonay 2007).

The ICRAM workshop discussed the current situation with fisheries and marine mammals in the Mediterranean. Workshop participants did not believe that bottlenose dolphin, short-beaked common dolphin , and Mediterranean monk seal populations are declining, or even that their populations are uncertain. As the region's fisheries have become marginal, dolphins are seen as competitors for the fish. Predator control has changed from harassment to deterring dolphins using non-lethal acoustic devices (Reeves 2001).

Monk Seals

Mediterranean monk seals have been reduced to two exclusive populations, one in the northeast Atlantic and one on the northwest coast of Africa (Johnson) year). More research is needed on the diving behavior of young seals and pups (Gucu 2004). Marine Protection Areas (MPAs) have been established in very few areas thus far. In situ methods, such as creating more MPAs, no-fishing zones, and seal rescue and rehabilitation programs could improve the outlook for this species (Johnson, year). The Turkish Ministry of Agriculture has banned all types of trawl and purse seine fishing in 15 square miles covering monk seal habitats (Tudela 2000).

Tense fishermen-seal relationships usually occur in the small-scale fleets that use nets. Overfishing exacerbates the problem, yet it is the medium-scale fleets that cause the overexploitation of fishing grounds (Gucu 2004)..

Illegal dynamite fishing in Kefallonia, Greece, and Turkey; fishing with chemicals, ; and using small fry for aquaculture seed threaten common fish resources in the

eastern Mediterranean. Tourism also increases seasonal demand for fish and may contribute to the shortage of food resources for the monk seals (Tudela 2000). Gucu (2004) points out that starvation reduces seal breeding success, therefore a management plan to secure food availability for both seals and fishermen is a key component for an ecosystem-based conservation method (Gucu 2004).

Fisheries management in the Mediterranean needs to encompass sustainable practices of complete marine ecosystems, including monk seals, as they are apex predators (Tudela 2000). Reducing the fishing pressure on monk seal feeding grounds is important to secure their food source, breeding success, and ultimate survival (Gucu 2004). Thus, critical habitats need to be protected under a management plan (Dendrinos 1999). Based on the biology of the Cilician monk seal colony, a MPA with two specific zones is recommended, one prohibiting human activity (protected breeding habitat) and one restricted fishery zone (protecting food source)(Ali Cemal Gucu 2004). A number of core zones would ban all human activity, particularly the gill net fishery (especially bottom set nets). The core zones would encompass the breeding caves (Gucu 2004).

Intentional killing is the primary cause of monk seal deaths (UNEP 31 March-3 April 2004). By enforcing currently unenforced rules, the priority for monk seal protection should be to halt seal killings and disturbance to their caves.

According to the FAO, the only acceptable level of fishing-related mortality is zero. Eliminating deliberate killings by fishermen, eliminating incidental entanglements in nets, and implementing effective management plans to prevent overfishing and rebuild depleted food resources are critical to preserving the remnant population of monk seals.

The most integrated solution for monk seal protection is to incorporate MPAs and the involvement of local artisanal fishermen. Immediate financial compensation for fishermen affected by seal attacks and campaigns to inform fishermen is are necessary.

- **Sea Turtles**

Reducing bycatch of marine turtles could be achieved by creating fishing bans, restricting gear use and protecting important habitat areas, monitoring fleets and gear use, and implementing other management practices (Caminas 2004). Possible solutions to limit indirect mortality of turtles are to create national public-awareness campaigns, increase direct contact between researchers and fishermen, enforce national protection laws with coercive monitoring bodies (Gerosa and Casale 1999), and switch to more selective gear. Turtles are believed to damage fishing nets, spoil catch, or remove bait. While most surveyed fishermen denied killing turtles, the majority of them stated that they thought other fishermen in the area kill turtles (Godley 1998). Immigration of

outside turtle populations into the Mediterranean is not likely to counterbalance fishing-related mortality. Therefore, the Mediterranean sea turtle population depends on conservation efforts within the Mediterranean to reduce "accidental mortality (Gerosa and Casale 1999)."

Methods to reduce turtle bycatch in longlines include using larger hooks (circle hooks?) that are less likely to be ingested, and setting hooks deeper in the water. Loggerheads spend most of their time above 60 meters and dive no deeper than 100 meters (Casale 2007). Branchlines made of rapidly degrading material could reduce turtle mortality. The acidity of turtle's stomachs could have enough time to break the line, while the intestine can, over time, expel the material (Casale 2007).

Lack of reliable mortality estimations makes it difficult for decision-makers to implement conservation strategies with the sense of urgency that may be necessary (Casale 2007). It is easiest to implement measures that are voluntarily acceptable to fishermen. An example of this is using different types of hooks that reduce the risk of bycatch but do not affect catch rates of their target species (Casale 2007).

The central Mediterranean has remarkable biodiversity that could benefit from an ecosystem-based management (EBM) approach to the fisheries. The countries that significantly fish this region are Italy, Tunisia, Libya, and Malta. Consequently, management efforts should target these four countries (Casale 2007).

Green turtles' restricted nesting habitat around the Asi River may function as an advantage for conservation, making cheaper, more efficient options available. However, without conservation measures, the species is more susceptible to extinction. Green turtles would benefit from protection of the Asi River and three kilometers on each side, which would include a 6,000-12,000 meter segment of beach (Sukran 2007).

Samandag Beach, near the Syrian boarder of Turkey, is one of the three crucial eastern Mediterranean nesting beaches for green and loggerhead sea turtles. According to a five-year study, Samandug Beach composed 17.7% of green sea turtle nesting habitat in the Mediterranean. In the study period from 2001-2005, sea turtle emergence in Samandag Beach was prevalent in July, and turtles maintained an average hatching success of 70.4% (green) and 71.8% (loggerhead)(Sukran 2007). In 2001, a local commission established by the Turkish Ministry of the Environment formed to monitor and conserve sea turtles on Samandug Beach. After training support in 2002, conservation measures persisted for several years. These actions included nest and hatchling protection, prevention of illegal sand extraction, fishermen education and awareness and integration of NGO's into conservation efforts. University

volunteers recruited local NGO's and governmental organizations to join the conservation campaign (Sukran 2007).

The Barcelona Convention adopted the Action Plan for the conservation of Mediterranean Marine Turtles in 1989, recognizing fishermen are the most severe threat to turtles at sea. Fisheries provide revenue in countries where only artisanal fishing takes place. The larger continental shelf in the northern Adriatic (Tunisia and Lybia) provides a resting and wintering area for turtles. Numerous studies have found that a turtle's contribution to the demographic growth of the population was related to its size, where larger individuals had a greater effect. Thus, conservation efforts should aim to protect large juveniles and adult turtles (Gerosa and Casale 1999). As previously stated, the most important life phase for turtles is the pelagic, when they reside in the relatively shallow waters of the continental shelf (Gerosa and Casale 1999). Reducing bycatch is important in two user groups, artisanal and commercial fishers. These groups differ in operating pattern and economic interest. In longlining, gear modifications include hook type and bait. There are knowledge gaps on how modifications work in other regions and other fisheries. Modifications such as using circle versus J-hooks and using mackerel for bait versus squid can decrease sea turtle bycatch (FAO 2004).

Turtles can cause an economic loss to fishermen including loss of hooks, bait, branch lines, or other gear. Capturing turtles also decreases fishing effort and yield due to the reduction of hooks and time to replace the gear (FAO 2004). Future mitigation measures include gear modifications for higher selectivity and raising fishermen awareness of dehooking and handling turtles. Other options include closing fishing areas or closing seasons and reducing chemical light stick use because it my inadvertently attract turtles. Fishermen usually do not bring turtles on board because this creates an even greater loss of time and effort. Fishermen that handle and dehook turtles lower their fishing operation efficiency (FAO 2004).

Hooks should be removed from live turtles immediately. Driftnets often cause anoxic brain damage due to prolonged immersion, which leads to death. Protecting nesting beaches can reduce the capture of adult turtles. Currently, fishing restrictions are often violated in coastal waters. Improving trawling gears by requiring turtle excluding devices (TEDs), reducing trawl times to 60 minutes or less, banning fishing during the nesting periods, improving experimental tagging that may increase risk of entanglement, and raising awareness could all effectively help the sea turtle population (Tudela 2000).

Long-term conservation requires international cooperation with bordering countries. Obtaining additional data, implementing regulations and agreements, efficient management planning, and monitoring the effects on turtle populations are obligatory recommendations for the region (Paolo Casale 2007). Armed with more information, managers can better understand where to target conservation efforts (Gerosa and Casale 1999).

- *Reducing fishing mortality*

While single fisheries may not have a vast impact, collectively fisheries and other impacts create a recovery challenge for sea turtles (FAO 2004). Reducing the fishing effort is the most effective way to protect the marine community and is the most wide-spread method in the Mediterranean. Caddy and Oliver (1996) found that quota control for target species was not an optimal management tool. Instead, switching to more selective gear may yield more positive results. Bycatch Reduction Devices (BRDs) can improve gear selectivity. Reduction of the fishing effort can be reached by limiting the number of fishing vessels, limiting total and individual power, and limiting total fishing time (Gerosa and Casale 1999).

Reducing bycatch can be achieved by adopting measures to protect the ecology of the species and their habitats, including both geographic and temporal restrictions (Gerosa and Casale 1999).

Trawling is known for its large amount of bycatch. To protect sea beds and nursery areas, countries often protect the nearshore areas (50 meters deep or less) from trawling. Marine reserves are another method of protection, and are particularly effective when used in conjunction with a reduction of fishing effort in neighboring areas. An expensive, more drastic solution involves putting obstacles on the sea bottom that would damage nets. Seasonal reduction measures can be useful in protecting the species in the most vulnerable stage of their life-cycle (Gerosa and Casale 1999).

- *Turtle Excluder Devices (TEDS)*

TEDs were invented in the USA, to aid in reduction of sea turtle mortality in shrimp fisheries. These devices also reduce other bycatch, which could provide broader habitat protections (Gerosa and Casale 1999). Casale *et al.* (2004) noted that TEDs are designed for shrimp trawls and would not be a viable solution for the Adriatic with catch species larger than 50 centimeters, as well as batoids (*e.g.*, stingrays, skates). (I disagree with this, the new US TEDS effectively exclude adult loggerheads 80 cm and greater)

Bycatch from trawlers mainly depends on trawl duration. The maximum trawl time should not exceed 60 minutes bottom time in cold waters (National Research Council recommendation,Gerosa and Casale 1999).

In the Mediterranean, shrimp is not a target-species for trawling fleets. Only Tunisia and some of Spain and Algeria have shrimp landings. Regarding turtles,

the best alternative is to ban fishing in specific areas and seasons (Gerosa and Casale 1999).

It is questionable if TEDs would be adopted in the Mediterranean trawl fisheries. Adopting onboard handling procedures and awareness campaigns is a more feasible suggestion. Additionally, using larger hooks that turtles cannot ingest and setting hooks deeper can reduce turtle bycatch. These solutions do not apply to bottom longlines, but alternative mitigation strategies could be assessed. Casale (year) recommended further research and implementation of the following mitigation measures:

- Awareness campaigns targeting fishermen (reduce post-release mortality)
- Test technical changes, such as gear modifications, in the field and then implement the changes in pelagic longlines
- Estimate mortality of turtles in bottom trawls with long-haul durations and possible mitigation measures
- Estimate bycatch from bottom longlines, turtle mortality rates, and mitigation strategies
- Investigate the relative contribution of different populations to the population of turtles in the central Mediterranean, to assess impact of fishing activities on individual species demography.

Further data on catch rates, fishing parameters, and spatio-temporal distribution of turtle captures are needed. Onboard observer programs can be used to collect this information.

- *Management and Conservation*

Lost or abandoned gear, called “ghost gear” or “ghost nets,” catch everything including marine debris. This mortality factor could be reduced by targeted management actions (Gerosa and Casale 1999). This needs to be expanded or removed.

Fishermen play a key role in turtle conservation programs, as they are in direct contact with the marine life. Fishermen can be directly involved in the following ways: supplying data for research; allowing observers on board; assisting with turtle rehabilitation (decreasing direct mortality); discouraging illegal trade (decreasing indirect mortality); and providing advice on correct use and gear maintenance (Gerosa and Casale 1999).

If fishermen find turtles economically rewarding, regulations and gear modifications are less significant. The demand for turtles needs to diminish. Enforcing and integrating laws and effective awareness campaigns could aid this situation (Gerosa and Casale 1999).

Nesting sites are commonly inhabited in summer months (both adults and hatchlings). Moving fishing activities away from the coast during nesting months could reduce effort in high density turtle areas (Gerosa and Casale 1999).

Research priority should be on fishing activities in areas with the biggest classes or turtles and areas with high turtle densities. Emphasis should also be in areas with fishing activities carried out by a few countries, thus minimizing problems with national regulations (Gerosa and Casale 1999).

IX. Conclusion

The following section summarizes regional policy alternatives potentially available:

Seabirds

In Mediterranean fisheries, bottom and surface longline fishing primarily cause seabird mortality. Because seabirds are attracted to bait, this proves fatal for the birds and can be disadvantageous to fishers, due to the loss of bait and damage to gear (Tudela 2000). Nocturnal setting prevents predation on bait, as does setting nets underwater or using training lines with floats to scare birds away. Priority measures included finding improved fishing methods to reduce discards, incidental bycatch, and impact on habitats. The FAO Commission of the European Communities stated cetaceans and sea birds as a priority for protection. Improving fishing methods included reducing or eliminating discards, incidental bycatch, and impact on the sea bed (Communities 2002). Implementing policies that require all or some of the above could reduce sea bird bycatch.

Marine Mammals

Cetaceans are adversely affected by numerous gear types. Eradication of driftnet fishing would significantly reduce marine mammal bycatch (Tudela 2000). Also, stronger regulations against deliberate killings are needed. As the region's fisheries fish stocks have become more marginaldepleted, dolphins are seen as competitors for the fish source. A similar trend occurs with the endangered Mediterranean monk seal around Greece and Turkey (Randall 2001).

Since the tuna purse seine fishery is growing quickly, monitoring will become essential to avoid adverse effects to the dolphin populations (Tudela 2000). Through monitoring reports, policy-makers will be more knowledgeable about which species are being caught and where most bycatch occurs.

While an effective solution, fishing capacity reduction--a more drastic measure--is best achieved through reductions of subsidies or vessel decommissioning. As in any region, reducing fishing capacity often is an unfavorable measure, as because fishers resist such changes. and it could cause a decline in the local economy.

Lastly, one solution proposed to protect Mediterranean Monk Seals, creating is to create Marine Protected Areas (MPA), with two zones would be functional. One zone would prohibit human activity to protect breeding habitat, and one would be a restricted fishery zone to protect their food source (Gucu 2004). By protecting breeding caves and reducing bycatch, this severely declined population may have a chance at survival and maintaining a small part of the biodiversity in the Mediterranean.

Sea Turtles

Reducing bycatch of sea turtles could be achieved by creating fishing bans, restricting use of and protecting important habitat areas, and monitoring fleets and gear use (Caminas 2004). Creating fishing bans and restricting use of important areas, including feeding and nesting habitats (e.g. Cyprus, Greece, Turkey, and Libya) could protect turtle populations for future generations. Monitoring fleets and gear use could increase understanding of sea turtle bycatch and allow for more accurate and effective policies. TEDs can reduce bycatch beyond turtles, saving fishers time and money by reducing both non-target catch and damage to gear (Caminas 2004).

Assuming all comatose sea turtles that are caught (and cannot swim) die, the potential mortality rate is 43.8%. This is logically a dire threat to the sea turtle population (Casale 2004). Fisher education can reduce mortality after turtles are caught. In longlines, if fishers cut the branchline close to the turtle, the turtle has a chance of survival, because sometimes it can expel the hook. Furthermore, if fishers catch a turtle in a comatose state, by keeping it onboard to recover, it has a chance to survive. If they release comatose turtles, the turtles will die because they cannot surface to breathe (Casale 2004).

Parting Thoughts

This region is complex and the problems herein are hard to solve. There is no enforceable or existing international law, nor a law involving all Mediterranean countries. Second, unknowns still exist in the fisheries, such as the biology and ecology of the species involved. Clandestine trades, for turtles in particular, are unidentified. Thus, inability to regulate trade that is illegal or unreported makes regional cooperation and education through sharing information and maintaining biodiversity databases difficult. Third, many unselective bottom gears are used in the Mediterranean, inflicting 'collateral damage' on the ecosystem. Gear types and their effects on the ecosystem should be assessed and prohibited, if necessary, such as the hydraulic dredging that once took place in Italy.

Finally, closing off small areas of habitat fishing could lead to positive ecosystem benefits over time. Benefits of no-take areas include genetic and biodiversity protection. These areas function as a more precautionary management approach for the marine environment. Additional research for all taxa affected by bycatch is needed. Education and outreach programs are key to increase public understanding, which can stir change. And finally, collaboration in the vast Mediterranean Sea is obligatory to reduce bycatch of taxa sharing a body of water with such multifaceted jurisdiction.

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