# Biodiversity impact of the Moroccan driftnet fleet operating in the Alboran Sea (SW Mediterranean)

*A case study of the harmful effects inflicted by current IUU large-scale driftnet fleets in the Mediterranean on protected and vulnerable species*

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# Contents

# Foreword

## About this document

In its 27th Session of 2002 the General Fisheries Commission for the Mediterranean (GFCM) mandated its Subcommittee on Marine Environment and Ecosystems (SAC/SCMEE) to:

> *"Provide an overview of driftnet and surface gillnet fisheries in the Mediterranean, broken down by main basin and geographical sub-areas. Essential points to report on are: fishing effort (Number and size of vessels, size of gears, duration of fishing), technical characteristics (mesh sizes, rigging, marking, control of drift), measures for environmental protection (prevention of gear loss, acoustic alarms) and research programmes in course for this type of fisheries, in particular those aiming to investigate by-catch."*

In 2003 the SAC/SCMEE, in turn, by realizing that no data whatsoever had been submitted from the concerned countries in spite of clear evidences pointing to the existence of IUU large-scale driftnet fleets inflicting mortality on protected and vulnerable species, recommended the GFCM Scientific and Advisory Committee (SAC):

> *"1) To ask the concerned flag countries with driftnet fleets operating in the Mediterranean to submit to the SAC/SCMEE next year all the information required by GFCM in its 27th Session (fishing effort, technical characteristics, by-catch, etc.); 2) To ask the GFCM formally reminding all GFCM member states the binding nature of the GFCM Resolution 97/1 banning large-scale driftnet fishing in the Mediterranean, also asking for their full compliance; 3) To assess the possibility of recommending GFCM adopting a more restrictive binding resolution totally banning driftnet fishing in the Mediterranean, in line with EU Regulation No 1239/98 (totally banning driftnet fishing of tuna and tuna-like species), as the only realistic way to ensure compliance with international obligations in force and avoid current IUU practices."*

Under a different context, Silvani *et al*. (1999) carried out a study of the incidental catches by the former Spanish driftnet fleet operating in the Alboran Sea in the period 1993-1994 and concluded the following:

> *"Further information is **urgently** needed on the number of boats and the pattern of operation of the Moroccan and Italian driftnet fleets [in the Alboran Sea], as well as their associated catches."*

Taking into account the framework configured by these antecedents, this scientific report by WWF arises as the first field assessment of the ecosystem impact of the Moroccan large-scale driftnet fleet operating in the Alboran Sea and nearby Straits of Gibraltar area, that seems to currently account for the bulk of this illegal –IUU- fishing practice in the entire Mediterranean basin. All estimates and calculations have been made following a conservative approach, as it is stressed in the document, so most of the results obtained should be regarded as a lower estimate of the actual magnitude of the problem.

Though focused on the activity of the Moroccan fleet, this study doesn't seek to put all the burden of the problem on this specific country. Similar practices are still in place at least in France ('thonnaille'), Italy and Turkey (Tudela, 2003). Rather, taking as a case study the Moroccan fishery, it warns against the current persistence of an illegal harmful fishing practice that is entailing a dramatic effect on the biological diversity of the Mediterranean Sea.

This research is expected to contribute with useful information to fulfill the mandate of the scientific bodies of GFCM, ICCAT, IWC and ACCOBAMS, among other international organizations dealing with fisheries and incidental catches of vulnerable species in the Mediterranean Basin.

# Executive summary

A total 369 fishing operations (worth 4140 km of driftnets set) by a subset of 4-5 boats from the driftnet fleet targeting swordfish based in Al Hoceima (Mediterranean coast of Morocco) were monitored between December 2002 and September 2003, focusing on the captures of the target species and the major by-catch groups. Parallel surveys were made in the ports of Al Hoceima and Nador, on the Alboran Sea Southern coast, and Tangiers, in the Gibraltar Straits area, to ascertain the magnitude of the fishing effort deployed and the main features defining the driftnet fishing pattern in the area. Results showed a total active driftnet fleet conservatively estimated at -at least- 177 units, less than half the size reported by official sources. Estimated average net length ranges from 6.5-7.1 km, depending on the port, though actual figures are suspected to be much higher (perhaps 12-14 km) according to field evidences. These figures point to a lack of compliance with the maximum legal length of 2.5 km according to national and international legislation, which makes this fleet to qualify for IUU (Illegal, Unreported and Unregulated fishing) according to FAO definition. Most boats of this fleet are able to use driftnets all year round, what results in very high annual effort levels that translate into high by-catch figures. It arose from our monitoring work that dolphins (both species: short-beaked common dolphin, *Delphinus delphis,* and striped dolphin, *Stenella coeruleoalba*), together with pelagic sharks (blue shark, *Prionace glauca*, shortfin mako, *Isurus oxyrinchus,* and thresher shark, *Alopias vulpinus*) are the most impacted groups, at least in absolute numbers. Other cetaceans such as the pilot whale (*Globicephala melas*), the bottlenose dolphin (*Tursiops truncatus*) or the fin whale (*Balaenoptera physalus*) are also known to be commonly caught. Loggerhead turtle (*Caretta caretta*), in turn, was caught moderately from December to April, being much less frequent in the captures during summer. These observations on loggerhead by-catch provide evidence in support of the migratory hypothesis for the population inhabiting the Alboran Sea. As much as 237 dolphins, 498 blue sharks, 542 shortfin makos and 464 thresher sharks were killed by the boats monitored during the sampling period, that encompassed the peak of the swordfish fishery, along with 2990 swordfish. By-catch estimates for a 12-month period by the whole driftnet fleet yielded a figure of approx. 1500-2000 striped dolphins and 1500-2000 short-beaked common dolphins in the Alboran Sea alone; according to our estimates a further 13000 individuals (50% corresponding to each species) would be killed annually by the fleet based in Tangiers around the Straits of Gibraltar and neighboring areas, mostly outside the Mediterranean Basin. As for sharks, about 23000 individuals are captured annually by the fleet from Al Hoceima and Nador and a further 77500 would be caught by the fleet of Tangiers, distributed in roughly equal proportions for *P. glauca*, *I. oxyrinchus* and *A. vulpinus*. These results point to an unsustainable impact, especially for dolphins, which could be suffering from annual take rates higher than 10% of their respective population sizes in the Alboran Sea. This is specially worrying in the case of *D. delphis*, that has in the Alboran Sea its last remnant healthy population in the whole of the Mediterranean.

# 1. Introduction

## 1.1. Driftnet fishing

Driftnets are defined by FAO (Glossary of Gear Types, FIGIS Fact Sheets) as a fishing gear "*consisting of a string of gillnets kept more or less vertical by floats on the upper line and weights on the lower line, drifting with the current, in general near the surface or in mid-water.*" The same source recognizes that "*the principal negative environmental impact produced by this type of nets is related to the by-catch of non-target species like marine mammals, seabirds and to a minor extent turtles … Despite the UN ban on large scale drift nets, serious concerns exist regarding ongoing violations*".

Worldwide, very light synthetic fibers allow to medium-scale and even small-scale boats deploying driftnets of many kilometers long, that are made of a series of smaller net panels or units attached between them. The different driftnet fisheries are mostly characterized by the following variables: target species, height of gillnet, soak time (normally less than 24 h) and the number of panels or units tied (that is to say, the total length of the net).

In the Mediterranean, driftnets have been used to capture several species of tuna and swordfish. Currently, the bulk of the remaining activity is focused to the latter species, which is also harvested throughout the Mediterranean by longlines.

## 1.2. The legal framework on driftnetting in the Mediterranean

The international debate on the harmful effects of driftnets on biodiversity, fuelled by the overwhelming worldwide evidences of massive by-catches of vulnerable marine species, was particularly virulent in the 80's and 90's. Scientific studies pointing to an intrinsically low selectivity of this gear with respect to non-target species crystallized in international binding legislation aiming at totally or partially eradicating these fisheries.

This way, Resolutions 44/225 and 46/215 adopted in 1989 and 1991 by the General Assembly of the United Nations recommended the imposition of a moratorium on all large-scale pelagic driftnet fishing by 30 June 1992. To endorse this legislation, European Regulation (EC) No 345/92 prohibited driftnet fishing in the Mediterranean with nets more than 2.5 km in length, as did the General Fisheries Commission for the Mediterranean (GFCM) in 1997 under Resolution 97/1[1], one of the few binding recommendations (that is, adopted under Article V of the GFCM Agreement) ever laid down by this regional fisheries body. Effective moves to restructure the EU driftnet fleet in the Mediterranean (especially the Italian one) have been made since the adoption of European Regulation (EC) No 1239/98 and later regulations totally banning the use of all kind of driftnets by Community fishing vessels within and outside Community waters from 1 January 2002.

As for the relevant international body in charge of the management of tuna and tuna like species in the Mediterranean, the International Commission for the Conservation of Atlantic Tuna (ICCAT), it also endorsed UN Resolutions 44/225, 45/197 and 46/215 and requested its contracting parties to support them. Accordingly, through Resolution 96-15[2] it

[1] see Annex 1
[2] see Annex 2

charged its Compliance Committee and the Permanent Working Group for the Improvement of ICCAT Statistics and Conservation Measures (PWG) to monitor compliance with UN Resolutions within the ICCAT Convention Area.

In summary, from a legal point of view the use of all kind of driftnets (irrespective of the total length and the fact of being or not attached to the boat) is totally banned in the Mediterranean to EU member states (Spain, France, Italy and Greece; and soon Malta, Cyprus and Slovenia). As for the other coastal states, including Morocco, the binding GFCM Resolution 97/1 in force limits the length of legal driftnets to only 2.5 km, unless national legislation is more restrictive. All fishing activities carried out outside this legal framework must be considered IUU fishing[3] (Illegal, Unregulated and Unreported), thus gravely violating international legislation such as the 1995 Fish Stock Agreement and strongly eroding the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU), a voluntary instrument within the framework of the FAO Code of Conduct for Responsible Fisheries.

## 1.3. Evolution of driftnet fisheries in the Alboran Sea

According to Silvani *et al*. (1999), following their introduction in the 1980's, about 100 Spanish boats using driftnets targeting swordfish were active in the Alboran Sea in 1990. This fleet was based in the ports of La Línea de la Concepción, Algeciras, Tarifa and Barbate, and operated in the Mediterranean and the adjacent Atlantic waters, on both sides of the Gibraltar Straits. As a result of the international ban on large-scale driftnets the activity of this fishery was permanently halted in August 1994. The remnant 27 boats entailed an incidental mortality of 366 dolphins in 1993 and 289 in 1994 (*Delphinus delphis* and *Stenella coeruleoalba* roughly in equal proportions).

In parallel, another driftnet fishery quickly developed in Northern Morocco, involving the ports of Larache, Asilah, Tangiers, Al Hoceima and Nador, focused on the same swordfish stock and operating in fishing grounds located in the Alboran Sea and nearby Atlantic waters. In 1995, the final report of the EC Project SUROESTE (Universitat de Barcelona, 1995) reported that the Moroccan driftnet in the Alboran Sea at that time probably exceeded 200 vessels and that the length of the net used was known to often exceed 2.5 km. The authors concluded that:

> *"… the magnitude of the cetacean catches incidental to the activities of this fleet is unknown, but it is believed not to be lower than that observed for the Spanish fleet."*

The reports submitted by the Institut National de Recherche Halieutique (INRH, Morocco) in 1999 and 2000 in the context of the Project 'Tunidos' under the FAO COPEMED Project[4] described that the Moroccan driftnet fleet developed in the beginning of the 1990's, being composed of 275 'active' boats in Tangiers and a further 45 in Nador. The length of each piece of net is reported to be 100 m, the total length of the gear ranging 'most frequently' from 2000 to 3000 m (20 to 30 pieces of net or driftnet units). Total fishing effort in 2000 by the fleet based in these two ports is reported at 5651 fishing days.

[3] see defintition of illegal fishing in IPOA-IUU in Annex 3 and ICCAT endorsement of this definition in Annex 4

[4] http://www.faocopemed.org/es/activ/research/tuna/tunidos00/general.htm

Accessory catch is described as composed mainly of sharks: *Alopias vulpinus*, *Isurus oxyrinchus* and *Prionace glauca*, as well as of blue marlin, *Makaira nigricans*.

Furthermore, according to the Standing Committee on Research and Statistics (SCRS) of the International Convention for the Conservation of Atlantic Tunas (ICCAT), to which Morocco formally reports its national fisheries information on large pelagic species, Morocco has a current driftnet fleet targeting swordfish of about 370 boats in the Mediterranean (from Asilah to the Algerian border) (document SCRS/2003/015). This same source specifically recognizes that this fleet is carrying out 'large-scale driftnet fisheries' (i.e., IUU fishing according to the legal framework in force detailed in section 1.2. above).

All driftnet boats in Morocco are officially classified into the category of 'longliners' since most of them, especially in Tangiers, were former surface longliners targeting swordfish. In Al Hoceima, on the contrary, the current fleet has a diverse origin; the original fleet was a polyvalent fleet engaged in bottom longlining and other artisanal fishing practices. This way, whereas the target species remained the same in Tangiers, in Al Hoceima it totally changed from demersal fish to swordfish.

The fishery shows a marked seasonality in terms of both fishing effort deployed and volume of catches, as a consequence of the migratory nature of the target species and the extreme sensitivity of the fishery face to rough weather conditions (especially in the case of the fleet based in Mediterranean ports). Swordfish appear to enter the Mediterranean Sea throughout the Gibraltar Straits from May to June, the return westward migration lasting from August to November (Camiñas, 1997). This migratory behavior determines the mobility of the driftnet fleet around the Alboran Sea, the Gibraltar Straits and adjacent Atlantic grounds, during the year.

## 1.4. Biodiversity importance of the Alboran Sea

The Alboran Sea (see map in Figure 1) is an outstanding area for biodiversity in the Mediterranean, being a transitional zone between the Atlantic Ocean and the Mediterranean Sea. The specific hydrological features linked to the exchange of waters through the Gibraltar Straits -such as the introduction of superficial Atlantic waters that generates an anticyclonic pattern of water circulation resulting in the upwelling of deep water rich in nutrients, and the Almeria-Oran hydrological front, that constitutes the western boundary of the Alboran Sea and act as a barrier to the distribution of many species- as well as the fact that it is crossed by all animal populations migrating through the Gibraltar Straits results in a unique biodiversity makeup with a strong Atlantic influence. At this regard, Lloris and Rucabado (1998) describe that

> *"The Alboran Sea can be regarded, to some extent, as an Atlantic biogeographic province placed at the western end of the Mediterraneran basin, its evolution being strongly influenced by the dynamics of surface waters or Atlantic origin".*

As for internationally protected species, the Alboran Sea is key for the migration of loggerhead turtle (*Caretta caretta*) from the Atlantic to the Western Mediterranean (Camiñas, 1997) and hosts –either on a sporadic or permanent basis- a high diversity of cetacean species (Universidad de Madrid and Alnitak, 2002). Among the resident ones it deserves particular attention the short-beaked common dolphin (*Delphinus delphis*), its population in the Alboran Sea being the healthiest in the Mediterranean after a dramatic decline of the species in most of its Mediterranean range.

Indeed, according to Notarbartolo di Sciara (2002), the latter species underwent a dramatic numerical decline during the last decades, and has almost completely disappeared from large portions of its former range (e.g., the northern Adriatic Sea, the Balearic Sea, Provençal Basin, and Ligurian Sea). Apart from the Alboran Sea population, small and apparently isolated communities of this species can only be observed in northern Sardinia, southern Tyrrhenian Sea, Sicily Channel, eastern Ionian Sea, and northern Aegean Sea.

According to worldwide evidences accumulated during many years on the biodiversity effects of driftnet fishing, cetaceans, marine turtles and elasmobranchs (other than swordfish, the target species of the fishery) are the biodiversity components of the Alboran Sea presenting an *a priori* higher risk face to large-scale driftnet fishing in the area.

# 2. Methodology

## 2.1. By-catch monitoring scheme

This study is based on the systematic daily monitoring of the fishing activity by 4 representative large-scale driftnet boats based at the port of Al Hoceima, one of the main fishing harbors of the Mediterranean Moroccan coast, along an uninterrupted period of more than 8 complete months (December 2002 – September 2003) encompassing the peak of driftnetting activity (spring-summer months).

The scientific methodology followed in the study has been tailored to the special circumstances surrounding this fishery, so as to allow for the collection of a set of high quality data susceptible to undergo a rigorous analysis able to yield robust scientific conclusions. Indeed, coinciding in time with the start of the fieldwork, the Moroccan Government circulated among the sector a draft project of a legislation banning driftnets[5], for public consultation. This triggered a big debate among the fishing sector, led by the fishing chamber of Tangiers (which encompasses all Mediterranean fishing ports and Larache), which strongly opposed to this measure. In this context, the atmosphere was extremely hostile to any attempt to rely on the boarding of observers alien to the fishing sector itself for data collection. In addition, skippers were also reluctant to accept foreign observers, given that a share of the total swordfish catch is unreported with the end of saving taxes. To overcome this problem, it was decided to work directly with a few reliable crewmembers from the 4 concerned boats, obtaining the daily data on catch composition directly from them, on their arrival from the fishing operation whenever possible. To secure stochastic independence of data, every collaborator was kept unaware of the existence of the others. All the collaborators were regularly paid a moderate sum in exchange for their cooperation and weren't informed about the precise purpose of the project. The person in charge or coordinating the gathering of information was native from Al Hoceima; he was familiar to the fishing harbor and a fluent speaker in the local tamazight language.

The information gathered focused on the most relevant items making part of the catch and the by-catch of the swordfish driftnet fishery, the list of such priority species being refined on an adaptive way. Selected by-catch species were purposely chosen according to both the magnitude of their by-catch and their conservation importance. It included 'swordfish' (*Xiphias gladius* and some sporadic billfish captures), 'marine turtles' (*Caretta caretta*), 'dolphins' (*Delphinus delphis* and *Stenella coeruleoalba*), blue shark (*Prionace glauca*), shortfin mako (*Isurus oxyrinchus*), thresher shark (*Alopias vulpinus*) and sunfish (*Mola mola*). Catch data were recorded as number of individuals per fishing operation. Also, information on effort was obtained, both as total length of net set per fishing operation and total net soaking time (by recording time at start of net setting and time at start of net hauling). Other complementary information such as fishing ground, other catches, etc. was recorded whenever possible.

Regarding dolphin by-catches, figures were initially taken for both species mixed. However, given the outstanding importance of the Alboran Sea population of short-beaked common dolphin (*D. delphis*) for the conservation of this rare species in the Mediterranean, it was considered essential accounting for the catch of both species

[5] see Annex 5. To date, this project legislation has not been adopted.

separately. To this end, the boat reporters were asked to accurately identify them, allowing to collect disaggregated information from mid April 2003.

Also, it was realized that the reported catches under the 'swordfish' category included some sporadic captures of billfish (all these species are known as *espadon*), so from July on our collaborators were asked to report billfish captures separately. Though all elaborations in this study refer to the mixed 'swordfish' category, the disaggregated information collected during the last months of sampling allowed to assess the precise contribution of billfish catch with regards to swordfish.

## 2.2. Estimation of fishing effort

Several surveys were conducted at the ports of Al Hoceima, Tangiers and Nador to gather first-hand information on the size and characteristics of the active driftnet fleets based there. Seasonality of fishing activity was also addressed. To this end, a complete questionnaire was addressed *in situ* to the relevant collaborative crewmen (usually the fisherman working as the 'keeper' of the driftnet boat), and information on almost all the active driftnet fleet based in these ports at the moment of the survey was obtained. An exploratory survey was also conducted on key fishing ports on the neighboring Atlantic façade (Asilah and Larache). A special effort was made under the form of interviews to crewmen and skippers of driftnetters based in Tangiers -the port harboring the bigger driftnetting fleet- to ascertain the precise pattern of activity of the fleet based there, including periods of activity and average fishing days per month.

Complementary official information on the driftnet fleet based at the ports of Al Hoceima, Tangiers and Nador was also obtained from the respective governmental fisheries delegations as well as from recent FAO-funded international research projects and also ICCAT official documents containing fleet data supplied by the Moroccan Government. The Office Nationale de Pêche in Tangiers submitted data on sales of swordfish in the fish market of Tangiers in 2002.

## 2.3. Estimation of species-specific catch rates and total by-catch

The suitability of different measures of fishing effort to describe the catch rates of the different species addressed was tested. Using a statistically sound effort measure is essential to achieve a meaningful catch rate which could then be used in comparative analyses as well as for the reliable estimation of absolute figures of catches by extrapolating to the total effort deployed by the whole driftnet fleet. To this end, different GLM (Generalised Linear Methods) analyses were performed on the original set of daily data, considering the following statistics as candidate estimators of catch rates (catch or capture per unit effort; cpue) for each one of the species considered: 1) *number of individuals caught per fishing operation* (N/fishing operation), 2) *number of individuals caught per length unit of net set per fishing operation* (N/km) and 3) *number of individuals caught per length unit of net set and unit of soaking time per fishing operation* (N/km.h). These analyses were carried out by considering the effect of the following factors: *month*, *boat*, *net length* and *net length x soaking time*.

GLM are an extension of multivariate analysis of variance methods, where the distribution function of the response variable (catch rates) can be different from normal. GLM methods allow testing the contribution of explanatory variables (or factors, such as month, vessel, net length and net length x soaking time). The significance of each explanatory variable was assessed by the F-statistic at the 5% significance level. All statistical analyses were carried out in S-plus.

First, an estimate of captures was jointly made for the fishing fleet based in the ports of Al Hoceima and Nador, in the Alboran Sea. The resultant figures are thought to be very reliable because the monitored boats were based in the former port and the coverage of fleet sampling there was particularly comprehensive. The behavior of the fleet based at Nador is known to be very similar to that of the Al Hoceima fleet, including the occurrence of driftnet fishing all the year round (with the exception of a few purse seiners using driftnets only 3 months a year) and the harvesting of fishing grounds located exclusively in the Mediterranean, East the Gibraltar Straits.

Based on the most adequate estimate of capture rate (and reference effort unit) resulting from the above analyses, the total capture during the 8-full-months sampling period for each one of the species considered was estimated by extrapolating the appropriate *capture per unit of effort* estimate to the estimate of total effort by the entire fleet. The extrapolation method used was the ratio method (Cochran, 1977) providing also an estimate of the variance of the extrapolation, as it is a standard statistical method in the analysis of sea mammal by-catch rates (Hobbs and Jones, 1993). Annual catches were then estimated by multiplying by a 3/2 factor the resultant 8-month estimates.

Then, the total capture by the driftnet fleet based in Tangiers was estimated by extrapolating to the fleet there the catch rates estimated from the Al Hoceima monitoring, using an estimate of annual fishing effort derived from accurate information on seasonal fleet activity recorded in Tangiers. The underlying assumption is that catch rates achieved in the Alboran fishing grounds by the Al Hoceima driftnet fleet are representative of those achieved by the fleet based in Tangiers, that operates around the Straits of Gibraltar and neighboring Atlantic waters, outside the Mediterranean Basin.

Given the exploratory nature of the survey carried out in Asilah and Larache and the lack of more detailed information, the driftnet fleet identified in those ports was not included in the total catch estimates, which should be regarded as being highly conservative in nature.

# 3. Results and discussion

## 3.1. Sampling coverage

The characteristics of the monitored boats are shown in Table 1, along with those of the rest of the driftnet fleet based in Al Hoceima. As detailed in Table 2, a total 369 fishing operations were monitored during the period ranging from 22$^{nd}$ Dec 2002 to 15$^{th}$ Sep 2003, which encompassed the utilization of 4140 km of net. This period covered the peak of the swordfish fishery, which ranges approx. from March to June. All the fishing operations performed by the 4 monitored boats during the period of study were sampled. Boat ALH-2 stopped driftnetting on 9$^{th}$ May, when it changed driftnets for fish traps to target axillary seabream (*Pagellus acarne*). To replace this boat in the monitoring scheme, a new driftnetter (ALH-12), of similar characteristics, was monitored starting from 16$^{th}$ July.

All fishing operations monitored took place within the Mediterranean Sea, in the Alboran Sea, East the Gibraltar Straits.

As for the total fishing effort deployed, an inventory of the active fleet using driftnets was made in January 2003 in the ports of Al Hoceima and Tangiers, which was repeated again in early August in Tangiers in order to complete the information previously gathered and capturing the possible seasonal variations. An inventory of the active fleet operating from Nador was made in August 2003. Also, an exploratory assessment of the driftnet fleet operating from the Atlantic ports of Larache and Asilah was made in June 2003. The rest of ports of potential minor driftnetting importance according to the different available sources, such as Jebha, M'dik and Ras Kebdana, weren't covered by this study.

## 3.2. Characteristics of the fishery

Driftnet boats are locally known as 'boniteros' in the port of Al Hoceima. Pictures in Figure 2 show two typical driftnetters from Al Hoceima port. According to our surveys, the height of the nets is of approximately 25-30 m, which is in agreement with the figure of 17 fathoms (approx. 31 m) found in the report made by INRH (Morocco) for the Project 'Tunidos', conducted under the FAO-COPEMED Project (see pictures in Figure 3). As for the length of the gear (see Tables 1, 3, 4 and 5), the number of net units used in the fishing operations ranged from 43-140 in Al Hoceima, 30-120 in Tangiers, 45-90 in Nador, 80-100 in Larache and 48-100 in Asilah. Since the length of each single net unit is 100 m, the resultant mean value of fishing gears deployed by the fleets based in Al Hoceima, Tangiers and Nador was estimated at, respectively, 6.8 km, 7.1 km and 6.5 km. According to these figures, all the Moroccan fleet monitored employed nets largely exceeding 2.5 km long (in contravention of GFCM Resolution 97/1 and *circulaire* Nº 5458 of 20 November 1992 issued by the Ministère des Pêches Maritimes of Morocco). Moroccan driftnets appear to be longer than those deployed by the former Spanish fleet in the Alboran Sea which according to Silvani *et al* (1999) was using nets of 4 km and 3.6 km on average the years 1993 and 1994, respectively (size of individual gears ranging from 2.9 to 5 km).

It should be warned that the estimates of mean net length relative to the fleets based in Al Hoceima, Tangiers and Nador presented here are likely underestimates. As it emerges from Table 1, the length of the gear reported by the 'keeper' fishermen from boats ALH-3, ALH-4 and ALH-12 when interviewed during the dock survey is near half the length reported by our crew collaborators from these same boats when submitting to us detailed information. This could pinpoint a general reluctance of fishermen using larger nets to report the actual length of the gear, which reinforces the conservative nature of our net size estimates discussed above. Also it is important to note that the length of the net deployed can vary throughout the fishing season, as it was the case of boat ALH-1 which increased the number of net units from 65 to 120 (6.5 km to 12 km) at the peak of the fishing season. At the end of the monitoring period, the net length deployed by the 4 boats monitored ranged from 12 km to 14 km.

Usually, the driftnet fishery takes place on a daily basis. As shown in Table 6, nets are set in the afternoon, from 14h to 19h, and are recovered about 11-12 hours later, approx. from 22h to 08h. On especial occasions, though, fishing trips can last a few days. The fishery is very sensitive to rough weather conditions, which largely determine the annual fishing effort deployed by the fleet. Whereas in Al Hoceima the fleet suffers specially from the winds blowing from the West, in Tangiers the average weather conditions are reported to be more favorable to driftnet fishing than are in the eastern ports of Al Hoceima and Nador.

As for the location of fishing grounds, the fleet based in Al Hoceima and Nador fish exclusively in Mediterranean waters. In contrast, the fleet from Tangiers mostly operates in the Gibraltar Straits area, often outside the proper Mediterranean basin, up to 30 miles far from Tangiers port. The heavy maritime traffic across the Gibraltar Straits makes driftnetting in certain areas there specially difficult.

Tangiers concentrates the bulk of trade of swordfish landings in Morocco, also channeling the production of fleets based in other fishing ports. Fishermen from Larache report to sent the local swordfish production –once gutted- to Tangiers, prior to its exportation. The Moroccan production of swordfish (arising mostly from driftnet fisheries) appears to be primarily exported to Spain (to the town of Algeciras), from where it enters the European markets. The commercialisation of the fish harvested by the Al Hoceima fleet is made at the fish market of this same town.

## 3.3. Fishing effort

### *3.3.1. Fleet size*

Tables 1, 3 and 4 contains the detailed inventory of the active driftnet fleet identified during this study in the ports of Al Hoceima, Tangiers and Nador. The characteristics of the active fleet size involved in driftnet fishing in the different Moroccan ports identified in this study are summarised in Table 5. As it arises from Table 7, there are very strong discrepancies among the different figures available relative to the size of the driftnet fleet based in the different Moroccan ports, depending on the source. To overcome this problem all estimates in this study exclusively rely on data on the active fleet gathered during the study period, even if these figures are in most of cases much lower than those reported by some official sources.

Indeed, we only identified 28 driftnetters active in Al Hoceima, which contrast with the range of 36-52 reported in official documents. The mismatch is even sharper regarding the fleets based in Nador and Tangiers (respectively, 45-144 and 134-275 reported by official sources compared to only 19 and 130 found in this study). The reason seems to lie in the maintenance of outdated censuses that could still reflect the situation at the peak of the the driftnet fishery, during the 90's. Many of the boats appearing on the official lists are no longer active whereas others are currently not involved in driftnetting. It is important to take into account that a part of the fleet based in Tangiers is currently being destroyed in exchange for the entrance of bigger surface longliner boats, owned by mixed companies involving foreign countries, which also target swordfish. Also, some active driftnet units based in potential minor driftnetting ports could have escaped our assessment. In any case, the figure of 357 active driftnetters recently submitted to ICCAT by official Moroccan sources is much higher than the active fleet size identified by this study (a very conservative estimate of 177 units, excluding the fleet detected in Asilah and Larache).

Whilst the entire driftnet fleet based in Al Hoceima appears to be active all year round (with the exception of a short period –about 10 days- in December when part of this fleet targets blackspot seabream for the European market), an important share of the fleet based in Tangiers only performs driftnetting during the high season of the swordfish fishery. According to our surveys and interviews, all the fleet remain active from March to approximately October, whilst during the period November-February some units engage in longline or trammelnet fishing and those with mixed licences use purse seiners to target small pelagic fish. In this period of lower season of the fishery an important number of units move towards Atlantic ports. This way, it can be considered that the 77 active units identified in January 2003 are active as driftnetters all year round whilst the 53 new boats detected in the August 2003 survey were only operational as driftnetters during the spring-autumn period. If we compare the mean length of the net and the average engine power of the boats identified as active in Tangiers during the winter survey and the new ones identified in August (see Table 5), it arises that the latter use on average less powerful engines and smaller nets (Student's T-test $p<0.001$). The resultant total figure of 130 active boats is completed with a further 7-8 active units that were reluctant to provide information and what we are not considering in this study, to keep a conservative approach.

As for Nador, 5 out of the 19 active boats identified are acting as purse seiners most of the year, only using driftnets the months of February, March and April. The remainder 14 units are driftnetters all year round.

### *3.3.2. Activity of the fleet*

The monitoring of boat ALH-1 had to be temporarily stopped from 9$^{th}$ May to 16$^{th}$ July because the boat during this period stayed at the dock under repairs. Also, our monitoring of boat ALH-2 was interrupted from the same date obeying to a complete change of *métier* (fishing practice). It stopped using driftnets to harvest swordfish and started targeting axillary seabream (*Pagellus acarne*) and other demersal species by means of fish traps.

The average number of driftnet fishing days per month in Al Hoceima (estimated from our sampling; accounting for the long period of inactivity of boat ALH-2) amounts to a *conservative* figure of 10.0 active days per boat *per month* (see Table 2). As for the fleet based in Tangiers, the interviews conducted point to a guess estimate of the average number of fishing operations per boat *per month* during the period of activity of about 15.

These noteworthy figures should be compared to the range of 32-44 days of activity *per year* estimated for the Italian *spadara* driftnet boats in 1991 (SGFEN/STECF, 2001) and the average of 21 days of activity per boat *per year* (with a range from 2 to 37 days) for the French *thonnaille* fleet in 2000 (Imbert *et al*. 2001, in SGFEN/STECF, 2001). Clearly, the extended fishing season by the Moroccan driftnet fleet (which often last the whole year) constitutes a key difference with respect to other current of former driftnet fisheries in the Mediterranean.

The monthly evolution of official figures of swordfish and shark landings commercialized at the port of Tangiers in 2002 are shown in Figures 4 and 5. Though it appears that a significant share of the catch is not reported to avoid taxes, it clearly follows from these figures that the peak of both target and some associated species catches lasts from March to September. However, as it has already been discussed above, an important feature of the Moroccan driftnet fishery -not shared with the other Mediterranean driftnet fleets- is that irrespective of the migratory nature of swordfish (which means that its abundance in the area is subject to strong seasonal fluctuations), many boats are able to use driftnets all year round, provided that weather conditions are suitable. This phenomenon was made obvious during our visit to the ports of Tangiers and Al Hoceima in winter 2003, and is confirmed by the annual pattern of activity of the 4 boats monitored; all of them were active in winter, when the abundance of swordfish in the area is at its lowest. This behavior results in an extremely high total annual effort carried out by the driftnet fleet operating in Morocco, what makes it susceptible to inflict very high mortality rates on populations of target and associated species.

As pinpointed in the precedent section, some boats are able to perform fishing activities alternative to driftnetting during the low season of the swordfish fishery (mostly in Tangiers). In fact, a share of the fleet is provided with mixed licences which allow them to use either driftnets or purse seines (to fish for small pelagic species).

## 3.4. Catches of target and incidental species

### *3.4.1. Overview*

A total 5285 individuals were identified and recorded during the period of sampling, belonging to the selected items of target and incidental species. Table 8 shows the total catch per species during the period of sampling, for all monitored boats combined. It gives a good insight into the relative importance of by-catch species in the fishery, since it allows comparing their catch figures to that of swordfish, the target species. It must be reminded that the capture of some species not prioritized in this study such as small tuna, etc. hasn't been recorded, so this table is representative of a subset of the catch. As explained before, selected by-catch species have been purposely chosen according to both the magnitude of their by-catch and their conservation importance.

Pelagic sharks -as a group- are the main by-catch of the fishery, the combined catch of the topmost 3 species caught reaching half the total swordfish capture in numbers (ratio 0.50:1). Sunfish (ratio 0.17:1) and dolphins (ratio 0.08:1) follow in the ranking of by-catch importance.

Tables 9 to 14 summarize the information gathered on absolute catch and capture per unit effort (cpue) for each one of the selected species, disaggregated by boat and presented on a monthly basis. Figure 6 shows the monthly evolution of daily capture per boat for the different species selected and the different boats monitored.

### *3.4.2. GLM analysis of cpue measures and by-catch estimations*

In the case of N/fishing operation, the distribution function was found to follow a Poisson distribution (as in other studies: Silvani et al., 1999; Hobbs and Jones, 1993), while the two other catch rate measures were log-normal. The results of the analyses of the 3 capture per unit effort (cpue) measures tested showed that in many cases any of the three measures was in general adequate, but the month or vessel factors were significant for some species (see Table 15).

For swordfish and dolphins (total and both species) any of the three measures was an appropriate measure of catch rates, affected only by the month of the year. Thus to estimate the total by-catch of dolphins by the combined fleet from Al Houceima and Nador, month-by-month estimates using the ratio method were produced for the 8 month sampling period (only complete sampled months) using cpue 1 (N/fishing operation) and 2 (N/km net set). The resultant total was then extrapolated to the entire year.

For pelagic sharks (3 species) the type of vessel was a significant variable determining catch rates along with the length of the net (in *P. glauca* and *A. vulpinus*), which is usually related to the vessel. A *post-hoc* analysis of the GLM results indicated that vessels ALH-1 and ALH-2 had significantly lower catch rates than the other 3 vessels, suggesting two different fishing patterns with respect to sharks: a passive ‘by-catch’ scheme and a possible ‘target fishery’ one. Thus to estimate the total by-catch for sharks in the Al Hoceima-Nador area 2 separate estimates using cpue 1 and 2 were made: one considering that 2/5 of the fleet have “low” shark catch rates and the other considering that 3/5 of the fleet have ‘high’ shark catch rates. The total catch estimates of the two ‘types’ of fleet were then combined. Sharks did not show any significant seasonality; the significance of the variable ‘month’ detected in *I. oxyrinchus* disappeared after grouping the information according to the two types of fleet. Obeying to the statistic signification of net length, by-catch estimates using cpue 1 are considered more reliable than those based on cpue 2 (except in the case of *Isurus*, for which the effect of net length was not significant).

The catch rates for turtles were not usable for extrapolation as the incidence of by-catch on this species was low.

As for the estimation of by-catch by the fleet based in Tangiers, the ratio method was applied on specific effort data in a way similar as detailed above for Al Hoceima-Nador.

Table 16 shows by-catch estimates for dolphins and pelagic sharks in the Alboran Sea, by the fleets based in Al Hoceima and Nador. Table 17 contains *orientative* by-catch estimates for the fleet from Tangiers, subject to the validity of the assumption that catch rates there are as in the Alboran Sea.

Average catch rates for swordfish and incidentally caught species are detailed in Table 18.

### 3.4.3. Swordfish

*Note*: The disaggregated information collected from July 2003 points to *Xiphias gladius* accounting for 96% of the individuals reported under the category 'swordfish', the remainder 4% being occasional billfish specimens (540 and 23 individuals, respectively). These results allow to roughly assuming that the category 'swordfish' mainly represents the former species. This assumption underlies the remaining of this report.

Capture rates, seasonality and estimation of total catch

Swordfish captures occurred in 99.4% of all sets monitored. The highest capture per fishing operation recorded amounts to 31 individuals. According to GLM analyses discussed above, swordfish catch rates presented a marked seasonality, with strong monthly variation. Average catch rates during the sampling period are roughly estimated at 8.1 individuals per fishing operation and 0.8 individuals per km of net set (Table 18). Picture in Figure 7 shows swordfish landed in Al Hoceima fishing port. Total catch was not estimated since the effect of the driftnet fishery on the target species goes beyond the scope of this study.

Discussion

Our data are in accordance with the INRH (Morocco) reports to the FAO COPEMED 'Tunidos' project in the sense that the month of May verifies the highest catch rates for this species (see Table 9 and Figure 6). During this month, the total capture per fishing operation ranges between 9 and 20 individuals, depending on the boat. This seasonal pattern was supported by the GLM analyses.

The capture relative to gear length ranges between 1.25 and 2 fish per km of net set for this same month, being considerably lower in other periods of the year. These results, together with the average catch rates presented above, point to the inherently low level of catch arising from the eventual compliance of the driftnet swordfish fishery in the Mediterranean with the maximum legal length of the gear (at best a few fish per boat if using 2.5 km), what clearly suggests that truly small scale driftnet fleets targeting swordfish in the Mediterranean could hardly be viable with regards of its economic performance.

Furthermore, swordfish driftnetting is becoming less interesting to fishermen, at least in Al Hoceima. In this regard, its is very meaningful that fishermen from this port acknowledge that due to the alleged reduction in swordfish abundance and the subsequent low catch rates relative to net length it is getting harder and harder to meet economic profitability. Consequently, they report to be genuinely interested in looking for other alternative fishing activities (mostly purse seining and bottom longlining) provided that enough public funding is available to cover this transition.

### 3.4.4. Marine turtles

Capture rates, seasonality and estimation of total catch

A total by-catch of 46 loggerhead turtles was recorded, which originated in 8.4% of the monitored sets. The highest capture in a single fishing set was recorded at 3 individuals.

The low incidence of catches prevented a robust assessment of the total by-catch. In addition, GLM analyses detected a strong seasonality and a significant effect of the vessel factor on catch rates (Table 15).

## Discussion

Though all captures of marine turtles recorded by this study belonged to the species *Caretta caretta*, fishermen from Larache report the frequent capture of Leatherback turtles (*Dermochelys coriacea*) in their driftnets. The latter is in agreement with Camiñas (1995) and Silvani *et al*. (1999) who also reported *D. coriacea* to be caught by the former Spanish driftnet fleet in the Alboran Sea.

Turtles are released alive whenever possible, which points to an effective fishing-induced mortality much lower than that suggested by the by-catch figures in Tables 11 and 18. Fishermen from Asilah declare that killing turtles is believed to entail bad luck to fishermen. This superstitious belief probably enhances the custom to actively disentangle and release the turtles immediately after recovering them alive. This, however, contrasts with the high numbers of dead turtles reported to be washed ashore in the city of Ceuta (N Africa), some of them with symptoms of net entanglement (Ocaña and García de los Ríos, 2002).

As it emerges from Table 11, the occurrence of the loggerhead turtle in the captures shows a marked seasonality. Whereas in the first months of the year turtles are commonly by-caught, they became rare from April-May onwards, being totally absent from the captures in early summer (June and July). These findings seem to reflect the existence of some kind of migratory event affecting the Alboran Sea.

Indeed, it has been reported that the Alboran Sea is a crucial area for the annual two-way migration of the species between the Mediterranean and the Atlantic throughout the Gibraltar Straits (Camiñas 1995; 1997), a phenomenon that overlaps in time with the activity of the Moroccan swordfish driftnet fishery, which takes place -with a varying intensity- all year round. Scattered data from Spanish fisheries in the area and stranding records analyzed by the latter author suggests the existence of a possible annual migration of turtles from the Atlantic to the Mediterranean during the first half of the year, especially from May-July, and an exit movement towards the Atlantic during summer, especially during July-August. The precise way this hypothesis can be reconciled with the data from this study remains yet to be accurately addressed. Perhaps, winter catches by the Moroccan driftnet fleet in the Alboran Sea reflect the presence of a local wintering population of loggerhead turtle in the Southern Alboran Sea which might be reinforced with a migration of individuals from the Western Mediterranean to the Atlantic crossing the area.

According to former driftnet fishermen from Al Hoceima, the occurrence of turtle captures might had been sensibly higher some years ago, when many individuals were caught also in summer.

As shown from Table 19, the by-catch rate of loggerhead turtle by driftnets in the Alboran Sea (0.21-0.78 N/haul; including this study) is much higher than that reported for the Italian driftnet fleet (0.04-0.05 N/haul), probably due to a much higher turtle density in Alboran waters linked to the strategic role of this sea in the Atlantic/Mediterranean exchanges.

### *3.4.5. Dolphins*

Capture rates, seasonality and estimation of total catch

The capture of dolphins, either *D. delphis* or *S. coeruleoalba*, was verified in 38.9% of all fishing sets monitored. Total by-catch by the 5 boats monitored in this study amounted to 237 specimens, all of them taken in Mediterranean fishing grounds in the Alboran Sea. The highest by-catch figure recorded was 11 individuals, captured on 21$^{st}$ April by boat ALH-1 after deploying 'only' 6.5 km of net. On the overall, our data point to a ratio swordfish/dolphin of 12.6:1 in number of individuals (see Table 8). According to GLM analyses a strong seasonality is detected in the incidence of by-catch with the month factor being highly significant. Higher catch rates in numbers per fishing operation were recorded approx. from April to July (Table 10; Figure 6).

As shown in Table 20, the disaggregated information available points to the short-beaked common dolphin accounting for 45.6% of the dolphin catch, whilst the remaining 54.3% corresponds to the striped dolphin. These data doesn't differ significantly from 50% ($\chi^2$ test, p = 0.27), the share estimated by Silvani *et al*. (1999) for the by-catch by the former Spanish driftnet fleet operating in the Alboran area.

Table 16 shows the total estimates of dolphin by-catch by the fleet operating in the Alboran Sea using two measures of catch rates: N/fishing operation and N/km of net. For a 12-month period, 3647 individuals are estimated to have been caught (± 537; 95% CI, note that CI is conservative because variable did not follow normal distribution, cf. Hobbs and Jones 1993), in equal proportions of 1555-2092 *D. delphis* and 1555-2092 *S. coeruleoalba*.

The estimate of annual by-catch by the fleet based in Tangiers amounts to an orientative figure of 11590-15127 individuals (both dolphin species pooled), under the hypothesis of same by-catch rates as in the Alboran Sea (see Table 17). This by-catch would be concentrated on the population found in the vicinity of the Straits of Gibraltar, mainly outside the Mediterranean Basin.

Discussion

Even though the driftnet fleet based in Morocco is known to entail the by-catch of a diversity of cetacean species (ranging from the large whales –such as the minke whale *Balaenoptera acutorostrata* and the fin whale *Balaenoptera physalus*- to the sperm whale *Physeter macrocephalus* the pilot whale *Globicephala melas* and even the bottlenose dolphin *Tursiops truncatus*; see Figure 8 and Appendix 1), during the period of sampling only the capture of striped and short-beaked common dolphin (*Stenella coeruleoalba* and *Delphinus delphis*, respectively) by the boats monitored was recorded.

Short-beaked common and striped dolphins are given different names by fishermen in Al Hoceima, what indicates that both species are well known to local fishermen. Whilst the short-beaked common dolphin is known as *denfir*, the striped dolphin is called *flipper*, after the name of the dolphin from the famous TV series. This fact suggests that this latter species, usually found offshore, became familiar to the fishermen only in recent times, after the introduction of driftnet fishing. Bottlenose dolphin *Tursiops truncatus* is known as *negro*. Purse seine crews involved in small pelagic fisheries (mainly sardine) in the port of Al Hoceima deeply complain about the high mortality on dolphin populations inflicted by driftnet fleets with which they share their fishing ports. They claim that a rarefaction of dolphins driven by driftnet fisheries have taken place in the area, which is having a negative effect on their activity. This is so because they report that purse seine operations uses to benefit from the behavior of dolphin groups that 'help' the fishermen to concentrate the shoals of small pelagic fish. This phenomenon is in agreement with the description by Tomilin (1967) referred by Spencer *et al*. (2000) to be contained in Northdridge (1984), in the sense that "*common dolphin is also known to help Mediterranean sardine fishermen, who follow the dolphins which are responsible for frightening the fish to the surface*".

As for the status of *D. delphis* and *S. coeruleoalba* in the Mediterranean, according to ACCOBAMS the Mediterranean population(s) of short-beaked common dolphin should be considered endangered. This population is regarded as a conservation priority by the IUCN 2002-2010 Conservation Action Plan for the World's Cetaceans (Reeves *et al*., 2003). Both species, the short-beaked common dolphin and the striped dolphin are listed in Appendix II of the Bern Convention, in Appendix II of the Bonn Convention, in Appendix II of the Washington Convention and in Annex IV of the EU Habitats Directive. The IUCN status of *S. coeruleoalba* is: *Lower risk: conservation dependant*. The only available estimate of the population size of both short-beaked common dolphin and striped dolphin in the Alboran Sea dates back to the period 1991-1992, when it amounted to 17728 (SE = $\pm$ 5850) and 14376 (SE = $\pm$ 5894) individuals, respectively (Forcada, 1996). The figure for striped dolphin should be regarded with caution since it was obtained at a moment when the species was suffering an important epizootic in the Mediterranean that induced a significant mortality on the population.

According to Universidad de Madrid and Alnitak (2002), the conservation of the healthy, thick population of *D. delphis* in the Alboran Sea might be the only hope for the species to expand towards the Mediterranean Sea and recovering from the population decline that according to some authors took place throughout the Mediterranean in a Northeast-Southwest sense, leaving only a few tiny relic populations in the Central and Eastern Mediterranean basins in only a few decades time span (i.e. rarefaction seems to have started in early 70's in the NW Mediterranean).

The International Whaling Commission (IWC) stated that the anthropogenic removal rate of any cetacean population should not exceed half the maximum net growth rate of the population (IWC, 1995). This organism advises that an estimated annual by-catch of 1% of estimated population size indicates that further research should be undertaken immediately to clarify the status of the stocks and that an estimated annual anthropogenic removal of 2% of the best available population estimate may cause the population to decline and requires immediate action to reduce by-catch, being an unacceptable level of interaction (López *et al*., 2003). As shown in Table 21, the results of our research point to a by-catch of *Stenella* and *Delphinus* in the Alboran Sea conservatively estimated to be higher than 10% of the population estimates respectively available for these species in the area (taken from Forcada, 1996). These results are one order of magnitude higher than other take rates achieved by other Mediterranean driftnet fisheries that are available in the scientific literature (Table 21). In fact, the total figures of dolphin by-catch by the Moroccan driftnet fleet in the Alboran Sea are extraordinarily high if compared to other by-catch estimates in the Mediterranean region (see Table 21). The fact that this mortality is inflicted on a very small area of the Mediterranean adds further importance to the issue. Also from Table 21, it can be drawn that catch rates by the Moroccan driftnet fleet are within the range of those reported by other driftnet fisheries in the Mediterranean. The key difference explaining the outstanding total catch figures would lie in the long nets used and the enormous annual fishing effort deployed as a result of the extended fishing season.

With these antecedents, it is difficult to understand how such a dramatic mortality on dolphin populations on a sustained way during about 15 year of existence of the fishery could have been compatible with the maintenance of their populations. Indeed, the very persistence of the short-beaked common dolphin in the Alboran Sea, demographically isolated from the rest of the Mediterranean, would only be explained by a significant flow of individuals from the Atlantic, in the context of a thick population occurring in the contiguous Atlantic waters (which in turn would suffer an enormous mortality by the driftnet fleet based in Tangiers).

Recently, a genetic study was carried out using both mitochondrial DNA and nuclear markers to ascertain the structure of the population of short-beaked common dolphin (*D. delphis*) in the Mediterranean and Northeast Atlantic (Universidad de Madrid and Alnitak, 2002). The results obtained suggested a higher genetic flow between the Alboran Sea population and the populations inhabiting the adjacent Atlantic waters than between the Alboran Sea population and those found in the rest of the Mediterranean (including Italy and Greece). This picture of the genetic continuity between populations on both sides of the Straits of Gibraltar is completed by the occurrence of important densities of short-beaked common dolphin in the middle of the Gibraltar Straits and in the adjacent Atlantic area of the Gulf of Cadiz, reported in the same study. These evidences might suggest the existence of a single demographic unit on both sides of the Gibraltar Straits, with strong implications for the conservation of the species. Indeed, if it were the case, the take rates (as % of the total population) attributable to the Moroccan driftnet fleet should be recalculated by accounting for the total mortality inflicted by the fleet (including the one based in Tangiers) and considering the size of the whole demographic unit of *D. delphis* inhabiting the Alboran Sea and neighboring Atlantic waters. Though unfortunately no information is available on the latter, it is quite unlikely that it will be of the order necessary to successfully cope with the combined mortality estimated for the fleet from Al Hoceima and Nador, on one hand, and the fleet from Tangiers, on the other (a total figure of about 8500 individuals for each species).

Clearly, driftnet fishing is posing a severe threat to the survival of *D. delphis* and *S. coeruleoalba* populations in the Alboran Sea. As recently summarized by Bearzi (2002) in a review of the interactions between cetacean populations and fisheries in the Mediterranean, during the peak of driftnet fisheries in the Mediterranean (in late 80's-early 90's, prior to the legislative measures banning totally or partially driftnet fishing) the total cetacean by-catch has been estimated at more than 8000 individuals in the Italian seas alone (Di Natale and Notarbartolo de Sciara, 1994), and up to 10000 individuals in the whole Mediterranean (IWC, 1994). This suggests that the impact of the current large-scale Moroccan driftnet fleet on dolphin populations is –in total numbers- similar to that achieved by the former Italian driftnet fleet in the peak of its activity, in the whole area harvested by this fleet. The striking differences are that the latter fleet was five-fold the size of the Moroccan fleet and the area harvested by them was much more extended.

### *3.4.6. Shark species*

*Note*: Though this section focus only on the 3 major shark species caught by the driftnet fleet monitored -*P. glauca*, *I. oxyrinchus* and *A. vulpinus*-, other shark species –mainly from the Carcharhinidae family- are known to be landed in Al Hoceima port on an occasional basis.

Capture rates and estimation of total catch

Blue shark, shortfin mako and thresher shark occurred in, respectively, 54.4%, 58.8% and 49.3% of the fishing operations monitored. Maximum catch figures per set range from 11 specimens in *P. glauca*, 6 in *I. oxyrinchus* and 9 in the case of *A. vulpinus*. Pictures in Figure 9 show several specimens of shortfin mako and blue shark caught by driftnetters based in Al Hoceima. According to total by-catch numbers shown in Table 8, the three species are, though slightly, unevenly represented in the catch ($\chi^2$ test, $p < 0.05$).

Overall, our data point to a ratio swordfish/sharks of 1.9:1 in number of individuals. Interestingly, GLM analyses suggested the existence of two different fishing patterns with respect to sharks by the driftnet fleet monitored; indeed, a share of the fleet (about 3/5) yields significantly higher shark catches what is suggestive of a target fishery rather than passive by-catch (see also Figure 6). No seasonality in catch rates was observed when treating the data separately according to the latter finding.

Table 16 shows the total estimates of shark by-catch in the Alboran Sea using two measures of catch rates: n/fishing operation and n/km of net. Incidental catches of blue shark, shortfin mako and thresher shark in a 12-month period are estimated at about 7000-8000 individuals each. Orientative estimates of the yearly by-catch by the Tangiers fleet, mostly occurring in the Straits of Gibraltar and nearby Atlantic waters, ranges from 24000-27000 individuals for each one of these 3 species (Table 17).

Discussion

Sharks are consumed by the Moroccan market. It seems that they are especially appreciated in the inner country, particularly in the area of Fez, where most of the shark landings from Al Hoceima head to. Fish are landed whole since finning practices are unknown in the region.

In general, there are no clear preferences from the market regarding the major shark species caught by driftnets, all of them reaching similar prices. Even though sharks were, in principle, by-catch species or at best a secondary target in the swordfish fishery, sometimes obeying to the scarcity of the target species some boats deploy the driftnets less offshore, at only 1-2 miles from the coast, where the chances of capturing some pelagic sharks (especially the thresher shark) are higher. According to catch rates for the two types of driftnetters shown in Table 18, *I. oxyrinchus* is the species more affected by the change from the by-catch scheme to the target fishery. Indeed, the catch rate per fishing operation for shortfin mako is near 3 times higher in those boats apparently behaving as active shark fishers (from 0.6 to 1.9 N/fishing operation) and the catch per km net follows a similar difference (from 0.06 to 0.14).

The high catch figures of sharks presented in this study sharply contrasts with the information available on the activity of the former Spanish driftnet fleet in the Alboran Sea.

Indeed, Silvani *et al*. (1999) report only an anecdotic occurrence of shortfin mako and blue shark in the catch (i.e. 3 and 4 individuals in 1994, from a total 54 fishing operations monitored) and don't report any capture of thresher shark. Conversely, Valeira *et al*. (2003) report that the Alboran Sea is the area of the Western Mediterranean where Spanish fleets targeting swordfish using surface longlines achieve the higher by-catch rates of pelagic sharks (between 78%-92% of the total by-catch in weight). According to this source the shark species involved in this by-catch are, in this order, *P. glauca*, *I. oxyrinchus* and *A. vulpinus*.

Shark species, by nature of their *k* life history strategies i.e. slow growth and delayed maturation, long reproductive cycles, low fecundity and long life spans, and their generally high position in trophic food webs, are more likely to be affected by intense fishing activity than most teleosts (Stevens *et al*., 2000; Castro *et al*., 1999). In this context, after reviewing the status of some important shark fisheries, Castro *et al*. (1999) concluded that the history of shark fisheries indicates that intensive fisheries are not sustainable and that complete collapses of the fishery are not rare.

The vulnerability of pelagic shark species in the area of study is best exemplified by the evolution of captures by the Spanish surface longline fleet in the Mediterranean (including the Alboran Sea) from 1984 to 1994 (Camiñas, 1998). As a result of a change in the target of the fishery, that expanded from only swordfish to also encompassing pelagic sharks, the annual capture of blue shark increased from 5557 to 14935 individuals, whilst those of shortfin mako and thresher shark dropped, respectively, from 1225 to only 122 and 176 to 93. In addition, the mean weight of all shark species decreased.

These findings pointed to a fishing pressure on shortfin mako and thresher shark well beyond the reproductive capacity of these species and suggest the likely dramatic impact that the massive by-catch by the Moroccan driftnet fleet on these same species reported here (about 23000 individuals by the fleet from Al Hoceima and Nador and further 77500 by the one from Tangiers, distributed in roughly equal proportions for the 3 species) is entailing on their Alboran Sea and adjacent Atlantic populations.

The impact of annual fisheries mortality (mainly of by-catch) on blue shark (*Prionace glauca*) is estimated at 10 to 20 million individuals on a global basis. Even if this species seems to rank high on the scale of shark species resilience to fishing owing to its relatively high fecundity (Smith *et al*., 1998), such high figures suggest a negative impact on the world population. The few fishery assessments carried out to date point to relatively little population decline (Stevens, 2000a). However, from the point of view of the dynamics of the oceanic ecosystems there is concern over the removal of such large numbers of this likely keystone predator (Compagno, 1984). For these reasons, blue shark was given the status 'Lower Risk (Near Threatened)' in the 2000 IUCN Red List Global Assessment. It is also listed in Annex III ('species whose exploitation is regulated') of the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA) of Barcelona Convention.

Unlike blue shark, shortfin mako (*Isurus oxyrinchus*) and thresher shark (*Alopias vulpinus*) have only a midrange rebound potential among a set of 26 shark species analysed.

Shortfin mako is listed as 'Lower Risk (Near Threatened)' in the 2000 IUCN Red List Global Assessment. Its relatively low reproductive capacity makes it very susceptible to depletion by fisheries, as pointed out by the decline in the catch by the driftnet fishery operating in California in early 90's (Stevens, 2000b).

As for thresher shark, according to Goldman (2000) there is strong evidence that this species is highly vulnerable to overfishing in a short period of time, as demonstrated by the heavy population depletion driven by the California driftnet fishery in the 70's and 80's. Consequently, by-catch is considered a potentially large problem for thresher shark populations. A further biological feature of this species that increases its vulnerability lies in the existence of many separated subpopulations or local coastal stocks. Whilst it was given the status of 'Data Deficient' in the 2000 IUCN Red List Global Assessment, the California population –intensively harvested by driftnets- is considered as 'Lower Risk (Near Threatened)'.

### *3.4.7. Other species*

As it can be drawn from Table 8, sunfish *Mola mola* is also an important by-catch species in the Moroccan driftnet fishery. It occurs in 63% of the monitored sets and GLM analyses point to a significant seasonality affecting catch rates. However, though high, its occurrence in the catch is not comparable to that reported by Silvani *et al*. (1999) for this species in the former Spanish driftnet fishery in the Alboran Sea. Indeed, according to the latter study this species accounted for 71% of the total catch in number of individuals in 1992, 93% in 1993 and 90% of 1994. The reason why the incidence of sun fish catch in Moroccan driftnetters harvesting swordfish in Southern Alboran Sea waters 10 years later is much lower is not known, possible hypotheses ranging from a change in the size of sun fish populations to a higher abundance of this species in Northern Alboran waters.

Though the Moroccan report to the Project 'Tunidos' conducted under the FAO-COPEMED Project refers to blue marlin *Makaira nigricans* as the main by-catch species of Moroccan driftnetters, contributing more to the total by-catch of the fishery than the thresher shark, the shortfin mako and the blue shark considered together, our study doesn't confirm such a feature, at least in the case of the fleet based in Al Hoceima. As already described, billfish (probably belonging to several species) would account for about 4% of the catch included in the swordfish category reported in this study. Fishermen from Al Hoceima refer to important catches of billfish in the past, following the start of the driftnet fishery, although in the last years it is no longer considered as a major component of the catch. It seems that these species fetch a lower price than swordfish does in the fish market.

# 4. Conclusions and recommendations

The main conclusions drawn from this study can be summarized as follows:

- There is a current large-scale driftnet fleet targeting swordfish in Morocco of at least 177 units, mostly based in the Mediterranean ports of Al Hoceima and Nador and in the port of Tangiers, in the Gibraltar Straits area.

- These fleets are using nets of a length conservatively estimated at between 6.5-7.1 km on average. Real measures probably double this figure, as exemplified by the boats monitored in Al Hoceima, with net lengths ranging from 12-14 km at the peak of the fishery.

- This fleet qualifies as IUU according to both national and international legislation in force.

- An unusual feature of this fishery is the extended fishing season, that in many cases lasts all year round. Fishing days per month range from 10-15 days for the active fleet. Added to the long nets involved, it results in very high values of fishing effort.

- Average catch rate for swordfish, the target species of the fishery, is estimated at 0.81 individuals per km of net set. This points to extremely low economic yields if complying with the legal maximum net length of 2.5 km.

- Catch rates for accessory species (in number of individuals per km of net set) amount to 0.06 in dolphins (both species mixed), 0.027 in turtles (in the period Dec-May, when the incidence of by-catch is higher), 0.117-0.121 in blue shark, 0.059-0.145 in shortfin mako and 0.092-0.117 in thresher shark. In the case of pelagic sharks, two different trends in captures were detected, suggesting a possible target fishery carried out on this group by a part of the fleet.

- Sound estimates of annual dolphin by-catch in the Alboran Sea point to 3647 +- 537 individuals, distributed as 1555-2092 short-beaked common dolphin *Delphinus delphis* individuals and 1555-2092 striped dolphin *Stenella coeruleoalba* individuals. Under the hypothesis of differentiated demographic units in the area, this would entail take rates higher than 10% of the estimated population sizes, what would be incompatible with the mid-term maintenance of the populations.

- Further 13358 individuals +- 1769 (both species in equal proportions) would be killed annually by the fleet based in Tangiers around the Straits of Gibraltar and neighboring areas, mostly outside the Mediterranean Basin. The uncertainty of this estimate is higher than for the Mediterranean side because of uncertainty in the actual fishing effort and in the by-catch rates there.

- Other cetacean species impacted by this fishery include minke whale *Balaenoptera acutorostrata*, fin whale *Balaenoptera physalus*, sperm whale *Physeter* *macrocephalus*, pilot whale *Globicepala melas* and bottlenose dolphin *Tursiops truncatus*.

- Loggerhead turtle *Caretta caretta* is not massively by-caught. Its capture is subject to a very strong seasonality, with by-catches decreasing to very low levels during the spring-summer period.

- A particular feature of this fishery is the dramatic captures achieved on pelagic sharks. About 23000 individuals are captured annually by the fleet from Al Hoceima and Nador and further 77500 would be caught by the one from Tangiers, distributed in roughly equal proportions for *Prionace glauca*, *Isurus oxyrinchus* and *Alopias vulpinus*.

- These very high catches might put at stake the populations of the more vulnerable species, that is, *I. oxyrinchys* and *A. vulpinus*.

- Based on the mortality inflicted on sharks and cetaceans the current Moroccan driftnet fleet can be considered as the most impacting Mediterranean driftnet fleet ever monitored as far as its impact on biodiversity is concerned.

From this study it is clear that the current activities of the Moroccan driftnet fleet should be put to an end in the shortest possible time frame. This is so because of the inherent IUU nature of this fishery and its incompatibility with international obligations derived from the presence of Morocco in ICCAT and GFCM. The massive mortality on protected species inflicted by these fleets is also in contravention of international obligations under the IWC, Bern Convention and ACCOBAMS, to which Morocco is also a contracting party.

Fortunately, though, there are clear indications that the Government of Morocco is fully aware of the unsustainability of the situation, as exemplified by the following quote from the preamble of the draft *circulaire* presented in Annex 5:

> *"En raison de la faible selection du filet maillant dérivant et notamment ses captures accidentelles;*
> *Face à l'augmentation de la pression sur les ressources et à l'accroissement des captures accessoires liées à celle-ci moyennant le filet maillant dérivant;"*

Also, many fishermen, at least from Al Hoceima, would be favorable to a complete transition toward other fisheries, abandoning driftnets, should public funds be available to support that. It is important here that the necessary change in the fishing gear by the concerned fleet should be made taking into account two important kind of factors: the socioeconomic and the environmental ones.

As for the first of them, it is important to note that in spite of being able to deploy very long nets, many of driftnet boats are rather small in size, with crew sizes that are able to reach the 10-12 persons. Any restructuring towards another fishery or fishing gear should preserve these features of small to medium scale nature of the fleet and labor intensive activity, to avoid the risk to result in a social disruption.

As for the second factor, it is important to avoid that a hypothetical increase of surface longlining as an alternative to driftnets could increase the mortality on the loggerhead turtle population, in an area key for the exchanges between Atlantic and Mediterranean populations. In short, it should be prevented that fixing one problem creates another. In this case, it is worth highlighting here that there are several on-going experiences at both the global and the Mediterranean scale to remedy the problem of turtle by-catch in longlines and that some promising new approaches could tentatively be tailored to the Moroccan case in the context of a truly Ecosystem-Based Fisheries Management.

Also, one of the main lessons drawn from the present study is that –as it is already well known from other case studies- compliance of Mediterranean driftnet fleets with international legal obligations on maximum net length (the 2.5 km limit) is intrinsically difficult to achieve. Indeed, it has already been discussed in this report that the levels of catch per km of net set are very low and that many fishermen using large-scale nets already complain about the poor profitability of the activity. Furthermore, it can be argued that legally allowing the practice of small-scale driftnet activities in the Mediterranean means in fact opening the door to large-scale driftnet fishing, compliance with international legislation being undermined by economic considerations. This, linked to the dramatic and unsustainable impact on biological diversity of this harmful fishing practice confirmed by this study, leads to conclude that the only way to prevent the massive damage to protected and vulnerable species inflicted by current driftnet fleets in the Mediterranean Sea is the complete banning of all driftnet fisheries in the Region, independently of the length of the gear, followed by its effective enforcement (see Joint statement by WWF and Greenpeace on driftnets in Annex 6).

Obviously, legislation is not enough to achieve compliance and a clear political will is essential for the elimination of driftnet fishing. This is best exemplified by the situation in the European Union where after the adoption of European Regulation (EC) No 1239/98 totally banning all kind of driftnets for tuna and tuna-like fishing in Mediterranean waters, driftnetters are still fully operative in Italy (90-130 boats; ICCAT/SCRS, 2001) and France -locally known as *thonnaille*- (75-100 boats; ICCAT/SCRS, 2001, EC Project 97/029).

Finally, it has to be mentioned that other driftnet fleets exist currently in the Mediterranean, namely in Turkey (more than 100 units; ICCAT/SCRS, 2001) and Tunisia (about 30 units; own information), for which no information whatsoever is available about their possible effects on biodiversity.

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# TABLES

Table 1. Active driftnet boats based at Al Hoceima port identified during the Jan 2003 survey. Codes aim at keeping confidentiality about boat owners.

| code | crew size (no. persons) | engine power (HP) | No. driftnet units (unit length: 100 m) |
|---|---|---|---|
| | | | |
| | | | |
| ALH-1* | 12 | 170 | 65/120** |
| ALH-2* | 7 | 190 | 60 |
| ALH-3* | 10 | 215 | 60 [120] |
| ALH-4* | 13 | 215 | 63 [140] |
| ALH-5 | 7 | 110 | 60 |
| ALH-6 | 6 | 125 | 50 |
| ALH-7 | 11 | 215 | 100 |
| ALH-8 | 7 | 110 | 45 |
| ALH-9 | 9 | 115 | 46 |
| ALH-10 | 5 | 115 | 43 |
| ALH-11 | 6 | 115 | 45 |
| ALH-12* | 9 | 170 | 70 [140] |
| ALH-13 | 6 | 150 | ? |
| ALH-14 | 11 | 215 | 75 |
| ALH-15 | 7 | 150 | 60 |
| ALH-16 | 11 | 150 | 80 |
| ALH-17 | 7 | 110 | 45 |
| ALH-18 | 21 | 215 | 67 |
| ALH-19 | 10 | 115 | 68 |
| ALH-20 | 5 | 110 | 40 |
| ALH-21 | 7 | 115 | 63 |
| ALH-22 | 8 | 150 | 60 |
| ALH-23 | 6 | 115 | 43 |
| ALH-24 | 7 | 150 | 60 |
| ALH-25 | 6 | 115 | 45 |
| ALH-26 | 5 | 110 | 40 |
| ALH-27 | 9 | 125 | 60 |
| ALH-28 | 19 | 220 | 85 |
| | | | |

(*) boats monitored in this study. Note in ALH-3, ALH-4 and ALH-12 the sharp difference between the real size of the driftnet gear, given in brackets, as learnt from the daily monitoring of the fishing activity, and the size recorded during the Jan 2003 survey at the port; this mismatch points to a likely general underestimation of the recorded length of the gears shown in this table.
(**) net length nearly doubled from 16/7/2003 on, when this boat started using 120 units

Table 2. Monthly account of the activity of the monitored boats during the study period. The total number of fishing operations conducted is shown (n), together with the total monthly effort. All fishing operations were monitored.

| | ALH-1 | | ALH-2 / ALH-12 [a] | | ALH-3 | | ALH-4 | |
|---|---|---|---|---|---|---|---|---|
| | n | Effort (km net set) | n | Effort (km net set) | n | Effort (km net set) | n | Effort (km net set) |
| Dec 2002[b] | 7 | 45.5 | 7 | 42 | - | - | - | - |
| Jan 2003 | 11 | 71.5 | 13 | 78 | 13 | 152 | 14 | 196 |
| Feb 2003 | 8 | 52 | 8 | 48 | 8 | 96 | 8 | 112 |
| Mar 2003 | 9 | 58.5 | 8 | 48 | 11 | 132 | 11 | 154 |
| Apr 2003 | 5[c] | 45.5[c] | 7 | 42 | 12 | 144 | 12 | 168 |
| May 2003 | 7[d] | 45.5[d] | 5[e] | 30[e] | 11 | 132 | 11 | 154 |
| Jun 2003 | - | - | - | - | 17 | 204 | 16 | 224 |
| Jul 2003 | 12[f] | 144[f] | 12[e] | 168[e] | 18 | 216 | 19 | 266 |
| Aug 2003 | 14 | 168 | 14 | 196 | 14 | 168 | 14 | 196 |
| Sep 2003[g] | 2 | 24 | 3 | 42 | 3 | 36 | 3 | 42 |
| total | 75 | 654.5 | 77 | 694 | 107 | 1280 | 108 | 1512 |

Total monitored hauls = 369
Total monitored km net = 4140.5
Average fishing days per boat per month[h] = 10.0

[a]boat ALH-12 replaced boat ALH-2 from 16th Jul on in the monitoring scheme
[b]sampling started on Dec 22nd for ALH-1 and ALH-2 and on 1st Jan for ALH-3 and ALH-4
[c]including an exceptional fishing trip lasting 3 days
[d]monitoring was stopped the 9th May due to logistic constraints (boat under repairs)
[e]monitoring of ALH-2 finalized the 9th May due to a change in fishing modality (from driftnets to fish traps); monitoring of ALH-12 started on 16th Jul
[f]monitoring was resumed on 16th Jul
[g]monitoring was closed on 15th September
[h]estimated using only data from complete sampled months, including the period of inactivity of boat ALH-2

Table 3. Active driftnet boats based at Tangiers port identified during the Jan 2003 ([J]) and August 2003 ([A]) surveys. Codes aim at keeping confidentiality about boat owners.

| code | crew size (no. persons) | engine power (HP) | No. driftnet units (unit length: 100 m) |
|---|---|---|---|
| | | | |
| | | | |
| TAN-1 [J] | 8 | 200 | 85 |
| TAN-2 [J] | 10 | 250 | 90 |
| TAN-3 [J] | 10 | 180 | 75 |
| TAN-4 [J] | 12 | 350 | 120 |
| TAN-5 [J] | 8 | 200 | 85 |
| TAN-6 [J] | 8 | 150 | 75 |
| TAN-7 [J] | 10 | 180 | 80 |
| TAN-8 [J] | 7 | 150 | 80 |
| TAN-9 [J] | 6 | 120 | 75 |
| TAN-10 [J] | 6 | 80 | 60 |
| TAN-11 [J] | 5 | 120 | 65 |
| TAN-12 [J] | 10 | 250 | 110 |
| TAN-13 [J] | 12 | 420 | 120 |
| TAN-14 [J] | 10 | 350 | 90 |
| TAN-15 [J] | 12 | 420 | 110 |
| TAN-16 [J] | 6 | 80 | 60 |
| TAN-17 [J] | 10 | 380 | 100 |
| TAN-18 [J] | 8 | 150 | 80 |
| TAN-19 [J] | 6 | 180 | 70 |
| TAN-20 [J] | 6 | 120 | 60 |
| TAN-21 [J] | 10 | 350 | 110 |
| TAN-22 [J] | 5 | 80 | 65 |
| TAN-23 [J] | 7 | 150 | 80 |
| TAN-24 [J] | 12 | 350 | 90 |
| TAN-25 [J] | 10 | 180 | 70 |
| TAN-26 [J] | 5 | 80 | 60 |
| TAN-27 [J] | 5 | 60 | 50 |
| TAN-28 [J] | 9 | 250 | 80 |
| TAN-29 [J] | 5 | 80 | 50 |
| TAN-30 [J] | 10 | 300 | 100 |
| TAN-31 [J] | 8 | 180 | 80 |
| TAN-32 [J] | 10 | 250 | 90 |
| TAN-33 [J] | 8 | 200 | 80 |
| TAN-34 [J] | 12 | 350 | 100 |
| TAN-35 [J] | 12 | 420 | 120 |
| TAN-36 [J] | 8 | 180 | 90 |
| TAN-37 [J] | 6 | 100 | 70 |
| TAN-38 [J] | 7 | 250 | 90 |
| TAN-39 [J] | 7 | 150 | 70 |
| TAN-40 [J] | 8 | 220 | 90 |
| TAN-41 [J] | 7 | 150 | 80 |
| TAN-42 [J] | 8 | 150 | 70 |
| TAN-43 [J] | 7 | 150 | 80 |
| TAN-44 [J] | 8 | 220 | 100 |
| TAN-45 [J] | 5 | 120 | 60 |

Table 3. continued

| code | crew size (no. persons) | engine power (HP) | No. driftnet units (unit length: 100 m) |
|---|---|---|---|
| | | | |
| | | | |
| TAN-46 [J] | 8 | 180 | 80 |
| TAN-47 [J] | 15 | 350 | 110 |
| TAN-48 [J] | 8 | 180 | 100 |
| TAN-49 [J] | 10 | 200 | 90 |
| TAN-50 [J] | 10 | 300 | 90 |
| TAN-51 [J] | 8 | 150 | 70 |
| TAN-52 [J] | 7 | 120 | 75 |
| TAN-53 [J] | 8 | 120 | 80 |
| TAN-54 [J] | 6 | 120 | 70 |
| TAN-55 [J] | 8 | 150 | 80 |
| TAN-56 [J] | 10 | 200 | 80 |
| TAN-57 [J] | 6 | 80 | 60 |
| TAN-58 [J] | 6 | 70 | 65 |
| TAN-59 [J] | 8 | 120 | 70 |
| TAN-60 [J] | 6 | 120 | 65 |
| TAN-61 [J] | 5 | 150 | 70 |
| TAN-62 [J] | 6 | 80 | 60 |
| TAN-63 [J] | 8 | 150 | 80 |
| TAN-64 [J] | 6 | 80 | 70 |
| TAN-65 [J] | 5 | 100 | 60 |
| TAN-66 [J] | 8 | 180 | 80 |
| TAN-67 [J] | 12 | 250 | 90 |
| TAN-68 [J] | 7 | 180 | 85 |
| TAN-69 [J] | 6 | 100 | 65 |
| TAN-70 [J] | 5 | 80 | 60 |
| TAN-71 [J] | 7 | 120 | 80 |
| TAN-72 [J] | 10 | 380 | 90 |
| TAN-73 [J] | 4 | 80 | 50 |
| TAN-74 [J] | 6 | 100 | 70 |
| TAN-75 [J] | 5 | 120 | ? |
| TAN-76 [J] | 10 | 350 | 100 |
| TAN-77 [J] | 12 | 420 | 110 |
| TAN-78 [A] | 5 | 60 | 30 |
| TAN-79 [A] | 5 | 45 | 40 |
| TAN-80 [A] | 6 | 120 | 40 |
| TAN-81 [A] | 8 | 80 | 60 |
| TAN-82 [A] | 8 | 90 | 80 |
| TAN-83 [A] | 6 | 33 | 30 |
| TAN-84 [A] | 6 | 50 | 30 |
| TAN-85 [A] | 8 | 90 | 60 |
| TAN-86 [A] | 6 | 50 | 40 |
| TAN-87 [A] | 10 | 80 | 40 |
| TAN-88 [A] | 8 | 50 | 40 |
| TAN-89 [A] | 8 | 120 | 50 |
| TAN-90 [A] | 12 | 360 | 120 |
| TAN-91 [A] | 10 | 300 | 80 |

Table 3. continued

| code | crew size (no. persons) | engine power (HP) | No. driftnet units (unit length: 100 m) |
|---|---|---|---|
| | | | |
| | | | |
| TAN-92 [A] | 8 | 80 | 80 |
| TAN-93 [A] | 10 | 300 | 80 |
| TAN-94 [A] | 8 | 80 | 70 |
| TAN-95 [A] | 8 | 50 | 40 |
| TAN-96 [A] | 10 | 250 | 80 |
| TAN-97 [A] | 6 | 50 | 30 |
| TAN-98 [A] | 7 | 50 | 40 |
| TAN-99 [A] | 6 | 50 | 30 |
| TAN-100 [A] | 6 | 180 | 50 |
| TAN-101 [A] | 8 | 150 | 80 |
| TAN-102 [A] | 10 | 150 | 80 |
| TAN-103 [A] | 10 | 120 | 60 |
| TAN-104 [A] | 10 | 120 | 100 |
| TAN-105 [A] | 10 | 120 | 100 |
| TAN-106 [A] | 8 | 120 | 60 |
| TAN-107 [A] | 8 | 120 | 80 |
| TAN-108 [A] | 10 | 120 | 80 |
| TAN-109 [A] | 6 | 80 | 40 |
| TAN-110 [A] | 5 | 50 | 30 |
| TAN-111 [A] | 8 | 120 | 60 |
| TAN-112 [A] | 8 | 80 | 40 |
| TAN-113 [A] | 6 | 50 | 40 |
| TAN-114 [A] | 6 | 80 | 40 |
| TAN-115 [A] | 8 | 120 | 60 |
| TAN-116 [A] | 12 | 350 | 100 |
| TAN-117 [A] | 5 | 50 | 30 |
| TAN-118 [A] | 5 | 50 | 30 |
| TAN-119 [A] | 5 | 50 | 30 |
| TAN-120 [A] | ? | 80 | 60 |
| TAN-121 [A] | 6 | 80 | 30 |
| TAN-122 [A] | 8 | 120 | 40 |
| TAN-123 [A] | 7 | 120 | 30 |
| TAN-124 [A] | 10 | 250 | 120 |
| TAN-125 [A] | 10 | 120 | 80 |
| TAN-126 [A] | 10 | 120 | 80 |
| TAN-127 [A] | 10 | 160 | 60 |
| TAN-128 [A] | 10 | 120 | 100 |
| TAN-129 [A] | 12 | 120 | 90 |
| TAN-130 [A] | 6 | 100 | 40 |

Table 4. Active driftnet boats based at Nador port identified during the August 2003 survey. Codes aim at keeping confidentiality about boat owners.

| code | crew size (no. persons) | engine power (HP) | No. driftnet units (unit length: 100 m) |
|---|---|---|---|
| | | | |
| | | | |
| NAD-1 | 6 | 150 | 60 |
| NAD-2 | 8 | 120 | 70 |
| NAD-3 | 8 | 150 | 70 |
| NAD-4 | 10 | 150 | 70 |
| NAD-5* | 20 | 170 | 70 |
| NAD-6* | 17 | 150 | 60 |
| NAD-7* | 20 | 170 | 80 |
| NAD-8 | 8 | 120 | 60 |
| NAD-9* | 16 | 150 | 65 |
| NAD-10 | 8 | 120 | 70 |
| NAD-11 | 7 | 150 | 60 |
| NAD-12 | 6 | 120 | 60 |
| NAD-13 | 7 | 80 | 60 |
| NAD-14 | 8 | 120 | 70 |
| NAD-15 | 8 | 150 | 80 |
| NAD-16 | 4 | 60 | 45 |
| NAD-17 | 8 | 158 | 90 |
| NAD-18* | 6 | 80 | 60 |
| NAD-19 | 6 | 60 | 50 |
| | | | |

(*) purse seiner boats only deploying driftnets during the months of February, March and April

Table 5. Average gear length and size of the active driftnet fleet identified and sampled in Moroccan ports (Mediterranean and adjacent Atlantic waters).

| | Number of active driftnet boats | Mean net length (km ± S.D.) | Mean engine power (hp ± S.D.) |
|---|---|---|---|
| Al Hoceima (Jan 2003) | 28 | 6.88 ± 3.0 | 149.28 ± 41.3 |
| Tangiers (Jan 2003) | 77 | 8.05 ± 1.7 | 190.64 ± 100.6 |
| Tangiers (Aug 2003)[a] | 53 | 5.86 ± 2.5 | 115.24 ± 76.8 |
| Tangiers (Total) | 130 | 7.15 ± 2.3 | 159.90 ± 98.6 |
| Nador (Aug 2003) | 19 | 6.57 ± 1.0 | 127.78 ± 34.9 |
| Larache (Jun 2003)[b] | ± 30 | 8-10 (80 to 100 units) | - |
| Asilah (Jun 2003)[b] | ± 10 | 4.8-10 (48 to 100 units) | - |

[a] only the new active units, not using driftnets during the previous Jan 2003 survey
[b] exploratory survey

Table 6. Daily pattern of driftnet fishing activity by the 5 boats monitored during this study.

| Boat | Range of setting time (GMT) | Range of hauling time (GMT) | Mean soaking time (h ± S.D.) |
|---|---|---|---|
| ALH-1 | 15h – 18h 30 | 22h – 07h 30 | 11.68 ± 2.12 |
| ALH-2 | 15h – 18h | 21h – 07h | 10.42 ± 2.41 |
| ALH-3 | 14h – 19h 15 | 02h – 8h 15 | 12.51 ± 1.86 |
| ALH-4 | 14h – 19h 45 | 01h – 08h | 12.49 ± 2.20 |
| ALH-12 | 14h – 19h | 00h 30 – 07h | 12.29 ± 1.83 |

Table 7. Size of the driftnet fleet based in Mediterranean Moroccan ports according to different sources.

| | Size of driftnet fleet (number of *longliners*) | Year | Source |
|---|---|---|---|
| Al Hoceima | 36[1] | - | official census |
| Al Hoceima/Cala Iris | 52[2] | 2000 | GFCM Studies and Reviews 71[3] |
| Jebha | 1 | 2000 | GFCM Studies and Reviews 71[3] |
| M'dik port | 11[4] | 2000 | GFCM Studies and Reviews 71[3] |
| Nador | 60 | 1998 | FAO-COPEMED ‘Gibraltar’98’ Project |
| Nador | 45 | 2000 | FAO-COPEMED ‘Tunidos’ Project |
| Nador | 144[5] | 2001 | official census |
| Nador | 57 | 2001 | doc. ICCAT SCRS/2002/139[6] |
| Nador | 63[7] | 2000 | GFCM Studies and Reviews 71[3] |
| Ras Kebdana | 14[4] | 2000 | GFCM Studies and Reviews 71[3] |
| Tangiers | 160 | 1998 | FAO-COPEMED ‘Gibraltar’98’ Project |
| Tangiers | 275 | 2000 | FAO-COPEMED ‘Tunidos’ Project |
| Tangiers | 246 | 2001 | doc. ICCAT SCRS/2002/139[6] |
| Tangiers | 278 | 2002 | official census |
| Tangiers/ Ksar Sghir | 122[8] | 2000 | GFCM Studies and Reviews 71[3] |
| Total Medit. | 357 | 2001 | doc. ICCAT SCRS/2002/139[6] |

[1] referred to the Al Hoceima maritime district (= *circonscription maritime*)
[2] including 7 units with mixed licenses for longlining (= driftnetting) and purse seining
[3] Franquesa *et al*. (2001)
[4] all with mixed licenses for longlining (= driftnetting) and purse seining
[5] including both inactive boats and those with mixed licenses for longlining (= driftnetting) and purse seining
[6] Srour and Abid (2003)
[7] including 18 units with mixed licenses for longlining (= driftnetting) and purse seining
[8] including 24 units with mixed licenses for longlining (= driftnetting) and purse seining

Table 8. Total catches achieved by the 5 boats monitored during the period of sampling Dec 2002/Jan 2003 to Sep 2003 relative to the set of target and by-catch species selected for this study. Data from 369 fishing operations –all of them carried out in the Mediterranean Sea- have been pooled.

| Species | n |
|---|---|
| Swordfish[1] (*Xiphias gladius*) | 2990 |
| Dolphins (*D. delphis* and *S. coeruleoalba*) | 237 |
| Loggerhead turtle (*Caretta caretta*) | 46 |
| Blue shark (*Prionace glauca*) | 498 |
| Shortfin mako (*Isurus oxyrinchus*) | 542 |
| Thresher shark (*Alopias vulpinus*) | 464 |
| Sunfish[2] (*Mola mola*) | 508 |

[1]including a small number (about 4%) of billfishes
[2]sunfish catches were monitored only from 2$^{nd}$ Feb in the case of boat ALH-1

Table 9. Monthly information on total captures and capture per unit effort (cpue) of swordfish (*Xiphias gladius*) by the 4 monitored driftnet boats. Three different measures of cpue are provided, monthly averages being calculated from daily (=single fishing operations) figures. Note that *N* refers to number of individuals.

| Month | Boat | Total capture (N) | Capture per fishing operation (N/fishing operation) | Capture per km net set (N/km) | Capture per km net set*soaking time (N/km.h) |
|---|---|---|---|---|---|
| | | | | | |
| Dec 2002[a] | ALH-1 | 41 | 5.85 (SE = ±1.10) | 0.90 (SE = ±0.16) | 0.071 (SE = ±0.011) |
| | ALH-2 | 41 | 5.85 (SE = ±1.40) | 0.97 (SE = ±0.23) | 0.086 (SE = ±0.018) |
| | ALH-3 | - | - | - | - |
| | ALH-4 | - | - | - | - |
| | | | | | |
| Jan 2003 | ALH-1 | 65 | 5.90 (SE = ±1.03) | 0.90 (SE = ±0.15) | 0.091 (SE = ±0.017) |
| | ALH-2 | 68 | 5.23 (SE = ±0.63) | 0.87 (SE = ±0.10) | 0.090 (SE = ±0.011) |
| | ALH-3 | 98 | 7.53 (SE = ±1.15) | 0.65 (SE = ±0.10) | 0.055 (SE = ±0.009) |
| | ALH-4 | 108 | 7.74 (SE = ±0.82) | 0.55 (SE = ±0.05) | 0.044 (SE = ±0.004) |
| | | | | | |
| Feb 2003 | ALH-1 | 62 | 7.75 (SE = ±0.91) | 1.19 (SE = ±0.14) | 0.099 (SE = ±0.012) |
| | ALH-2 | 60 | 7.50 (SE = ±1.01) | 1.25 (SE = ±0.16) | 0.095 (SE = ±0.013) |
| | ALH-3 | 102 | 12.75 (SE = ±2.80) | 1.06 (SE = ±0.23) | 0.084 (SE = ±0.021) |
| | ALH-4 | 98 | 12.25 (SE = ±1.39) | 0.87 (SE = ±0.09) | 0.071 (SE = ±0.009) |
| | | | | | |
| Mar 2003 | ALH-1 | 103 | 11.44 (SE = ±2.64) | 1.76 (SE = ±0.40) | 0.142 (SE = ±0.036) |
| | ALH-2 | 86 | 10.75 (SE = ±1.59) | 1.79 (SE = ±0.26) | 0.167 (SE = ±0.025) |
| | ALH-3 | 120 | 10.90 (SE = ±1.53) | 0.90 (SE = ±0.12) | 0.074 (SE = ±0.010) |
| | ALH-4 | 111 | 10.09 (SE = ±0.99) | 0.72 (SE = ±0.07) | 0.054 (SE = ±0.006) |
| | | | | | |
| Abr 2003 | ALH-1[b] | 100 | 8.75 (SE = ±3.14) | 1.34 (SE = ±0.48) | 0.146 (SE = ±0.049) |
| | ALH-2 | 61 | 8.71 (SE = ±2.02) | 1.45 (SE = ±0.33) | 0.173 (SE = ±0.041) |
| | ALH-3 | 141 | 11.75 (SE = ±1.76) | 0.97 (SE = ±0.14) | 0.076 (SE = ±0.011) |
| | ALH-4 | 153 | 12.75 (SE = ±1.66) | 0.91 (SE = ±0.11) | 0.070 (SE = ±0.009) |
| | | | | | |
| May 2003 | ALH-1[c] | 91 | 13.00 (SE = ±1.95) | 2.00 (SE = ±0.30) | 0.225 (SE = ±0.045) |
| | ALH-2[d] | 45 | 9.00 (SE = ±1.47) | 1.50 (SE = ±0.24) | 0.168 (SE = ±0.019) |
| | ALH-3 | 165 | 15.00 (SE = ±2.13) | 1.25 (SE = ±0.17) | 0.101 (SE = ±0.012) |
| | ALH-4 | 200 | 20.00 (SE = ±1.85) | 1.42 (SE = ±0.13) | 0.119 (SE = ±0.009) |
| | | | | | |
| Jun 2003 | ALH-1[c] | - | - | - | - |
| | ALH-2[d] | - | - | - | - |
| | ALH-3 | 139 | 8.17 (SE = ±1.12) | 0.68 (SE = ±0.09) | 0.057 (SE = ±0.008) |
| | ALH-4 | 124 | 7.75 (SE = ±1.14) | 0.55 (SE = ±0.08) | 0.046 (SE = ±0.007) |
| | | | | | |

[a] incomplete data: sampling started the 22nd Dec for ALH-1 and ALH-2 and the 1st Jan for ALH-3 and ALH-4
[b] the catch attributed to an exceptional fishing trip lasting three days has been excluded from cpue calculations
[c] monitoring was stopped the 9th May due to logistic constraints (boat under repairs)
[d] monitoring finalized the 9th May due to a change in fishing modality (from driftnets to fish traps)

Table 9. Monthly information on total captures and capture per unit effort (cpue) of swordfish (*Xiphias gladius*) by the 4 monitored driftnet boats (continued)

| Month | Boat | Total capture (N) | Capture per fishing operation (N/fishing operation) | Capture per km net set (N/km) | Capture per km net set*soaking time (N/km.h) |
|---|---|---|---|---|---|
| | | | | | |
| Jul 2002 | ALH-1[a] | 73 | 6.08 (SE = ±0.89) | 0.50 (SE = ±0.07) | 0.039 (SE = ±0.005) |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 89 | 4.94 (SE = ±0.88) | 0.41 (SE = ±0.07) | 0.034 (SE = ±0.005) |
| | ALH-4 | 99 | 5.50 (SE = ±0.56) | 0.38 (SE = ±0.03) | 0.031 (SE = ±0.003) |
| | ALH-12[b] | 56 | 4.66 (SE = ±0.83) | 0.33 (SE = ±0.05) | 0.029 (SE = ±0.005) |
| | | | | | |
| Aug 2003 | ALH-1 | 52 | 3.71 (SE = ±0.51) | 0.30 (SE = ±0.04) | 0.025 (SE = ±0.004) |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 66 | 4.71 (SE = ±0.49) | 0.39 (SE = ±0.04) | 0.030 (SE = ±0.003) |
| | ALH-4 | 51 | 3.64 (SE = ±0.61) | 0.26 (SE = ±0.04) | 0.022 (SE = ±0.004) |
| | ALH-12 | 65 | 4.64 (SE = ±0.54) | 0.33 (SE = ±0.03) | 0.026 (SE = ±0.003) |
| | | | | | |
| Sep 2003[c] | ALH-1 | 9 | 4.50 (SE = ±0.49) | 0.37 (SE = ±0.04) | 0.031 (SE = ±0.002) |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 14 | 4.66 (SE = ±1.20) | 0.38 (SE = ±0.10) | 0.030 (SE = ±0.007) |
| | ALH-4 | 16 | 5.33 (SE = ±0.88) | 0.38 (SE = ±0.06) | 0.030 (SE = ±0.003) |
| | ALH-12 | 14 | 4.66 (SE = ±0.88) | 0.33 (SE = ±0.06) | 0.025 (SE = ±0.004) |
| | | | | | |

[a] monitoring was resumed on Jul 16th after 2 months of inactivity
[b] sampling of this boat started on Jul 16th
[c] all sampling activities were closed on Sep 15th

Table 10. Monthly information on total captures and capture per unit effort (cpue) of dolphins (*Delphinus delphis* and *Stenella coeruleoalba*) by the 4 monitored driftnet boats. Three different measures of cpue are provided, monthly averages being calculated from daily (=single fishing operations) figures. Note that *N* refers to number of individuals.

| Month | Boat | Total capture (N) | Capture per fishing operation (N/fishing operation) | Capture per km net set (N/km) | Capture per km net set*soaking time (N/km.h) |
|---|---|---|---|---|---|
| | | | | | |
| Dec 2002 [a] | ALH-1 | 5 | 0.714 (SE = ±0.473) | 0.109 (SE = ±0.072) | 0.0085 (SE = ±0.0055) |
| | ALH-2 | 4 | 0.571 (SE = ±0.296) | 0.095 (SE = ±0.049) | 0.0081 (SE = ±0.0043) |
| | ALH-3 | - | - | - | - |
| | ALH-4 | - | - | - | - |
| | | | | | |
| Jan 2003 | ALH-1 | 4 | 0.363 (SE = ±0.202) | 0.055 (SE = ±0.031) | 0.0065 (SE = ±0.0040) |
| | ALH-2 | 5 | 0.384 (SE = ±0.240) | 0.064 (SE = ±0.040) | 0.0107 (SE = ±0.0077) |
| | ALH-3 | 5 | 0.384 (SE = ±0.310) | 0.032 (SE = ±0.026) | 0.0033 (SE = ±0.0027) |
| | ALH-4 | 3 | 0.214 (SE = ±0.214) | 0.015 (SE = ±0.015) | 0.0012 (SE = ±0.0012) |
| | | | | | |
| Feb 2003 | ALH-1 | 3 | 0.375 (SE = ±0.262) | 0.057 (SE = ±0.040) | 0.0057 (SE = ±0.0043) |
| | ALH-2 | 2 | 0.250 (SE = ±0.163) | 0.041 (SE = ±0.027) | 0.0032 (SE = ±0.0021) |
| | ALH-3 | 4 | 0.500(SE = ±0.326) | 0.041 (SE = ±0.027) | 0.0036 (SE = ±0.0023) |
| | ALH-4 | 4 | 0.500 (SE = ±0.500) | 0.035 (SE = ±0.035) | 0.0037 (SE = ±0.0037) |
| | | | | | |
| Mar 2003 | ALH-1 | 0 | 0 | 0 | 0 |
| | ALH-2 | 2 | 0.250 (SE = ±0.249) | 0.041 (SE = ±0.041) | 0.0039 (SE = ±0.0039) |
| | ALH-3 | 4 | 0.363 (SE = ±0.109) | 0.030 (SE = ±0.016) | 0.0026 (SE = ±0.0015) |
| | ALH-4 | 2 | 0.181 (SE = ±0.121) | 0.012 (SE = ±0.008) | 0.0012 (SE = ±0.0008) |
| | | | | | |
| Abr 2003 | ALH-1 | 14 | 3.500 (SE = ±1.686) | 0.538 (SE = ±0.259) | 0.0526 (SE = ±0.0245) |
| | ALH-2 | 1 | 0.142 (SE = ±0.142) | 0.023 (SE = ±0.023) | 0.0023 (SE = ±0.0023) |
| | ALH-3 | 11 | 0.916 (SE = ±0.473) | 0.076 (SE = ±0.026) | 0.0060 (SE = ±0.0020) |
| | ALH-4 | 8 | 0.666 (SE = ±0.255) | 0.047 (SE = ±0.018) | 0.0037 (SE = ±0.0014) |
| | | | | | |
| May 2003 | ALH-1 [b] | 4 | 0.571 (SE = ±0.296) | 0.087 (SE = ±0.045) | 0.0090 (SE = ±0.0046) |
| | ALH-2 [c] | 5 | 1.000 (SE = ±0.632) | 0.166 (SE = ±0.105) | 0.0177 (SE = ±0.0114) |
| | ALH-3 | 15 | 1.363 (SE = ±0.309) | 0.113 (SE = ±0.025) | 0.0089 (SE = ±0.0019) |
| | ALH-4 | 13 | 1.181 (SE = ±0.225) | 0.084 (SE = ±0.016) | 0.0071 (SE = ±0.0014) |
| | | | | | |
| Jun 2003 | ALH-1 [b] | - | - | - | - |
| | ALH-2 [c] | - | - | - | - |
| | ALH-3 | 10 | 0.588 (SE = ±0.172) | 0.049 (SE = ±0.014) | 0.0038 (SE = ±0.0011) |
| | ALH-4 | 15 | 0.937 (SE = ±0.265) | 0.066 (SE = ±0.018) | 0.0053 (SE = ±0.0014) |
| | | | | | |

[a] incomplete data: sampling started the 22nd Dec for ALH-1 and ALH-2 and the 1st Jan for ALH-3 and ALH-4
[b] monitoring was stopped the 9th May due to logistic constraints (boat under repairs)
[c] monitoring finalized the 9th May due to a change in fishing modality (from driftnets to fish traps)

Table 10. Monthly information on total captures and capture per unit effort (cpue) of dolphins (*Delphinus delphis* and *Stenella coeruleoalba*) by the 4 monitored driftnet boats (continued)

| Month | Boat | Total capture (N) | Capture per fishing operation (N/fishing operation) | Capture per km net set (N/km) | Capture per km net set*soaking time (N/km.h) |
|---|---|---|---|---|---|
| | | | | | |
| Jul 2002 | ALH-1[a] | 9 | 0.750 (SE = ±0.249) | 0.062 (SE = ±0.020) | 0.0049 (SE = ±0.0016) |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 21 | 1.166 (SE = ±0.282) | 0.097 (SE = ±0.023) | 0.0079 (SE = ±0.0018) |
| | ALH-4 | 24 | 1.263 (SE = ±0.213) | 0.090 (SE = ±0.015) | 0.0075 (SE = ±0.0013) |
| | ALH-12[b] | 10 | 0.833 (SE = ±0.240) | 0.059 (SE = ±0.017) | 0.0050 (SE = ±0.0014) |
| | | | | | |
| Aug 2003 | ALH-1 | 7 | 0.500 (SE = ±0.202) | 0.041 (SE = ±0.016) | 0.0033 (SE = ±0.0013) |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 7 | 0.500 (SE = ±0.173) | 0.041 (SE = ±0.014) | 0.0035 (SE = ±0.0013) |
| | ALH-4 | 6 | 0.428 (SE = ±0.137) | 0.030 (SE = ±0.009) | 0.0023 (SE = ±0.0007) |
| | ALH-12 | 7 | 0.500 (SE = ±0.228) | 0.035 (SE = ±0.016) | 0.0028 (SE = ±0.0012) |
| | | | | | |
| Sep 2003[c] | ALH-1 | 0 | 0 | 0 | 0 |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 0 | 0 | 0 | 0 |
| | ALH-4 | 2 | 0.666 (SE = ±0.666) | 0.047 (SE = ±0.047) | 0.0032 (SE = ±0.0032) |
| | ALH-12 | 1 | 0.333 (SE = ±0.333) | 0.023 (SE = ±0.023) | 0.0018 (SE = ±0.0018) |
| | | | | | |

[a] monitoring was resumed on Jul 16th after 2 months of inactivity
[b] sampling of this boat started on Jul 16th
[c] all sampling activities were closed on Sep 15th

Table 11. Monthly information on total captures and capture per unit effort (cpue) of loggerhead turtle (*Caretta caretta*) by the 4 monitored driftnet boats. Three different measures of cpue are provided, monthly averages being calculated from daily (=single fishing operations) figures. Note that *N* refers to number of individuals.

| Month | Boat | Total capture (N) | Capture per fishing operation (N/fishing operation) | Capture per km net set (N/km) | Capture per km net set*soaking time (N/km.h) |
|---|---|---|---|---|---|
| | | | | | |
| Dec 2002[a] | ALH-1 | 2 | 0.285 (SE = ±0.183) | 0.043 (SE = ±0.028) | 0.0035 (SE = ±0.0022) |
| | ALH-2 | 2 | 0.285 (SE = ±0.285) | 0.047 (SE = ±0.047) | 0.0036 (SE = ±0.0036) |
| | ALH-3 | - | - | - | - |
| | ALH-4 | - | - | - | - |
| | | | | | |
| Jan 2003 | ALH-1 | 2 | 0.181 (SE = ±0.121) | 0.027 (SE = ±0.018) | 0.0026 (SE = ±0.0017) |
| | ALH-2 | 3 | 0.230 (SE = ±0.165) | 0.038 (SE = ±0.027) | 0.0039 (SE = ±0.0027) |
| | ALH-3 | 0 | 0 | 0 | 0 |
| | ALH-4 | 7 | 0.500 (SE = ±0.251) | 0.035 (SE = ±0.017) | 0.0027 (SE = ±0.0017) |
| | | | | | |
| Feb 2003 | ALH-1 | 2 | 0.250 (SE = ±0.250) | 0.038 (SE = ±0.038) | 0.0029 (SE = ±0.0029) |
| | ALH-2 | 2 | 0.250 (SE = ±0.163) | 0.041 (SE = ±0.027) | 0.0032 (SE = ±0.0020) |
| | ALH-3 | 4 | 0.500 (SE = ±0.377) | 0.041 (SE = ±0.031) | 0.0029 (SE = ±0.0021) |
| | ALH-4 | 3 | 0.375 (SE = ±0.262) | 0.026 (SE = ±0.018) | 0.0019 (SE = ±0.0014) |
| | | | | | |
| Mar 2003 | ALH-1 | 4 | 0.444 (SE = ±0.241) | 0.068 (SE = ±0.037) | 0.0056 (SE = ±0.0032) |
| | ALH-2 | 2 | 0.250 (SE = ±0.163) | 0.041 (SE = ±0.027) | 0.0037 (SE = ±0.0024) |
| | ALH-3 | 2 | 0.181 (SE = ±0.121) | 0.015 (SE = ±0.010) | 0.0012 (SE = ±0.0083) |
| | ALH-4 | 1 | 0.090 (SE = ±0.090) | 0.006 (SE = ±0.006) | 0.0004 (SE = ±0.0004) |
| | | | | | |
| Abr 2003 | ALH-1 | 5[b] | - | - | - |
| | ALH-2 | 0 | 0 | 0 | 0 |
| | ALH-3 | 0 | 0 | 0 | 0 |
| | ALH-4 | 0 | 0 | 0 | 0 |
| | | | | | |
| May 2003 | ALH-1[c] | 2 | 0.285 (SE = ±0.285) | 0.043 (SE = ±0.043) | 0.0043 (SE = ±0.0043) |
| | ALH-2[d] | 1 | 0.200 (SE = ±0.200) | 0.033 (SE = ±0.033) | 0.0033 (SE = ±0.0033) |
| | ALH-3 | 0 | 0 | 0 | 0 |
| | ALH-4 | 0 | 0 | 0 | 0 |
| | | | | | |
| Jun 2003 | ALH-1[c] | - | - | - | - |
| | ALH-2[d] | - | - | - | - |
| | ALH-3 | 0 | 0 | 0 | 0 |
| | ALH-4 | 0 | 0 | 0 | 0 |
| | | | | | |

[a] incomplete data: sampling started the 22nd Dec for ALH-1 and ALH-2 and the 1st Jan for ALH-3 and ALH-4
[b] all of them were captured during a single fishing trip lasting three days; these data have been excluded from cpue calculations
[c] monitoring was stopped the 9th May due to logistic constraints (boat under repairs)
[d] monitoring finalized the 9th May due to a change in fishing modality (from driftnets to fish traps)

Table 11. Monthly information on total captures and capture per unit effort (cpue) of loggerhead turtle (*Caretta caretta*) by the 4 monitored driftnet boats (continued)

| Month | Boat | Total capture (N) | Capture per fishing operation (N/fishing operation) | Capture per km net set (N/km) | Capture per km net set*soaking time (N/km.h) |
|---|---|---|---|---|---|
| | | | | | |
| Jul 2002 | ALH-1[a] | 0 | 0 | 0 | 0 |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 0 | 0 | 0 | 0 |
| | ALH-4 | 0 | 0 | 0 | 0 |
| | ALH-12[b] | 0 | 0 | 0 | 0 |
| | | | | | |
| Aug 2003 | ALH-1 | 1 | 0.071 (SE = ±0.071) | 0.005 (SE = ±0.005) | 0.0004 (SE = ±0.0004) |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 0 | 0 | 0 | 0 |
| | ALH-4 | 1 | 0.071 (SE = ±0.071) | 0.005 (SE = ±0.005) | 0.0004 (SE = ±0.0004) |
| | ALH-12 | 0 | 0 | 0 | 0 |
| | | | | | |
| Sep 2003[c] | ALH-1 | 0 | 0 | 0 | 0 |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 0 | 0 | 0 | 0 |
| | ALH-4 | 0 | 0 | 0 | 0 |
| | ALH-12 | 0 | 0 | 0 | 0 |
| | | | | | |

[a] monitoring was resumed on Jul 16th after 2 months of inactivity
[b] sampling of this boat started on Jul 16th
[c] all sampling activities were closed on Sep 15th

Table 12. Monthly information on total captures and capture per unit effort (cpue) of blue shark (*Prionace glauca*) by the 4 monitored driftnet boats. Three different measures of cpue are provided, monthly averages being calculated from daily (=single fishing operations) figures. Note that *N* refers to number of individuals.

| Month | Boat | Total capture (N) | Capture per fishing operation (N/fishing operation) | Capture per km net set (N/km) | Capture per km net set*soaking time (N/km.h) |
|---|---|---|---|---|---|
| | | | | | |
| Dec 2002[a] | ALH-1 | 3 | 0.428 (SE = ±0.296) | 0.065 (SE = ±0.045) | 0.0053 (SE = ±0.0036) |
| | ALH-2 | 4 | 0.571 (SE = ±0.296) | 0.095 (SE = ±0.049) | 0.0084(SE = ±0.0044) |
| | ALH-3 | - | - | - | - |
| | ALH-4 | - | - | - | - |
| | | | | | |
| Jan 2003 | ALH-1 | 8 | 0.727 (SE = ±0.358) | 0.111 (SE = ±0.055) | 0.0098 (SE = ±0.0047) |
| | ALH-2 | 9 | 0.692 (SE = ±0.327) | 0.115 (SE = ±0.054) | 0.0110 (SE = ±0.0052) |
| | ALH-3 | 16 | 1.230 (SE = ±0.410) | 0.102 (SE = ±0.034) | 0.0081 (SE = ±0.0027) |
| | ALH-4 | 20 | 1,428 (SE = ±0.520) | 0.102 (SE = ±0.037) | 0.0083 (SE = ±0.0031) |
| | | | | | |
| Feb 2003 | ALH-1 | 15 | 1.875 (SE = ±0.548) | 0.288 (SE = ±0.084) | 0.0258 (SE = ±0.0086) |
| | ALH-2 | 17 | 2.125 (SE = ±0.579) | 0.354 (SE = ±0.096) | 0.0281 (SE = ±0.0080) |
| | ALH-3 | 13 | 1.625 (SE = ±0.651) | 0.135 (SE = ±0.054) | 0.0098 (SE = ±0.0038) |
| | ALH-4 | 13 | 1,625 (SE = ±0.496) | 0.116 (SE = ±0.035) | 0.0106 (SE = ±0.0033) |
| | | | | | |
| Mar 2003 | ALH-1 | 2 | 0.222 (SE = ±0.146) | 0.034 (SE = ±0.022) | 0.0026 (SE = ±0.0017) |
| | ALH-2 | 5 | 0.625 (SE = ±0.323) | 0.104 (SE = ±0.053) | 0.0094 (SE = ±0.0047) |
| | ALH-3 | 26 | 2.363 (SE = ±0.788) | 0.196 (SE = ±0.065) | 0.0160 (SE = ±0.0051) |
| | ALH-4 | 23 | 2.090 (SE = ±0.679) | 0.149 (SE = ±0.048) | 0.0120 (SE = ±0.0039) |
| | | | | | |
| Abr 2003 | ALH-1[b] | 3 | 0.250 (SE = ±0.250) | 0.038 (SE = ±0.038) | 0.0042 (SE = ±0.0042) |
| | ALH-2 | 3 | 0.428 (SE = ±0.427) | 0.071 (SE = ±0.071) | 0.0102 (SE = ±0.0101) |
| | ALH-3 | 21 | 1.750 (SE = ±0.477) | 0.145 (SE = ±0.039) | 0.0119 (SE = ±0.0033) |
| | ALH-4 | 29 | 2.416 (SE = ±0.970) | 0.172 (SE = ±0.069) | 0.0126 (SE = ±0.0045) |
| | | | | | |
| May 2003 | ALH-1[c] | 1 | 0.142 (SE = ±0.142) | 0.021 (SE = ±0.021) | 0.0021 (SE = ±0.0021) |
| | ALH-2[d] | 2 | 0.400 (SE = ±0.400) | 0.066 (SE = ±0.066) | 0.0074 (SE = ±0.0074) |
| | ALH-3 | 11 | 1.000 (SE = ±0.403) | 0.083 (SE = ±0.033) | 0.0068 (SE = ±0.0027) |
| | ALH-4 | 21 | 1.909 (SE = ±0.529) | 0.136 (SE = ±0.037) | 0.0115 (SE = ±0.0031) |
| | | | | | |
| Jun 2003 | ALH-1[c] | - | - | - | - |
| | ALH-2[d] | - | - | - | - |
| | ALH-3 | 19 | 1.117 (SE = ±0.426) | 0.093 (SE = ±0.035) | 0.0071 (SE = ±0.0026) |
| | ALH-4 | 18 | 1.125 (SE = ±0.340) | 0.080 (SE = ±0.024) | 0.0069 (SE = ±0.0021) |
| | | | | | |

[a] incomplete data: sampling started the 22nd Dec for ALH-1 and ALH-2 and the 1st Jan for ALH-3 an ALH-4
[b] the catch attributed to an exceptional fishing trip lasting three days has been excluded from cpue calculations
[c] monitoring was stopped the 9th May due to logistic constraints (boat under repairs)
[d] monitoring finalized the 9th May due to a change in fishing modality (from driftnets to fish traps)

Table 12. Monthly information on total captures and capture per unit effort (cpue) of blue shark (*Prionace glauca*) by the 4 monitored driftnet boats (continued)

| Month | Boat | Total capture (N) | Capture per fishing operation (N/fishing operation) | Capture per km net set (N/km) | Capture per km net set*soaking time (N/km.h) |
|---|---|---|---|---|---|
| | | | | | |
| Jul 2002 | ALH-1[a] | 13 | 1.083 (SE = ±0.415) | 0.090 (SE = ±0.034) | 0.0073 (SE = ±0.0028) |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 30 | 1.166 (SE = ±0.418) | 0.138 (SE = ±0.034) | 0.0121 (SE = ±0.0031) |
| | ALH-4 | 27 | 1.421 (SE = ±0.360) | 0.101 (SE = ±0.025) | 0.0088 (SE = ±0.0023) |
| | ALH-12[b] | 20 | 1.666 (SE = ±0.480) | 0.119 (SE = ±0.034) | 0.0107 (SE = ±0.0029) |
| | | | | | |
| Aug 2003 | ALH-1 | 20 | 1.428 (SE = ±0.342) | 0.119 (SE = ±0.028) | 0.0098 (SE = ±0.0024) |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 22 | 1.571 (SE = ±0.440) | 0.130 (SE = ±0.036) | 0.0105 (SE = ±0.0029) |
| | ALH-4 | 20 | 1.428 (SE = ±0.290) | 0.102 (SE = ±0.020) | 0.0084 (SE = ±0.0057) |
| | ALH-12 | 27 | 1.928 (SE = ±0.384) | 0.137 (SE = ±0.027) | 0.0186 (SE = ±0.0021) |
| | | | | | |
| Sep 2003[c] | ALH-1 | 4 | 2.000 (SE = ±0.000) | 0.166 (SE = ±0.000) | 0.0141 (SE = ±0.0003) |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 5 | 1.666 (SE = ±0.333) | 0.138 (SE = ±0.027) | 0.0113 (SE = ±0.0029) |
| | ALH-4 | 3 | 1.000 (SE = ±0.000) | 0.071 (SE = ±0.000) | 0.0058 (SE = ±0.0002) |
| | ALH-12 | 5 | 1.666 (SE = ±0.666) | 0.119 (SE = ±0.047) | 0.0096 (SE = ±0.0047) |
| | | | | | |

[a] monitoring was resumed on Jul 16th after 2 months of inactivity
[b] sampling of this boat started on Jul 16th
[c] all sampling activities were closed on Sep 15th

Table 13. Monthly information on total captures and capture per unit effort (cpue) of shortfin mako (*Isurus oxyrinchus*) by the 4 monitored driftnet boats. Three different measures of cpue are provided, monthly averages being calculated from daily (=single fishing operations) figures. Note that *N* refers to number of individuals.

| Month | Boat | Total capture (N) | Capture per fishing operation (N/fishing operation) | Capture per km net set (N/km) | Capture per km net set*soaking time (N/km.h) |
|---|---|---|---|---|---|
| | | | | | |
| Dec 2002[a] | ALH-1 | 1 | 0.142 (SE = ±0.142) | 0.021 (SE = ±0.021) | 0.0015 (SE = ±0.0015) |
| | ALH-2 | 0 | 0 | 0 | 0 |
| | ALH-3 | - | - | - | - |
| | ALH-4 | - | - | - | - |
| | | | | | |
| Jan 2003 | ALH-1 | 1 | 0.090 (SE = ±0.090) | 0.013 (SE = ±0.013) | 0.0012 (SE = ±0.0012) |
| | ALH-2 | 0 | 0 | 0 | 0 |
| | ALH-3 | 0 | 0 | 0 | 0 |
| | ALH-4 | 5 | 0.357 (SE = ±0.357) | 0.025 (SE = ±0.025) | 0.0021 (SE = ±0.0021) |
| | | | | | |
| Feb 2003 | ALH-1 | 4 | 0.500 (SE = ±0.326) | 0.076 (SE = ±0.050) | 0.0072 (SE = ±0.0048) |
| | ALH-2 | 1 | 0.125 (SE = ±0.125) | 0.020 (SE = ±0.020) | 0.0014 (SE = ±0.0014) |
| | ALH-3 | 10 | 1.250 (SE = ±0.646) | 0.104 (SE = ±0.053) | 0.0079 (SE = ±0.0041) |
| | ALH-4 | 14 | 1.750 (SE = ±0.772) | 0.125 (SE = ±0.055) | 0.0107 (SE = ±0.0048) |
| | | | | | |
| Mar 2003 | ALH-1 | 2 | 0.222 (SE = ±0.222) | 0.034 (SE = ±0.034) | 0.0028 (SE = ±0.0028) |
| | ALH-2 | 3 | 0.375 (SE = ±0.262) | 0.062 (SE = ±0.043) | 0.0057 (SE = ±0.0040) |
| | ALH-3 | 27 | 2.454 (SE = ±0.677) | 0.204 (SE = ±0.056) | 0.0167 (SE = ±0.0046) |
| | ALH-4 | 19 | 1.727 (SE = ±0.556) | 0.123 (SE = ±0.039) | 0.0092 (SE = ±0.0027) |
| | | | | | |
| Abr 2003 | ALH-1 | 0 | 0 | 0 | 0 |
| | ALH-2 | 1 | 0.142 (SE = ±0.142) | 0.023 (SE = ±0.023) | 0.0021 (SE = ±0.0021) |
| | ALH-3 | 22 | 1.833 (SE = ±0.518) | 0.152 (SE = ±0.043) | 0.0117 (SE = ±0.0034) |
| | ALH-4 | 16 | 1.333 (SE = ±0.525) | 0.095 (SE = ±0.037) | 0.0064 (SE = ±0.0024) |
| | | | | | |
| May 2003 | ALH-1[b] | 1 | 0.142 (SE = ±0.142) | 0.021 (SE = ±0.021) | 0.0024 (SE = ±0.0024) |
| | ALH-2[c] | 1 | 0.200 (SE = ±0.200) | 0.033 (SE = ±0.033) | 0.0037 (SE = ±0.0037) |
| | ALH-3 | 30 | 2.727 (SE = ±0.468) | 0.227 (SE = ±0.039) | 0.0188 (SE = ±0.0037) |
| | ALH-4 | 32 | 2.909 (SE = ±0.413) | 0.207 (SE = ±0.029) | 0.0174 (SE = ±0.0026) |
| | | | | | |
| Jun 2003 | ALH-1[b] | - | - | - | - |
| | ALH-2[c] | - | - | - | - |
| | ALH-3 | 35 | 2.058 (SE = ±0.325) | 0.171 (SE = ±0.027) | 0.0146 (SE = ±0.0025) |
| | ALH-4 | 37 | 2.375 (SE = ±0.406) | 0.169 (SE = ±0.029) | 0.0140 (SE = ±0.0024) |
| | | | | | |

[a]incomplete data: sampling started the 22nd Dec for ALH-1 and ALH-2 and the 1st Jan for ALH-3 an ALH-4
[b] monitoring was stopped the 9th May due to logistic constraints (boat under repairs)
[c] monitoring finalized the 9th May due to a change in fishing modality (from driftnets to fish traps)

Table 13. Monthly information on total captures and capture per unit effort (cpue) of shortfin mako (*Isurus oxyrinchus*) by the 4 monitored driftnet boats (continued)

| Month | Boat | Total capture (N) | Capture per fishing operation (N/fishing operation) | Capture per km net set (N/km) | Capture per km net set*soaking time (N/km.h) |
|---|---|---|---|---|---|
| | | | | | |
| Jul 2002 | ALH-1[a] | 29 | 2.416 (SE = ±0.357) | 0.201 (SE = ±0.029) | 0.0162 (SE = ±0.0027) |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 40 | 2.222 (SE = ±0.285) | 0.185 (SE = ±0.023) | 0.0153 (SE = ±0.0020) |
| | ALH-4 | 50 | 2.631 (SE = ±0.277) | 0.187 (SE = ±0.019) | 0.0154 (SE = ±0.0016) |
| | ALH-12[b] | 26 | 2.166 (SE = ±0.364) | 0.154 (SE = ±0.026) | 0.0137 (SE = ±0.0023) |
| | | | | | |
| Aug 2003 | ALH-1 | 27 | 1.928 (SE = ±0.304) | 0.160 (SE = ±0.025) | 0.0132 (SE = ±0.0022) |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 24 | 1.714 (SE = ±0.220) | 0.142 (SE = ±0.018) | 0.0113 (SE = ±0.0017) |
| | ALH-4 | 31 | 2.214 (SE = ±0.299 | 0.158 (SE = ±0.021) | 0.0132 (SE = ±0.0021) |
| | ALH-12 | 29 | 2.071 (SE = ±0.266) | 0.147 (SE = ±0.019 | 0.0112 (SE = ±0.0013) |
| | | | | | |
| Sep 2003[c] | ALH-1 | 5 | 2.500 (SE = ±0.499) | 0.208 (SE = ±0.041) | 0.0176 (SE = ±0.0031) |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 5 | 1.666 (SE = ±0.333) | 0.138 (SE = ±0.027) | 0.0111 (SE = ±0.0028) |
| | ALH-4 | 9 | 3.000 (SE = ±0.577) | 0.214 (SE = ±0.041) | 0.0180 (SE = ±0.0050) |
| | ALH-12 | 4 | 1.333 (SE = ±0.333) | 0.095 (SE = ±0.023) | 0.0071 (SE = ±0.0013) |
| | | | | | |

[a] monitoring was resumed on Jul 16th after 2 months of inactivity
[b] sampling of this boat started on Jul 16th
[c] all sampling activities were closed on Sep 15th

Table 14. Monthly information on total captures and capture per unit effort (cpue) of thresher shark (*Alopias vulpinus*) by the 4 monitored driftnet boats. Three different measures of cpue are provided, monthly averages being calculated from daily (=single fishing operations) figures. Note that *N* refers to number of individuals.

| Month | Boat | Total capture (N) | Capture per fishing operation (N/fishing operation) | Capture per km net set (N/km) | Capture per km net set*soaking time (N/km.h) |
|---|---|---|---|---|---|
| | | | | | |
| Dec 2002[a] | ALH-1 | 0 | 0 | 0 | 0 |
| | ALH-2 | 6 | 0.857 (SE = ±0.854) | 0.142 (SE = ±0.142) | 0.0204 (SE = ±0.0203) |
| | ALH-3 | - | - | - | - |
| | ALH-4 | - | - | - | - |
| | | | | | |
| Jan 2003 | ALH-1 | 9 | 0.818 (SE = ±0.583) | 0.125 (SE = ±0.089) | 0.0153 (SE = ±0.0105) |
| | ALH-2 | 6 | 0.461 (SE = ±0.242) | 0.076 (SE = ±0.040) | 0.0070 (SE = ±0.0036) |
| | ALH-3 | 14 | 1.076 (SE = ±0.444) | 0.099 (SE = ±0.041) | 0.0080 (SE = ±0.0035) |
| | ALH-4 | 21 | 1.500 (SE = ±0.571) | 0.107 (SE = ±0.040) | 0.0086 (SE = ±0.0035) |
| | | | | | |
| Feb 2003 | ALH-1 | 8 | 1.000 (SE = ±0.462) | 0.153 (SE = ±0.071) | 0.0113 (SE = ±0.0051) |
| | ALH-2 | 8 | 1.000 (SE = ±0.421) | 0.166 (SE = ±0.070) | 0.0121 (SE = ±0.0051) |
| | ALH-3 | 24 | 3.000 (SE = ±0.885) | 0.250 (SE = ±0.073) | 0.0199 (SE = ±0.0059) |
| | ALH-4 | 13 | 1.625 (SE = ±0.651) | 0.116 (SE = ±0.046) | 0.0080 (SE = ±0.0031) |
| | | | | | |
| Mar 2003 | ALH-1 | 0 | 0 | 0 | 0 |
| | ALH-2 | 1 | 0.125 (SE = ±0.125) | 0.020 (SE = ±0.020) | 0.0018 (SE = ±0.0018) |
| | ALH-3 | 14 | 1.272 (SE = ±0.774) | 0.106 (SE = ±0.064) | 0.0086 (SE = ±0.0052) |
| | ALH-4 | 22 | 2.000 (SE = ±0.699) | 0.142 (SE = ±0.049) | 0.0113 (SE = ±0.0042) |
| | | | | | |
| Abr 2003 | ALH-1 | 6[b] | - | - | - |
| | ALH-2 | 2 | 0.285 (SE = ±0.285) | 0.047 (SE = ±0.047) | 0.0050 (SE = ±0.0050) |
| | ALH-3 | 17 | 1.416 (SE = ±0.771) | 0.118 (SE = ±0.064) | 0.0087 (SE = ±0.0046) |
| | ALH-4 | 26 | 2.166 (SE = ±0.624) | 0.154 (SE = ±0.044) | 0.0132 (SE = ±0.0040) |
| | | | | | |
| May 2003 | ALH-1[c] | 3 | 0.428 (SE = ±0.296) | 0.065 (SE = ±0.045) | 0.0085 (SE = ±0.0063) |
| | ALH-2[d] | 3 | 0.600 (SE = ±0.600) | 0.100 (SE = ±0.100) | 0.0100 (SE = ±0.0100) |
| | ALH-3 | 22 | 2.000 (SE = ±0.538) | 0.166 (SE = ±0.044 | 0.0144 (SE = ±0.0041) |
| | ALH-4 | 17 | 1.545 (SE = ±0.492) | 0.110 (SE = ±0.035) | 0.0091 (SE = ±0.0028) |
| | | | | | |
| Jun 2003 | ALH-1[c] | - | - | - | - |
| | ALH-2[d] | - | - | - | - |
| | ALH-3 | 25 | 1.470 (SE = ±0.383) | 0.122 (SE = ±0.031) | 0.0099 (SE = ±0.0026) |
| | ALH-4 | 21 | 1.312 (SE = ±0.350) | 0.093 (SE = ±0.025) | 0.0083 (SE = ±0.0022) |
| | | | | | |

[a] incomplete data: sampling started the 22nd Dec for ALH-1 and ALH-2 and the 1st Jan for ALH-3 and ALH-4
[b] all of them were captured during a single fishing trip lasting three days; these data have been excluded from cpue calculations
[c] monitoring was stopped the 9th May due to logistic constraints (boat under repairs)
[d] monitoring finalized the 9th May due to a change in fishing modality (from driftnets to fish traps)

Table 14. Monthly information on total captures and capture per unit effort (cpue) of thresher shark (*Alopias vulpinus*) by the 4 monitored driftnet boats (continued)

| Month | Boat | Total capture (N) | Capture per fishing operation (N/fishing operation) | Capture per km net set (N/km) | Capture per km net set*soaking time (N/km.h) |
|---|---|---|---|---|---|
| | | | | | |
| Jul 2002 | ALH-1[a] | 15 | 1.250 (SE = ±0.427) | 0.104 (SE = ±0.035) | 0.0075 (SE = ±0.0023) |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 27 | 1.500 (SE = ±0.344) | 0.125 (SE = ±0.028) | 0.0106 (SE = ±0.0024) |
| | ALH-4 | 28 | 1.473 (SE = ±0.299) | 0.105 (SE = ±0.021) | 0.0086 (SE = ±0.0018) |
| | ALH-12[b] | 15 | 1.250 (SE = ±0.537) | 0.089 (SE = ±0.038) | 0.0078 (SE = ±0.0031) |
| | | | | | |
| Aug 2003 | ALH-1 | 22 | 1.571 (SE = ±0.271) | 0.130 (SE = ±0.022) | 0.0106 (SE = ±0.0072) |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 21 | 1.500 (SE = ±0.358) | 0.125 (SE = ±0.029) | 0.0099 (SE = ±0.0022 |
| | ALH-4 | 17 | 1.214 (SE = ±0.380) | 0.086 (SE = ±0.027) | 0.0068 (SE = ±0.0021) |
| | ALH-12 | 16 | 1.142 (SE = ±0.360) | 0.081 (SE = ±0.025) | 0.0065 (SE = ±0.0020) |
| | | | | | |
| Sep 2003[c] | ALH-1 | 2 | 1.000 (SE = ±0.000) | 0.083 (SE = ±0.000) | 0.0070 (SE = ±0.0001) |
| | ALH-2 | - | - | - | - |
| | ALH-3 | 2 | 0.666 (SE = ±0.333) | 0.055 (SE = ±0.027) | 0.0045 (SE = ±0.0023) |
| | ALH-4 | 7 | 2.333 (SE = ±0.333) | 0.166 (SE = ±0.023) | 0.0132 (SE = ±0.0009) |
| | ALH-12 | 4 | 1.333 (SE = ±0.666) | 0.095 (SE = ±0.047) | 0.0069 (SE = ±0.0034) |
| | | | | | |

[a] monitoring was resumed on Jul 16th after 2 months of inactivity
[b] sampling of this boat started on Jul 16th
[c] all sampling activities were closed on Sep 15th

Table 15. Significant factors in the GLM analysis with respect to the three measures of cpue considered (NS: none of the factors were significant)

| | Variables | | |
|---|---|---|---|
| | N/fishing operation | N/km net set | N/km net * soaking time |
| Swordfish | month p(F)<0.0001 | month p(F)<0.0001 | month p(F)<0.0001 |
| Dolphins | month p(F)=0.00074 | month p(F)=0.0016 | month p(F)=0.0045 |
| Turtles | month p(F)<0.0001<br>vessel p(F)<0.0001 | month p(F)<0.0001<br>vessel p(F)<0.0001 | month p(F)<0.0001<br>vessel p(F)<0.0001 |
| *P. glauca* | vessel p(F)=0.0007<br>net length p(F)=0.0026 | NS | NS |
| *I. oxyrinchus* | month p(F)<0.0001<br>vessel p(F)<0.0001 | month p(F)<0.0001<br>vessel p(F)=0.0019 | month p(F)<0.0001<br>vessel p(F)=0.0036 |
| *A. vulpinus* | vessel p(F)=0.0020<br>net length p(F)=0.0079 | NS | NS |

Table 16. Estimates (in number of individuals) of total catch of cetaceans and pelagic sharks by drifnetters from Alhoceima and Nador based on the ratio method and different measures of catch per unit effort (cpue). Category 'dolphins' includes equal proportion (50%) of *D. delphis* and *S. coeruleoalba* specimens. Estimates are in number of individuals (N). Estimation of by-catch of *P. glauca* and *A. vulpinus* using cpue 2 (in italics) is not fully adequate since GLM analyses show a significant effect of net length in the catch of both species.

| | Estimates of the 8 month sampling period | | | | Extrapolation to 12 months sampling period | | | |
|---|---|---|---|---|---|---|---|---|
| | cpue1 | | cpue2 | | **cpue1** | | cpue2 | |
| | total catch | 95% CI | total catch | 95% CI | **total catch** | **95% CI** | total catch | 95% CI |
| Dolphins | 2431.25 | 357.87 | 2431.25 | 329.10 | **3646.88** | **536.81** | 3646.88 | 493.65 |
| *Prionace* | 5041.40 | 548.40 | *4755.45* | *161.43* | **7562.09** | **822.62** | *7133.11* | *242.15* |
| *Isurus* | 5457.90 | 698.44 | 5288.25 | 205.41 | **8186.94** | **1047.67** | 7932.38 | 308.10 |
| *Alopias* | 4791.20 | 535.81 | *4466.65* | *161.99* | **7186.82** | **803.71** | *6699.98* | *243.00* |

cpue1: daily catch per boat (N/fishing operation)
cpue2: daily catch per km net set per boat (N/km net set)

Table 17. Estimates of total catch of cetaceans and pelagic sharks by drifnetters from Tangiers based on the ratio method and using as a cpue unit the daily catch per boat. Category 'dolphins' includes equal proportion (50%) of *D. delphis* and *S. coeruleoalba* specimens. Estimates are in number of individuals (N). These estimates should be regarded with caution since they rely on the assumption that by-catch rates by the Al Hoceima fleet are applicable in Tangiers.

| | Estimates for 12 month period | |
|---|---|---|
| | total catch | 95% CI |
| Dolphins | *13358.30* | *1768.61* |
| *Prionace* | *26110.16* | *4274.05* |
| *Isurus* | *26944.76* | *6712.94* |
| *Alopias* | *24441.69* | *4116.95* |

Table 18. Catch rate estimates (cpue) for swordfish and the major by-catch species considered. Two different scenarios are presented for pelagic sharks ('low' and 'high'), attributable to the by-catch capture pattern (approx. 2/5 of the fleet) and to the target fishing pattern (approx. 3/5 of the fleet) revealed by glm analyses (see text).

| | Period | Capture per fishing operation (N/fishing operation) | Capture per km net set (N/km) |
|---|---|---|---|
| Swordfish[1] | Dec-Sep | 8.102 | 0.810 |
| Loggerhead turtle[1] | Dec-May | 0.211 | 0.026 |
| Dolphins[1, 2] | Dec-Sep | 0.642 | 0.060 |
| *Prionace* (low) | Dec-Sep | 0.872 | 0.117 |
| *Prionace* (high) | Dec-Sep | 1.594 | 0.121 |
| *Isurus* (low) | Dec-Sep | 0.608 | 0.059 |
| *Isurus* (high) | Dec-Sep | 1.909 | 0.145 |
| *Alopias* (low) | Dec-Sep | 0.728 | 0.092 |
| *Alopias* (high) | Dec-Sep | 1.528 | 0.117 |

[1]Catch rates presented are just for comparative purposes, since glm analyses revealed a strong seasonality; in the case of loggerhead turtle, rates are only estimated for the period verifying the bulk of by-catches
[2] both species pooled

Table 19. By-catch estimates and catch rates of sea turtles caught by driftnet fleets operating in the Mediterranean.

| Species | Area / Fishery | Year | By-catch estimate | Catch rate | Ref. |
|---|---|---|---|---|---|
| *Caretta caretta* | Alboran Sea | 1994 | 236 (117-354) | 0.45 N/haul | 1 |
| *Caretta caretta* | Gibraltar Straits[a] | 1989-90 | - | 0.78 N/haul | 2 |
| *Caretta caretta* | Ligurian Sea | 1990-91 | - | 0.057 N/haul | 3 |
| *Caretta caretta* | Tyrrhenian Sea | 1990-91 | - | 0.046 N/haul | 3 |
| *Caretta caretta* | Ionian Sea | 1980's | 16000[b] | - | 4 |
| This study: | | | | | |
| *Caretta caretta* | Alboran Sea | 2003 | - | 0.21 N/haul[c] | |

[a] both sides
[b] annual catch
[c] period Dec-May; see Table 18
References: (1) Silvani *et al*., 1999; (2) estimated from Camiñas, 1997; (3) Di Natale, 1995; (4) De Metrio and Megalofonou, 1988

Table 20. By-catch of dolphins per species. Data (in number of individuals) have been pooled on a monthly basis for boats ALH-3 & ALH-4 (from April 2003) and ALH-1 & ALH-12 (from July 2003)

| | ALH-1, ALH-3, ALH-4 & ALH-12 | |
|---|---|---|
| | *Delphinus delphis* (N) | *Stenella coeruleoalba* (N) |
| Apr 2003[a] | 7 | 8 |
| May 2003 | 13 | 15 |
| Jun 2003 | 8 | 17 |
| Jul 2003 | 32 | 32 |
| Aug 2003 | 14 | 13 |
| Sep 2003 | 0 | 3 |
| **Total** | 74 | 88 |

[a] disaggregated data is available only from 12th April

Table 21. By-catch estimates (no. ind.), catch rates and take rates (by-catch/population size) of dolphins caught by driftnet fleets operating in the Mediterranean. Take rates in the first three rows are from SGEN/STECF (2001).

| Species | Area / Fishery | Year | By-catch estimate | Catch rate | Take rate as % | Ref. |
|---|---|---|---|---|---|---|
| *D. delphis* & *S. coeruleoalba* | Alboran Sea | 1993 | 366[a] (268-464) | 0.11 N/km net[a] | 1.2[b] | 1 |
| *D. delphis* & *S. coeruleoalba* | Alboran Sea | 1994 | 289[a] (238-340) | 0.15 N/km net[a] | 1.2[b] | 1 |
| *S. coeruleoalba* | Ligurian-Provençal Basin | 2000 | 326 (180-472) | 0.34 N/haul | 1.3 | 2 |
| *S. coeruleoalba* | Ligurian Sea | 1990 | - | 0.455 N/haul | - | 3 |
| *S. coeruleoalba* | Ligurian Sea | 1991 | - | 0.125 N/haul | - | 3 |
| *S. coeruleoalba* | Central Mediterranean | 1990 | - | 0.052 N/haul | - | 3 |
| *S. coeruleoalba* | Central Mediterranean | 1991 | - | 0.087 N/haul | - | 3 |
| *S. coeruleoalba* | Italian driftnet fishery | 1990 | 1149 | - | - | 4 |
| *S. coeruleoalba* | Italian driftnet fishery | 1991 | 1363 | - | - | 4 |
| <u>This study:</u> | | | | | | |
| *D. delphis* & *S. coeruleoalba* | Alboran Sea | 2003 | 3647[a] (3110-4184) | 0.642 N/haul[a]<br>0.06 N/km net[a] | | |
| *D. delphis* | Alboran Sea | 2003 | see above | see above | 12.3[c] | |
| *S. coeruleoalba* | Alboran Sea | 2003 | see above | see above | 10.2[c] | |
| *D. delphis* & *S. coeruleoalba* | Gibraltar Straits & nearby Atlantic area | 2003 | *13358 [a,d] (11590-15126)* | - | - | |

[a] each species accounting for 50% of this total; see Table 18
[b] attributable to each one of the species, separately
[c] under the hypothesis of separated demographic units in the Alboran sea
[d] orientative data (see main text and Table 18)
References: [1]Silvani *et al*., 1999); [2]Imbert *et al*., 2001, in: SGEN/STECF, 2001; [3]Di Natale *et al*., 1993; [4]Di Natale, 1995