# TOTAL ALLOWABLE CATCHES (TAC) AND QUOTA SYSTEMS WITHIN PORTUGUESE FISHERIES

ΒY

MÁRCIA FILIPA FERNANDES DIAS MARQUES

PROMOTOR: PROF. DR. PAULO SANTOS, OPORTO UNIVERSITY CO-PROMOTOR: PROF. DR. KARIM ERZINI, ALGARVE UNIVERSITY

MASTER THESIS FOR THE PARTIAL FULFILMENT OF THE TITLE OF **MASTER OF SCIENCE IN MARINE BIODIVERSITY AND CONSERVATION** WITHIN THE ERASMUS MUNDUS MASTER PROGRAMME EMBC



JUNE, 2012

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4<sup>th</sup> of June 2012

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# GLOSSARY

- ACOM Advisory Committee
- CFP Common Fisheries Policy
- EC European Commission
- FAO Food and Agriculture Organizations of the United Nations
- Fmsy Fishing mortality rate that if applied constantly would result in maximum sustainable yield
- ICES International Council for the Exploration of the Sea
- MSY Maximum Sustainable Yield
- Quota The amount of each stock allocated to each Member State
- STEF- Scientific, Technical and Economic Committee for Fisheries
- TAC Total Allowable Catch

# ABSTRACT

The impact of fisheries has increased over the last decades and has affected directly and indirectly the marine ecosystems.

Due to the low selectivity of most fishing methods, the incidental capture of non-target species or undersized individuals of target species has become a problem. This phenomenon known as "bycatch" is misreported, and the discards represent a high source of mortality for some species and fisheries.

Discards are underestimated and may cause changes to the marine ecosystem structure and diversity, and enhance the risk of stock overexploitation and depletion (Karagiannakos, 1996).

The European Commission has established several conservation measures through the Common Fisheries Policy to promote the sustainability of fishing activities in EU waters. These measures include Total allowable catches (TAC) to limit the amount of fish that can be caught from a specific stock over a given period of time.

TAC are set annually based on the ICES (International Council for the Exploration of the Sea) scientific advice. Afterwards, TAC are divided into national quotas between the various Member States using a relative stability key. But in a multispecies fishery, as it is the case of Portuguese fisheries, TAC and Quotas systems increase the risk of bycatch and discards.

Regarding the problematic situation of the world fisheries and also of the Portuguese fisheries, this thesis analyses recent history (last 11 years) of the TAC and Quotas systems concerning the Portuguese fisheries, identifies trends, analyses the mismatch between scientific advice and political decision making, and identifies reasons for the malfunctioning of this system regarding the Portuguese fisheries.

It was concluded that TAC always exceeded the scientific advice. There is a cumulative problem especially in demersal and deep water species fisheries as total landings exceeded the set TAC. However some operational and methodological suggestions presented can improve the marine resources management and contribute to their conservation and sustainable exploitation.

Key words: TAC, Quotas, Multispecies fisheries, Sustainability

## **1. GENERAL INTRODUCTION**

Fisheries effects and consequences have increasingly over the last decades, with several direct and indirect impacts on marine ecosystems. The direct impacts include fishing mortality exerted in target populations, which can lead to overfishing, fishing that affects non-target populations (bycatch), and physical impacts caused by towed gears in benthic organisms and in the seabed substratum. The indirect impacts include environmental effects of dumping discards and organic detritus, mortality caused by lost fishing gear (ghost fishing) and possible break of biological interactions. (Borges *et al.*, 2001; Garcia *et al.* 2003; Pauly *et al.*, 2002).

The main direct impact of fishing practice is the reduction of the abundance of target species, being assumed that the abundance is proportional to the catch per unit effort, a constructed idea that is generally false (Goñi, 1998; Garcia et al., 2003; Mayers, *et al.*, 1997). In fact, fishing preferentially removes larger and older fish, consequently modifying size, age and genetic structure of exploited populations and reducing spawning potential (Charles, 1994; Goñi, 1998). Despite, the continuously decrease in abundance, the fishing fleets, usually, have the capacity to continue fishing with high catches due to advances in technology that help them find the fish, i.e. GIS and sonars, (Mayers *et al.*, 1997).

The global state of exploitation of the world marine fishery resources has been fluctuating with time. (FAO, 2011).

Due to the low selectivity of most fishing methods, the incidental capture of non-target species or undersized individuals of target species became a problem. The last can compromise the recruitment opportunity and replacement of new fish generations (Alverson *et al.*, 1994; European Commision, 2012; ICES, 2011d; Mayers *et al.*, 1997). M Additionally, many of these species that are accidentally captured have little or no economic value (Pope *et al.*, 2000). This phenomenon is called bycatch and includes those non-target species or species that do not meet certain criteria for fisheries, including marine mammals, birds, turtles and other marine species (Alverson *et al.*, 1994; European Commission, 2011) As a consequence, most of the bycatch is misreported and discarded which represents a source of mortality

which is high for some species and fisheries (European Commision, 2012; Mayers *et al.*, 1997; Prellezo & Gallastegui, 2008). Discards are described as the proportion of catches representing the total organic matter of animal origin that is thrown or emptied into the sea (Alverson *et al.*, 1994; Fernández *et al.*, 2010)..Plant matter and post-harvest waste are not included. As a source of fishing mortality, discards are usually underestimated, which enhances the risk of stock overexploitation and depletion (Karagiannakos, 1996). In addition discarding may cause changes in the marine ecosystem structure and diversity with poorly studied consequences to the general biota (Borges *et al.*, 2001) The main reasons driving this problem are economic and institutional. Economic because fish are sold at very different prices depending on their size, quality and species. There are strong incentives to discard fish, as the storage space onboard is used for high-value organisms. It is an institutional problem too because there are certain regulatory instruments in the fisheries sector that imply discarding, namely minimum landing sizes and also total allowable catches (TACs) (Borges *et al.*, 2001; Caddy & Cochrane, 2001). For example, in the Iberian Peninsula, discards represent between 30 to 60% of catches (European Commission, 2012).

Byctach and discards represent a serious problem in European fisheries with a lot of consequences such as:

- A waste of societal resources and contributes to the increase of necrophagous species and promotes the decomposition process (Cabral & Murta, 2002);
- Less future catch opportunities with catching of juveniles species;
- Reduction of spawning biomass of mature individuals;
- Negative impact on the marine ecosystem and biodiversity.

However, discards have been reduced over the last years. More selective gears and fishing practices and especially the higher retention of what if caught even if it is not within the rules, have been contributing for this reduction but this decline is also associated with the decline in total landings over the last decade (Zeller & Pauly, 2005).

In addition to the problems described above, there is also the devastation of physical sea bottom due to the impacts of fishing gear, enforcing alteration of topographic complexity and consequently alteration of benthic communities, resuspension and fragmentation of rock and biogenic substrate, with implications for eutrophication processes and biogeochemical cycles (Kaiser *et al.*, 2002) all of which can also indirectly influence associated species, situation with recognized commercial importance. It is worth to note that all these together can alter structure of marine communities since the effects can cascade along the entire food web through competition and predator links (Goñi, 1998; ICES, 2011d; Pauly *et al.*, 2005).

#### FISHERIES MANAGEMENT IN EUROPEAN AND THE PORTUGUESE CONTEXT

Fisheries represent an important role in the economies of many countries such as Portugal. The management of natural resources has failed worldwide, with the collapse of many important fish stocks around the world (Steele & Hoagland, 2003).

It is essential to maintain the sustainable exploitation of the marine resources as marine resources together with fisheries are responsible for providing a significant share of food supply for human consumption and jobs and incomes for millions of people worldwide. There is a need to ensure the species and ecosystems that support these fisheries are maintained in healthy and productive conditions to assure all benefits provided by fisheries remain sustainable into the future (European Commission, 2009; (Pauly, *et al.*, 2005).

Europe has a coastline of 70 000 km and the European Union's coastal regions accounts for some 40% of its gross domestic product and about 40% of its population.

To manage fisheries in Europe, the Common Fisheries Policy (CFP) was created in 1983 by the European Union (EU). This instrument is applicable inside and beyond Community waters both to aquaculture and fisheries. The main objectives of CFP were:

- Protection of the stocks against overfishing;
- A guaranteed income for fishers;
- A regular supply at reasonable prices for consumers and the processing industry;

- Sustainable biological, environmental and economic exploitation of living aquatic resources;

The Common fisheries Policy provided several guidelines and measures for the granting of national licenses and quotas, the limitation of "days at sea" for certain fisheries, and various measures to limit fleet capacity. Despite the good intentions of CFP with regard allocating rights among the Member states, it is shown by the depleted condition of many fish stocks, and poor economic performance of some parts of the fleets that the measures are not sufficient (European Commission, 2012).

Measures concerning the adoption of a common market in fisheries products and the coordination of the modernization of fishing vessels and on-shore installations were also adopted. The significance of these measures increased when, in 1976, Member States extended their rights to marine resources from 12 to 200 miles from their coasts, in line with the international strategic tendencies (Andersen *et al.*, 2009).

The CFP established diverse conservation measures to promote the sustainability of fishing activities in EU waters and protect specific stocks or a groups of stocks. These measures include Total Allowable Catches (TAC) to limit the amount of fish that can be caught from a specific stock over a given period of time; technical measures, such as mesh sizes, selective fishing gear, closed areas, minimum landing sizes and bycacth limits; limiting fishing effort by reducing the number of fishing days at sea of fishing vessels; and fixing the number and type of fishing vessels authorized to fish (Baeta, 2009; European Commission, 2012).

The CFP was reformed in 2002 to ensure the sustainable development of fishing activities from environmental, economic and social perspectives. These reforms had as an objective a long-term approach to fisheries management and introduced a precautionary approach to protect and conserve living aquatic resources, and to minimize the impact of fishing activities on marine ecosystems. It aimed to progressively implement an ecosystem –based approach to fisheries management and also improve the basis of decision-making process through a transparent scientific advice and increasing the participation of the stakeholders. (Baeta, 2009). However several factors made the attempts to manage fisheries sustainability unsuccessful and the state of the majority of commercial fish stocks in EU waters continues to be a cause of concern. In 2007, independent fisheries scientists assessed the condition of 33 of Europe's most important commercial fish stocks, and concluded that 29 were overfished. (European Commission, 2012).

Despite these warning signs, decisions on catch levels remain dominated by short-term goals, and the catching capacity of the European fleet remains more than twice the necessary to harvest our own fish stocks sustainably (Baeta, 2009).

#### TOTAL ALLOWABLE CATCHES AND QUOTA DEFINITION PROCESS

Total Allowable Catches, known as TACs, are set annually by the European Union Commission based on ICES (International Council for the Exploration of the Sea) scientific advice (Andersen et al., 2009) This institution delegates the task of advice formulation to the Advisory Committee on Fisheries Management (ACFM) that is composed by national representatives in the field of fisheries science (Daan, 1997).

The assessment and analysis of the state of stocks and the catch predictions to be derived from these, is delegated by ACFM to a number of assessment working groups composed by scientist from all member states (Daan, 1997) that annually set an advice for different unit stocks within the different areas.

The European Commission analyzes the ACFM advice, checks it internally by the Scientific Technical and Economic Committee on Fisheries (STECF) and finally the Council of Ministers set the final TACs considering and consulting fishery industry (Daan, 1997). TACs proposals are based on maximum sustainable yield of the stocks. (European Commission, 2012). TACs are divided into national quotas between the various Member States, using the relative stability key. (Andersen et al., 2009). Relative stability principle concerning TAC shared, is based on historic catches as a proxy to prevent repeated arguments over how quotas should be allocated and to provide a relative stable environment among fishers (European Commission, 2009) being possible to exchange quotes between the States (Morin, 2000). Counties as Norway, he Faroe Islands and Russia also obtain a share of the TAC (Andersen *et al.*, 2009).

The Total Allowable Catches (TACs) and quotas management system are considered by the CFP as the corner stone of all conservation measures (Karagiannakos, 1996; Shepherd, 2003) According to the European Commission services, TACs are estimated in the "light of scientific advice" and at present the council fixes the TACs for 84 fish stocks each year of which only 45are based on sufficient data. Those that

have sufficient data are called "analytical TACs" and the others are called "precautionary TACs" and are based on intelligent and educated guesswork rather than solid scientific data (Karagiannakos, 1996; ICES, 2011d; European Commission, 2012).

The demersal stocks in the North Sea are most representative stocks for assessing the TAC management system since their analytical TACs are among the best scientifically estimated in EU waters. They are based on consistent analytical assessments of catch-at-age information using commercial catch and effort as well as research vessel survey data. The reason for the selection of these stocks is that they are economically significant for a number of fleets in several Member States (Karagiannakos. 1996).

As was mentioned above, the TAC system "encourages" fishermen to retain the larger and more valuable fish in order to maximize the economic benefits from their quotas. When the catch consists of species with no commercial potential or market interest in the country of the vessel fishing, discarding becomes the solution and retaining the more valuable fish is the rational economic solution when the costs of fishing are also considered. In addition, when the costs of fishing are increased by long trips or by storage and packing facilities on board or other reasons, bycatch and discarding are more frequent due to the targeting of high value fish species (Karagiannakos.,1996; Borges *et al.*, 2001) In summary, bycatches are increased not only by non target species, or target species but by small sized fish and those damaged by the fishing gear, and because fishermen are obliged to discard species for which their quotas have been exhausted, even though the fish were caught in a mixed fisheries catch.

#### **MULTISPECIES CONSIDERATIONS**

The Portuguese fishery is a typical multispecies fishery. In a mixture of species, it is very difficult to control which species and how much of each is caught and consequently it is almost impossible to achieve the TAC of all stocks simultaneously. The main problem in the case of multispecies fishery is that the TACs of different species can be exhausted at different rates, i.e., TACs for some stocks will be exceeded in trying

to catch the TAC of other stocks, or on the other hand the TAC for some stocks will not be caught to prevent TACs for other stocks from being exceeded (ICES, 2011d; Kaak *et al.*, 2008; Prellezo & Gallastegui, 2008; Shepherd, 2003; Vinther *et al.*, 2004) Different stock conservation needs is also a problem in the multispecies fishery management concern. For example two species that are caught together can be in different state ,i.e., one can be in a very low level whereas another can be in the highest biomass level (Reeves & Ulrich, 2007).

Coastal and maritime activities have been traditionally important in Portugal to the national economy and to the historical, social and cultural identity. Portugal has long relied on fishing as a major of means of subsistence, particularly in many coastal communities that depend almost exclusively on fisheries and related activities. The Portuguese exclusive economic zone (EEZ) is 18 times larger than its territory and has a total of 1,7 milion km<sup>2</sup>. (Baeta, 2009). It may increase even more following the submission to the United Nations of an application based on surveys of the extent of the continental platform. At present it is one of the largest EEZs of the EU member States. The fish consumption is over 80kg per capita per year, the largest in EU and well above the average, showing the primary importance of fisheries in Portugal (Failler *et al.*, 2007; MADRP-DGPA, 2007). However, the domestic production meets only one half of market demand.

When Portugal became a member of the EU in 1986, the national fisheries sector had lost importance at different levels, namely in the national economy. The fleet dimension, the number of fishermen and the catches decreased since then and landings dropped to half of the values registered on 1980 At present the number of vessels its approximately half of the number in the 1980s, consisting mainly of small wooden vessels with open decks, and the sector currently employs less than 0,35% of the active population (INE, 2011).

Portuguese fisheries are characterized as multi-species fisheries. This multispecificity managed by TAC and quota systems, increases the risk of bycatch and discards.

Regarding the problematic situation of the world fisheries and also of the Portuguese fisheries, the main objective of this thesis is to evaluate the recent history of the TAC and Quotas system concerning the

Portuguese fisheries, to identify trends, to analyze the mismatch between scientific advice and political decision making, and to identify reasons for the malfunctioning of this system regarding the Portuguese fisheries. For this purpose we propose an analysis of the Portuguese TAC and quotas data for the last 11 years, their levels of utilization, degree of convergence with ICES TAC proposals and a comparison of the annual evolution of stocks of species that are subjected to a TAC. Finally, it is our intention to present some operational or/and methodological suggestions in order to improve the management of the marine resources and to contribute to their conservation and sustainable exploitation.

The species that will be analyzed include Pelagic, Demersal and Deep Water Species within waters of Portuguese jurisdiction. The species are: Anchovy (*Engraulis encrasicolus*), Blue Whiting (*Micromesistius poutassou*), Horse Mackerel (*Trachurus trachurus*), Blue Jack Mackerel (*Trachurus piscatorius*), Mackere (*Scomber scombrus*) I (Pelagic species); Hake (*Merluccius merluccius*), Anglerfish (*Lophius budegassa* and *Lophius piscatorius*), Megrims (*Lepidorhombus boscii* and *Lepidorhombus* whiffiagonis), Whiting (*Merlangius merlangus*) and Neprhops (*Nephrops norvegicus*) (demersal species) and Black Scabbardfish (*Aphanopus carbo*) and Blackspot Seabream (*Pagellus bogaraveo*) (deep water species). Sardine (*Sardina pilchardus*) a pelagic species, was also considered in this study. It has neither TAC nor Quota but it is one of the most important fisheries resources in Portugal.

The actual state of the stocks of the above mentioned species is not consensual among several institutions. Some assessments are more pessimistic than others and this influences the fishery industry point of view.

The current state of the stocks of the species that will be analyzed in this thesis are given in Table 1.

Table 1. Summary of the current state of the stocks of the 13 species subjected to TACs in portuguese

#### fisheries.

	SPECIES	Stock State (FAO (2011), M.C.S.(2012), OCEANA(2011))	Stock State (ICES 2011b, 2011c)
	Horse mackerel (Division Ixa) Southern Stock	Full reproductive capacity	Stable Stock
	Blue jack mackerel	No information	F- insufficient information; SSB increasing
	Sardine (Division VIIIc and Ixa)	Unknown however biomass has been declining	Fpa and Bpa not defined
Pelagic	Anchovy (Division IXa)	Overexploited; Low biomass of ages 0	Insufficient information regarding F and SSB.
	Blue Whiting (Combined stock)	Fully exploited	Harvested sustainably and full reproductive capacity
	Mackerel (Combined Stock Northeast Atlantic)	Harvested sustainably in short term; harvested unsustainably in long term	Fpa increase is in risk; Bpa full reproductive capacity
	Hake (Division VIIIc and Ixa (Southern Stock)	Overexploited	Fpa and Bpa undefined
	Megrims(Divisions VIIIc and Ixa)	Overexploited; Low recruitment; Low stock level	Fpa and Spa Undefined
Demersal	Anglerfish (Division VIIIc and Ixa)	<i>L. budegassa</i> in poor condition	<i>L. budegassa</i> – Fpa and Bpa undefined; <i>L. piscatorus</i> : Fpa and Bpa undefined
	Whiting (Division VIII and Subareas Ixa)	-	Insufficient information
	Nephrops (Division Ixa)	Overexploited and Depletion	Fpa and Bpa Unknown
Deep Water	Black Scabbardfish (Subareas VIII and IX)	Vulnerable to overfishing	Unknown
Species	Blackspot Seabream (Subareas IX and X)	Unknown condition in IX and X; Vulnerable to overexploitation	Fpa and Bpa unknown in both areas (IX and X)

# 2. STUDY AREA

Portuguese and Azorean waters (FIGURE 1) are part of a large FAO division, the major fishing area 27, Atlantic Northeast (FAO, 2012a) Madeira waters are part of another division, the Atlantic, East Central area 34. The FAO code corresponding to Madeira is 34.1.2 and includes the Canaries islands.



Figure 1. FAO fishery area 27 (Source: www.fao.org/fishery/area/Area27/en)

- Portugal has total jurisdiction in the following Subareas (FAO, 2012a):
- Portuguese waters Subarea IX divided in East Division IXa and West division IXb,
- Azores Grounds Subarea X divided in Azores Grounds division Xa and Northeast Atlantic South Division Xb.

Portugal has the largest Exclusive Economic Zone within the European Union, with 1 700 000 km<sup>2</sup>. The continental Portugal coastline is 942km long and there and two archipelagos: Azores and Madeira (FAO, 2012a).

The Portuguese fishery sector if quite large and diversified (FAO, 2012a) and has an important role in the economic activity. Portuguese fisheries have many kinds of fleet segments, including a small- scale regional fleet, a purse-seine fleet, a trawl fleet and artisanal/multigear fleet (ICES, 2008a).

The main landings sites in Portugal, including the two archipelagos (Azores and Madeira) are Matosinhos, Aveiro, Figueira da Foz,Nazaré, Peniche, Sesimbra, Setúbal, Sines, Portimão, Olhão, São Miguel and Pico (in Azores archipelago) and Madeira island (INE, 2011; FAO, 2012a).

## 2. MATERIALS AND METHODS

### **2.1. COLLECTING INFORMATION**

The first idea for this project was to analyse all kind of species present in Portuguese waters, i.e., benthic, pelagic, migratory species, deep water species. Due to a lack of information needed to achieve the objectives of this project, mainly regarding migratory species and deep water species in Portuguese waters, we ended up with a group of 13 species – benthic and pelagic. They are: hake, horse mackerel, blue jack mackerel, mackerel, sardines, anchovy, blue whiting and mackerel as pelagic and Nephrops, Megrims (*Lepidorhombus boscii and Lepidorhombus* whiffiagonis), Anglerfish (*Lophius budegassa* and *Lophius piscatorius*), Whiting, Black Scabbardfish and Blackspot Seabream.

In order to obtain the necessary information regarding all items of the species used in this analysis, a great amount of data was gathered, compiled and checked from various data centres/sites.

Part of the data was collected from the International Council for the Exploration of the Sea (ICES) website. ICES, is responsible for the collection of data, promotion of marine research (oceanographic, ecosystem, environment, marine resources) in the North Atlantic and adjacent Seas. This organization receives information from its national delegations in 20 member countries. The ICES database is part of a global network of distributed data centres. Governments and regulatory bodies that manage the North Atlantic Ocean and adjacent seas ask ICES for scientific advice on marine ecosystem issues (ICES, 2012).

Thus, all data of scientific nature, total allowable catches, total landings, fishing mortality, recruitment and spawning stock biomass of the species mentioned above were collected from ICES Reports (ICES, 2011b, 2011c).

Another important source of data was the *Direcção Geral de Pescas e Aquicultura* (DGRM) (its website and headquarters in Lisbon) that provided information about Portuguese quotas and adjustments (transferred quotas) as well as on Portuguese official landings. This is a central service under government administration with its own autonomy with regard fisheries, aquaculture, fisheries industries and all kinds of issues related with the concerning matter enclosing knowledge about all the activities related to it (DGRM,

2012). This data is officially published in their website. Some clarifications and the list of quotas changed since 2000 until 2011 were kindly provided by Dr.<sup>a</sup> Emília Baptista (Resources and Services Director in the DGPA – *Direcção Geral das Pescas e Aquicultura*).

The Portuguese official statistical data information centre, *Instituto Nacional de Estatística* (INE), was used as a source of information but mainly to confirm and compare the data taken from the DGRM.

These three main databases were extremely important for this thesis since they contain the basic information for the analysis.

Many indicators were used to understand and quantify the conditions and trends of the Portuguese waters fisheries, mainly the extent to which scientific advice is incorporated in decision making and to evaluate the compliance of the industry and the authorities in the decision making (Piet, Overzee, & Pastoors, 2010). The indicators used were operational indicators, in order to assess the TAC and Portuguese quotas efficiency and the inclusion of scientific advice in the decision making, and outcome-based indicators to measure the degree of compliance of some management goals. Finally, we compared the recorded landings (Portuguese official landings and ICES total landings) with Portuguese Quotas and the official TACs (Piet et al., 2010).

## **3.2. TIME PERIOD CONSIDERED**

The period of time covered by this study is from 2000 to 2011 (11 years). However, it should be mentioned, there is a lack of information for some species in some years within the interval considered. However, some adaptations were applied case by case and explained in the Results chapter.

## **3.3. SPECIES SELECTION**

The first criteria used to choose which species to include in this study was to target species that are present in Portuguese waters (Division IX and X) even if shared with other Divisions (in most cases, the stocks present in Portuguese waters are also present in Spanish subdivision VIIIc). The second criteria included species subjected to TAC in Portuguese waters.

Some species were considered or rejected exceptionally for different reasons.

Although the sardines stock present in Division IXa and VIIIc does not have a TAC established by EC, it was considered in this study. This stock is managed directly by Portugal and Spain. However, as an important fishery resource for Portugal, it was considered in this study, and is analysed as much as possible to understand its variation during the considered period.

The stocks rejected were plaice, pollock and sole, although these species have a TAC in Portuguese waters divisions. Plaice was not included because the plaice fishery in Portugal is residual or the result of a misidentification, as it was several times verified (Santos, pers. comm.). In the case of Pollock, although it is mainly a by-catch of different species, pollock landings statistics might be uncertain due to misclassification as whiting (ICES, 2011d). This might bring important deviations in stock analysis and consequently wrong conclusions.

The sole stock respects all the criteria considered in the study. However, the TAC is set for three species of sole (*S. lascaris*, *S. solea* and *S. senegalensis*), and total landings records correspond only to two sole species (*S. lascaris* and *S. solea*). This cannot be ignored because it originates a high deviation in the analysis and conclusions. The total landings records are much less than Portuguese landings records. Another problem concerning this species is that in national statistics sole spp. landings are recorded together with other flatfish species. All these reasons were considered sufficient to justify sole not to be included.

Summing-up, the final list of selected species is:

**Pelagic Species:** 

- Horse Mackerel (*Trachurus trachurus*)
- Blue Jack Mackerel (Trachurus piscatorius)
- Sardine (Sardina pilchardus)

- Anchovy (*Engraulis encrasicolus*)
- Mackerel (widely distributed species) (Scomber scombrus)
- Blue Whiting (widely distributed species) (*Micromesistius poutassou*)

Demersal species:

- Hake (*Merluccius merluccius*)
- Megrims (Lepidorhombus boscii and Lepidorhombus whiffiagonis)
- Anglerfish (Lophius budegassa and Lophius piscatorius)
- Whiting (Merlangius merlangus)

#### **Deep Water Species**

- Black Scabbardfish (Aphanopus carbo)
- Blackspot Sea Bream (Pagellus bogaraveo)

### **3.4.** DATA ANALYSIS

- The study includes the variation during the considered period of ICES Advice and TAC data for each species selected, whenever data was available starting in 2000. In the same analysis a statistical test was performed to evaluate if the differences between variables (ICES Advice and TAC) were statistically significant or not. It was used MiniTab14 statistic software In order to understand if ICES Advice and TAC were correlated and to quantify it, it was performed to a Spearman's correlation using MiniTab14 statistic software.
- 2. As a relative quantification of how scientific advice was taken into account in the political decisions made by the European Commission, an indicator designated as ICES ACCORDANCE DEGREE was calculated using the mathematical expression ICES ACCORDANCE DEGREE = TAC/ICES Advice x1 00. This indicator shows how the ICES advice was respected / exceeded. Positive percentages will be displayed in green showing a good accordance degree, i.e., the maximum limit set by the EC did not exceed the ICES advice and quantifies how much ICES Advice is effectively

implemented by TAC set. Negative percentages will be displayed in red, showing a bad accordance, i.e., scientific advice was not respected and the amount set by the EC was exceeded. In this case the percentage refers to how much the scientific advice was exceeded.

- 3. Another indicator was used to quantify how the fisheries industry respects the maximum limits imposed by the EC: TAC COMPLIANCE RATE using the mathematical expression TAC COMPLIANCE RATE = Total landings / TAC x 100. The compliance is satisfactory when the rates are positive, and so it is displayed in green. When the fish landed is more than the allowed amount, the rate is negative, and so it is displayed in red and it shows how much the maximum limit was exceeded by.
- 4. Study of TAC and Total landings on SSB variation, in tones when data is available.

In order to understand which one, TAC or Total landings, influences SSB more, multiple linear regression was performed. When a p-value's coefficient term is lower than 0.05, there is a statistically significant effect on SSB. The software used to perform the multiple linear regression was MIniTab 14.

- Portuguese Quota and Portuguese landings variations along the considered period and when data was available. Differences between variables means were evaluated using MiniTab14 statistical software.
- 6. To quantify how the Portuguese fishery industry fulfils the allocated quota, we included the indicator QUOTA COMPLIANCE RATE using the mathematical expression QUOTA COMPLIANCE RATE = Portuguese landings /Portuguese quota x 100. As for the other indicators used in this study, positive rates are displayed in green and represent a satisfactory compliance by the fishery industry. The negative rates are displayed in red and represent how much the allocated quota was exceeded. In analysis 1 and 5, to know which test to use, the normality of each variable was tested. When both were normal, a parametric test was used, in this case a T-test. If one variable was not normal, the non-parametric Mann-Whitney test was performed. Both, T-test and Mann-Whitney tests were performed in MiniTab14 statistical software.

## 4. RESULTS/DISCUSSION:

## a) PELAGIC SPECIES

#### HORSE MACKEREL

Horse Mackerel ICES Advice only includes *Trachurus trachurus*. However the established TAC includes all *Trachurus* spp (Annex II, table 2)

Nevertheless, the main species of *Trachurus* in Portuguese waters is *Trachurus trachurus*. INE landings records do not specify which *Trachurus* species is landed, except for Blue jack mackerel.

In the considered period for this study, political decision never respected the scientific advice as we can see in Figure 2.



Figure 2. Horse Mackerel (Division IXa – Southern Stock) - ICES Advice and TAC variation between 2000 and 2012 (Source: ICES, 2011b)

Between 2000 and 2005 ICES advice varied a lot. Highest TAC advice values were registered between 2000 and 2001, and again in 2003 and 2004. Since 2005 the scientific advice remained below 30 000 tons,

with a slight increase in 2012. However the political decision did not integrate the scientific advice during all this period. TAC was always above the advice, with some years closer to and others far from the advised TAC.

In 2003 the TAC suffered a decrease relative to two years before. TAC followed the decrease tendency of ICES advice, although not in the rate. The imposed maximum limit continued to decrease until 2004 and remained constant until 2007. In 2008 and 2009 even when the scientific advice did not suffer any alteration, the European commission decided to increase the TAC. In 2010 the TAC was reduced considerably to values close to ICES Advice, although still above it. The same scenario was repeated in 2011. Finally in 2012 the values of both variables match. Statistics show significant differences between the means of the two variables (T-test: p - value = 0.0003; t = -4.8; n= 13). There is a positive correlation between the scientific advice and political decision (Spearman's correlation: r = 0.495; p - value = 0.085), meaning that both variables varied in the same way along the years.

The lack of match between political management and scientific recommendation may compromise the stock conservation state as it has experienced some years of low biomass levels (OCEANA, 2011).

Except for 2012, the accordance degree between ICES Advice and TAC is negative for all years (Figure 3).



Figure 3. Horse Mackerel (Division IXa – Southern Stock) - ICES Accordance Degree between 2000 to 2012

Scientific advice was constantly disrespected. The given advice was sometimes exceeded more than 100%. 2008 and 2009 were the worst years, with the advised amount exceeded by 131% (this corresponds to 32800 tons more than the scientific advice).

TAC compliance rate fortunately was always positive in interval time considered (Figure 4).



Figure 4. Horse Mackerel (Division IXa – Southern Stock) - TAC Compliance Rate between 2000 and 2010

The fishery industry respected the TAC and never overshot the established amount. 2010 was the year when total landings were closer to the amount established, with 88% of the allowable amount landed.

The amount of *Trachurus trachurus* caught could be less than the total landings because *Trachurus picturatus* is caught together with *T. trachurus* in Division IXa (ICES, 2011b) and are not differentiated when the fish is landed.

Nevertheless it should be kept in mind that the TAC is well above the scientific advice and this has negative consequences for the stock.



**Figure 5**. Horse Mackerel (Division IXa – southern stock) – TAC and Total Landings variation influence on SSB evolution between 2000 and 2012 (Source: ICES, 2011b)

Total landings as was referred, were always below the TAC (Figure 5). There was a slight decrease in SSB since 2001 probably as consequence of high TAC before 2000. Probably, the registered TAC decrease in 2002 had positive consequences in SSB in 2005 and 2006. Since then SSB decreased again until 2011. However the TAC remained stable until 2007 and the consequences for SSB in the following years should be positive but were not. One of the reasons to explain this situation is that the SSB estimates could not correspond to the true values as retrospective analysis shows an underestimation of SSB (ICES, 2011b).

These fluctuations could correspond to more horse mackerel available due to natural causes (ICES, 2011e). When we try to understand which one (TAC or total landings) have more weight in horse mackerel SSB modeling, we end up with non-significant coefficients, with none of the variables important for SSB modeling. Only the constant coefficient term has a statistically significant (T-test: p-value 0.004, which could reflect the influence of environmental factors, utilized gears, etc. (see annex II, table 2).



Figure 6. Horse Mackerel (Division IXa – Southern Stock) - Portuguese Quotas and Portuguese landings variation between 2000 and 2011 (Source: Batista, 2012; DGPA, 2001; INE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011)

Horse Mackerel Portuguese landings were well below the available amount allocated for Portugal (Figure 5). The fisheries industry respected the allocated quota and never exceeded it between 2000 to 2010.

It is curious to find that for almost all the years in the considered period, Portuguese landings behavior were opposite to the established quota. For example the quota decreased in 2002 (relative to two years before) while Portuguese landings increased (relative to two years before). In 2003 the Portuguese quota increased and Portuguese landings decreased. The oscillations maintained in the following years until 2011 in the case of the quota and the same for Portuguese landings. The lowest amount landed (9250 tons) was recorded in 2008 when the opportunity to fish Horse Mackerel was 57800 tons (one of the highest within the interval period). The difference between the two variables is statistically significant (T-test: p value =  $7.61 \times 10^{-8}$ ; t = 13.83; n = 11).

Quota compliance rate is always positive during the period considered. 33% of the allocated quota was landed on average (Figure 7).



Figure 7. Horse Mackerel (Division IXa – Southern Stock) - Quota Compliance Rate between 2000 and

2010

It is strange since horse mackerel is one of the most consumed fish in Portugal. The quota could be better exploited but maintaining the positive fulfillment.

#### **BLUE JACK MACKEREL**

Blue Jack Mackerel is a species only present in the Azores and it is Portugal alone that has the total rights to fishing it. Thereby the imposed TAC is the same as the allocated Quota for Portugal as ICES does not advise any maximum amount as a limit to be caught. The advice since 2000 until nowadays is no increase in the catch (Figure 8).


**Figure 8.** Blue Jack Mackerel (Subdivision IXa<sub>2</sub> – Azores) - TAC and Total landings variation between 2000 and 2011 (Source: ICES, 2011b)

Thus in this case it does not make sense to compare ICES advice and its integration in political decisions but to compare the set TAC with Total landings and to verify if in fact there is or is not an increase in catch. Total landings corresponds to all landings of blue jack mackerel in Portugal.

The imposed TAC by the European Commission started high (5000 tons) in 2000 but landings were below 2000 tons. Total landings increased until 2003 and TAC decreased respectively. Between 2003 and 2011 TAC maintained stable with a little decrease in 2010. Total landings remained below the maximum allowed until 2007, exceeding it in 2008, 2009 and 2010. The means of each variable are significantly different (Mann-Whitney test : p value= 0.0232; n = 11).

The TAC compliance rate was always positive until 2007 because, as described above, total landings do not overshoot the political decision (Figure 9).



Figure 9. Blue Jack Mackerel (Subdivision  $IXa_2 - Azores$ ) - TAC Compliance Rate between 2000 and 2010

The highest compliance rates, above 90%, were in 2003, 2006 and 2007, which means that the total landings were close to the maximum limit. The fishing industry did not respect the political decision since 2008 and overshot the TAC. The worst year was in 2009 when 54% more of the amount allowed was landed (1739 tons more that the limit).

However the situation can be worse than the published data shows because this species is used not only for human consumption but is also used as bait for tuna in the Azores fishery and the rate of discards is not quantified but is known to be high in recent years (ICES, 2011b).

### **SARDINES**

The sardines are a special species for Portuguese fisheries as it is one of the most consumed fish species in Portugal. Our analysis will be limited to the available data as this species does not has TAC. ICES advice will work as a theoretical TAC.

ICES provided advice but the European Commission does not set a TAC. The sardine stock is managed by Portugal and Spain and only their fleets are allowed to fish this stock. This is one of the reasons why there

is no quota distribution. TAC compliance rate will be replaced by an ICES compliance rate. It represents the theoretical fulfillment as the ICES only provided advice and it is not effective concerning fulfillment (Figure 10).



Figure 10. Sardines (Stock in Divisions VIIIc and IXa) - ICES Compliance Rate between 2000 and 2009

The ICES compliance rate, although not effective, shows fishery industry accomplishment. Between 2000 and 2002 and in 2008 and 2009 the amount of sardines landed exceeded ICES advice. Thereby the compliance rate is negative in those years. It was in 2009 that the highest overshoot was recorded, with 24% more sardines landed than the value advised.

Between 2003 and 2007 the ICEs compliance rate was high and positive, i.e., the total amount landed did not exceed the ICES advice and was very close to the advised value.

As has been done in other species we would like to understand the SSB behavior concerning TAC and total landings. Since there is no TAC, again ICES advice will work as "theoretic TAC" allowing the comparison between European Commission maximum limit, the amount landed and its indirect consequences on SSB level.



Figure 11. Sardines (Stock in Divisions VIIIc and IXa) - ICES Advice, Total landings and SSB evolution between 2000 and 2012 (Source: ICES, 2011b)

From 2000 to 2009 total landings were always close to scientific advice, although the scientific advice was exceeded in some years. Although in general the deviation is not high. There is a significant difference between the means of ICES Advice and Total landings (T- test: p - value = 0.712; t = 0.38; n= 10).

SSB increased from 2000 until 2002 and remained stable thereafter until 2004. In 2005 SSB dropped and increased again in 2006. Since then it decreased considerably until 2009. These variations did not correspond to total landings variations and not even to high scientific advice. There are other possible reasons to explain these variations. These fluctuations could be due to variations in recruitment, related to variations in environmental variables such as upwelling and the NAO index (ICES Advice, 2001). However there is no scientific proof that these are the reasons for SSB oscillation.

None of the coefficients show a statistical significance in SSB modeling (ICES Advice p - value = 0.078; Total landings p value=0.543; constant p - value= 0.522).

SSB has declined since 2006 due to lack of strong recruitment. In 2010 SSB was 33% below the long-term average. In 2009 fishing mortality was at the same level as in 2008, being within the historical level.

European Union policy paper concerning fisheries management, refers that the sardines' stock abundance in the last two years in 39% lower in average than the estimated in the three preceding years.

#### <u>ANCHOVY</u>



Anchovy is another case of total disagreement between ICES advice and the established TAC (Figure 12).

Figure 12. Anchovy (Stock in Division IXa) - ICES Advice, TAC and Total Landings variation between 2000 and 2011 (Source: ICES, 2011b)

ICEs advice was fairly constant between 2000 and 2010. The advised values were around 4600 and 4900 tons. However the EC established a higher value for the TAC. In 2000 and in 2001 the differences between advice and established TAC were higher than the next years. Nevetheless from 2003 to 2010 the TAC remained above scientific advice. In 2010 ICES advised a revision of the stock assessment procedure different stock dynamics were found in different areas within thee same division (ICES, 2011b). It is not possible to project reliable advice taking this into account. The differences between ICES advice and TAC means are statistically significant (T-test: p-value =  $4 \times 10^{-8}$ ; t= -14,54; n=11), and there is a little correlation between both (r = 0.039; p - value = 0.909).

It was decided to include in this graph (Figure 12) the total landings as it is no use to do a TAC/Total landings and Stock variation analysis due to the lack of information of spawning stock biomass. Therefore the total landings included in this analysis allow us to have a macro ideia of political decision making and fishery industry compliance at the same time. In general, total landings were below the established TAC. So the fishery industry compliance was positive as they fulfilled the maximum limit. There was however an exception in 2002.

However, half of the times within the time interval considered total landings were above scientific advice. In 2000, 2005, 2006, 2008, 2009 and 2010 less anchovy was landed than what was advised and less than what was established by the European Comission.

Although I had no access to SSB or to the latest biomass data, OCEANA write in the "Risk Map for fisheries management report" that Anchovy shows almost no presence of age class 0. Therefore this species is considered overexploited, with the recruitment declining considerably and the stock not under the MSY objectives (OCEANA, 211). Lastly the difference between total landings and TAC means is statistically significant (T-test: p-value = 0.000851; t = 4.69; n=11) (Figure 13).



Figure 13. Anchovy (Stock in Division IXa) - ICES Accordance Degree between 2000 and 2010

The ICES Advice compliance degree has been always negative. Effectively, the TAC has always exceeded the scientific proposal within the time span considered. In 2000 and 2001 the political decision exceeded the scientific advice with the lowest accordance in the decade. Between 2002 and 2010, period the ICES Advice was exceeded by 60% to 70%.

The TAC compliance rate indicator shows a general positive fulfillment by the fishery industry. There is only an exception in 2002, when the TAC was exceeded by 10% (Figure 14).



Figure 14. Anchovy (Stock in Division IXa) - TAC Compliance Rate between 2000 and 2010

Anchovy is highly dependent on environmental conditions and experience high natural mortality, high dependency on recruitment and it is prey species for other pelagic and demersal species (ICES, 2011b, 2011e). These factors can be some of the possible explanations for the fact that the amount of anchovy landed during the last decade was, on average, half of the limit allowable. For example, in 2008 and 2009 the the landings decrease was a consequence of fishing effort decrease (ICES, 2011e).

Nevertheless the stock status was relatively constant within considered period. The changes registered until 2009, did not showed any problems (ICES, 2011e).

Since 2000, Portuguese quotas were never exceeded. Portuguese landings were very low concerning Anchovy. The mean amount landed was 370 tons in 2000 and 2010 (Figure 15).



**Figure 15.** Anchovy (Stock in Division IXa) - Portuguese Quotas and Portuguese landings variation between 2000 and 2012 (Source: Batista, 2012; DGPA, 2001; INE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011)

The differences between Portuguese Quotas and Portuguese landings means are statistically significant (T-test: p - value= 0.000281; t=5.44; n=11).

The compliance rate is satisfactory over the last decade (Figure 16).



Figure 16. Anchovy (Stock in Division IXa) - Quota Compliance Rate between 2000 and 2010

Portuguese landings never exceeded the maximum limit imposed by quota. In 2001 and 2002 more than 50% of the quota allocated to Portugal was used, however the percentage decreased in the following years. Since 2005 the catches concerning Portuguese waters were quite low (an average of 3% of available quota).

# MACKEREL

Mackerel is a widely distributed species in Northeast Atlantic and it is the Southern component of the stock that will be analyzed. Concerning ICES Advice and TAC variation within the interval time considered there was a good approximation of both (Figure 17).



Figure 17. Mackerel (Stock in Northeast Atlantic – Southern Component) - ICES Advice and TAC evolution between 2000 and 2011 (Source: ICES, 2011c)

The integration of scientific advice by political decision makers was not bad until recent years. In 2000 the TAC was set below the advice, while in 2001 there was an almost imperceptible inversion of the situation with TAC a little bit higher than the advice. Since 2003, the maximum limit set by political decision makers was always higher than the scientific advice until 2011. Nevertheless, the established TACs in 2010 and 2011 were not international TACs but the sum of unilateral TACs. Statistics shows that the means of the two variables are significantly different (T test: p-value = 0. 057; t = -2.12; n = 12) and there is a strong correlation between both (Spearman's Correlation: r = 0. 860; p – value = 0.000).

The accordance degree was not always satisfactory (Figure 18).



Figure 18. Mackerel (Stock in Northeast Atlantic – Southern Component) – ICES Accordance Degree between 2000 and 2011

In 2000, 2002 and 2004 the political decision was not higher than the scientific advice but very close. For all the other years until 2011, the EC established a TAC above scientific expectations. This disagreement increased over the last years.

But it was not only the EC decisions that were bad, with the fishingexceeding the TAC in five out of eleven years (Figure 19).



Figure 19. Mackerel (Stock in Northeast Atlantic - Southern Component) - TAC Compliance Rate

The maximum exceeded was 11%, corresponding to 56000 tons more than the allowable. All the others years the compliance rate was high with a good approximation of the amount landed to the established TAC. However, is it known that discards before 2005 were high so the positive compliance rate verified in 2001 and 2002 is probably overestimated (ICES, 2011c).

There is a management plan agreed in 2008 but since 2009 that plan has not been fulfilled. There is lack of international agreement in setting a TAC (ICES, 2011c). These two reasons combined may cause overexploitation taking into account the precautionary approach.

Analyzing TAC and Total landings within the interval time considered and SSB evolution, some oscillations can be seen (Figure 20).



**Figure 20.** Mackerel (Stock in Northeast Atlantic – Southern Component) – TAC and Total landings variation influence on SSB evolution (source: ICES, 2011c)

The amount of Southern stock mackerel landed was close to the established amount. SSB decreased a bit between 2000 and 2003 and increased progressively until 2009. The SSB variations are an indirect consequence of total landings (Catch). Total landings influence F (fishing mortality) and that will influence SSB. However since mackerel is a small pelagic species, stock fluctuations may depend on others factors, namely variability of environmental factors that influence recruitment (ICES, 2011c). A slight decrease in 2010 and in 2011 did not alter its full reproductive capacity status. However negative consequences could arise if this situation goes on and total landings continue increasing,

The lack of international agreement can exacerbate this situation. As a wide distributed species that is very sensitive to environmental alterations, the management plan should be enforced effectively in order to control the catch.

In the SSB regression model all coefficients (TAC, total landings and a constant that can correspond to environmental conditions, etc) are statistically significant (T-test: TAC p value = 0.048; t = 2.34 / Total landings p value = 0.042; t = -2.42 / Constant p value =0.009; t = 3.46). However the p-value of the

"constant" is lower compared with the p-values of other two coefficients. This effectively can be related to environmental conditions and of their influence on the mackerel.

Regarding the Portuguese situation, we can see that national landings never exceeded the allocated quota (Figure 21).



Figure 21. Mackerel (Stock in Northeast Atlantic – Southern Component) - Portuguese Quotas and Portuguese landings variation between 2000 and 2012 (source: Batista, 2012; DGPA, 2001; INE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011)

The Portuguese mackerel Quota is not high. The Quota suffered some alterations during the decade but it was since 2009 that the alterations were more evident. However, the allocated quota was always respected by the Portuguese fishing industry. It is curious that in one of the years with highest allocated quota, the Portuguese fleet landed less mackerel against the general scenario (as we can see above total landings in 2007 were very close to the TAC). The Portuguese quota increased in 2011 and 2012, however landings data for 2011 were not available. The means of the two variables are significantly different (T-test: p- value = 0.002; t= 3.95; n = 11).

Quota Compliance was always positive within the time span considered (Figure 22).



Figure 22. Mackerel (Stock in Northeast Atlantic – Southern Component) – Quota Compliance Rate

As mentioned above the lowest compliance rate was registered in 2009 because less was landed than the allocated quota. For all remaining years the compliance rate was high, with 75% of compliance on average. As can be seen in Figure 19, the worst compliance was in 2000 and 2007. However it was not the Portuguese fishing industry that exceeded the allocated amount (as can be seen in Figure 21). Total landings records are the sum of all landings from all areas components. So far it can be affirmed that Portugal fishing industry is not the responsible for a possible bad mackerel stock state.

### **BLUE WHITING**

Blue whiting is a semi - pelagic species that is widely distributed and migratory.

Despite the ICES advice being available within the span of time considered, TAC data is only available since 2006, the year when it started to be set (Figure 23).



Figure 23. Blue Whiting (Stock in Subareas I-IX, XII and XIV (combined Stock)) - ICES Advice and TAC variation (Source: ICES, 2011c)

The scientific advice regarding the blue whiting was not constant over the time period considered. Since 2006, the blue Whiting has been experiencing low recruitment and constant fluctuations in SSB (ICES, 2011c) which forced the decrease of the advised TAC since then. There is an exception in 2010 when the ICES decided to increase the blue whiting advised TAC. The European Commission started to impose a limit to this species in 2006. However, it is in general well above the scientific advice. The TAC decreased along the following years matching the ICES Advice in 2011 and 2012. Nevertheless, it is not clear if this is enough to allow the stock to recover; the situation is so critical that the scientific community questions whether the biomass will reach safe precautionary levels soon (OCEANA, 2011). Before 2006 there was no catch limit established because there was no international agreement on how to divide the total quota among the countries, as happens with the Mackerel stock. The means of the two variables are not statistically significant (T-test: p = value = 0.057; t = -2.3; n = 7).but there is a strong correlation between both (Spearman's correlation: r = 0.893; p - value = 0.007).

Analysing the ICES accordance degree, we can easily verify and quantify how much the TAC exceeded the scientific advice (Figure 24).



Figure 24. Blue Whiting (Stock in Subareas I-IX, XII and XIV (combined Stock)) - ICES Accordance Degree

In fact, the accordance degree between the TAC and the scientific advice was quite bad between 2006 and 2009, with 2007 registering the lowest accordance. The maximum limit set was 88% higher than the advice. In 2011 and 2012 the accordance degrees are the highest. The European Commission decided to take into account the scientific advice and imposed the same value.

TAC Compliance rate was not bad within the period for which data was available (Figure 25).



Figure 25. Blue Whiting (Stock in Subareas I-IX, XII and XIV (combined Stock)) - TAC Compliance Rate

TAC compliance rate was satisfactory, with the catch limit exceeded by 5% only in 2009. The lack of international agreement and the consequent lack of TAC, probably was an opportunity for the fishing industry to fish without any penalties in the previous years. Thus, despite lack of scientific advice integration into the political decision, the fishing industry almost always accepted and fulfilled the imposed limits.

Comparing the TAC and the Total landings and the evolution of SSB we can easily understand the necessity of new management measure (Figure 26).



**Figure 26.** Blue Whiting (Stock in Subareas I-IX, XII and XIV (combined Stock)) - TAC and Total landings variation influence on SSB evolution (source: ICES, 2011c)

As mentioned above, recruitment has been very low since 2006, with negative impacts on SSB. It is evident that the SSB of the blue whiting combined stock of sub-areas I-IX, XII and XIV decreased since 2006. Once the TAC was established, it followed the same negative tendency and consequently total landings too.

This species is under a management plan since 2008 that stipulates a reduction of 35% of F in the first two years (ICES Advice, 2009). In fact, since 2008 total landings were the lowest observed over the time span of this analysis.

Curiously, the regression model shows that TAC and total landings do not influence SSB (TAC p – value = 0.688; total landings p value = 0.726). Nevertheless, a very small time period was used (from 2006 to 2010) and the conclusion can be incorrect.

But in fact, this species is declining and experiencing difficulties. Attention should be paid to this situation because the blue whiting is an important prey to large predators and its bad condition will affect negatively the ecosystem equilibrium (ICES, 2011c). In addition, according to OCEANA (2011) most of the stock consists of individuals of older age classes, so the recruitment levels are expected to be low, delaying the short term recovering of the stock (OCEANA, 2011).

Concerning Portuguese Quota and landings variation along the considered period, there was a big oscillation in quota and a relative constant amount of Blue Whiting landed in Portugal (Figure 27).



**Figure 27.** Blue Whiting (Stock in Subareas I-IX, XII and XIV (combined Stock)) - Portuguese Quota and Portuguese Landings variation between 2000 and 2012 (Source: Batista, 2012; DGPA, 2001; INE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011)

Despite the inexistence of a TAC before 2006, there is a quota for Portugal. The Portuguese quota oscillates during the study period with highest allocated quantities in 2004 and 2005. Since then, the Portuguese have followed the general tendency of a decrease for this species.. The Portuguese quota achieved the minimum value in 2011 (483 tons to be fished by Portugal). The data concerning the landings of 2011 were not available at the time of this data analysis. Portuguese landings were always very low as this fish is not normally eaten by the Portuguese. The highest landings occurred in Alentejo and Algarve, however not in high amounts (ICES, 2011c). The highest amount landed in Portuguese quota and the Portuguese landings for Blue whiting sample, are significantly different (T-test: p- value = 0.0032; t = 3.84; n = 11).

As expected, the Quota compliance rate for this species will be always positive (Figure 28).

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Figure 28. Blue Whiting Quota Compliance Rate

In 2008 and 2009 despite the low quota, almost all of the possible amount allocated was landed. If not, serious problems can arise if the compliance rate suffers an inversion.

# **b) DEMERSAL SPECIES**

### <u>Hake</u>

Hake is a very important fishery resource in Portuguese waters and in the Portuguese diet. Despite its importance and consequently necessity of a sustainable exploitation, there is a clear evidence of a failure in political decision making concerning scientific advice (Figure 29).



Figure 29. Hake (Stock in Divisions VIIIc and IXa (Southern Stock)) - ICES Advice and TAC variation between 2000 and 2012 (Source: ICES, 2011b)

From 2000 to 2012, except in 2002 and 2012, the TAC was set above the ICES advice, with scientific recommendations consistently ignored. An increase in fishing mortality has been recorded over the last few years (OCEANA, 2011). The worst period registered was between 2003 and 2009. Although ICES advised zero catches, established TACs reached values between 6000 and 8000 tons. The differences between the two variables are statistically significant (T-test: p-value =0.0003; t= -5.05; n=12), and there is a positive strong correlation between both (Spearman's correlation: r=0.842; p - value= 0.000).

ICES accordance degree quantifies, in percentage, this mismatch between ICES advice and TAC (Figure 30).



Figure 30. Hake (Stock in Divisions VIIIc and IXa (Southern Stock)) – ICES Accordance Degree between 2000 and 2012

The accordance degree between TAC and ICES Advice for hake southern stock, between 2000 and 2012 was not bad in general. ICES advice was not always implemented except in 2002 and in 2012. Scientific advice was exceeded by 100% between 2003 and 2009. Fortunately in 2010 and 2011 the accordance increased despite being negative and in 2012 became positive. It can be easily concluded that the recovery plan in force since 2006 is not being followed by the EC.

The situation is serious as total landings exceeded the TAC limit since 2004 (Figure 31). Thus there is a cumulative problem in this species.



Figure 31. Hake (Stock in Divisions VIIIc and IXa (Southern Stock)) – TAC Compliance Rate between 2000 and 2010

Hake TAC compliance rate, in ICES division VIIIc and subdivisions IXa, and EU waters CECAF 34.1.1 was high and positive in the beginning of the decade until 2003. Less hake was landed than the maximum limit allowed, but in the following years until 2010 this compliance rate decreased substantially. In 2007 143% more was landed than the maximum limit, which represents 8772 tons more than the TAC. On the other hand the TAC was fixed in a year in which ICES advised zero catch of hake. However, since 2004 the established TAC has not being fulfilled.

Comparing the evolution of Hake TAC and Total landings over the time period with the SSB it can be seen that there is an increase in SSB, but this does not necessarily mean that the stock is in a good state (Figure 32).



Figure 32. Hake (Stock in Divisions VIIIc and IXa (Southern Stock)) - TAC and Total Landings variation influence on SSB evolution between 2000 and 2012 (Source: ICES, 2011b)

Should be noted that TAC and Total landings have a delayed effect on the state of the stock, influencing SSB positively or negatively in the following years. This is especially true for demersal species as their life cycle is bigger than in pelagic species.

As can be seen, until 2004 the established TAC and Total landings were close and the SSB remained stable until 2005. Since 2005 total landings were much higher than the TACs. In 2007 almost 9000 tons were fished, more than what was established and the spawning stock biomass of 2008 almost remained the same. It is curious that even with high discrepancy between what was set officially and what was landed officially, the SSB continued to grow. But of course, episodes like that registered in 2010, when landings decreased, approaching the value of the TAC, will have a positive effect on the SSB the following year.

Southern hake is subjected to a recovery plan established in 2006 where the main objectives are to maintain the stock within safe biological limits of SSB =35000 tons and F towards 0,27 (ICES, 2008c). Technical measures were applied beyond the TAC such as: a minimum landing size (27 cm), protected area and minimum mesh size (ICES, 2011b). Effectively these technical measures can explain how stock continues increasing despite total landings that exceed the SSB.

However, the recovery plans main recommendations (decrease TAC in 10% and decrease F in 15%) were not yet met yet. So, it can be concluded that the hake southern stock is overexploited due to bad management

The regression analysis showed that the total landings coefficient is statistically significant. Total landings have more influence on SSB than the TAC (p-value= 0.000; t =7.49; n=11).

The trends in Portuguese quota and landings over the interval of time considered can be seen in Figure 33.



Figure 33. Hake (Stock in Divisions VIIIc and IXa (Southern Stock)) - Portuguese Quota and Portuguese Landings variation between 2000 and 2011 (Source: Batista, 2012; DGPA, 2001; INE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011)

In general the amount of hake landed did not exceed the quota. There are some exceptions in 2001, 2005 and 2007. The differences between Quota and landings are statistically significant (T-test: t = 1.45; p = 0.177; n = 11).



Figure 34. Hake (Stock in Divisions VIIIc and IXa (Southern Stock)) – Quota Compliance Rate between 2000 and 2010

In general quota the compliance rate was not bad except in four years. As referred above, only in 2001, 2005, 2006 and 2007 was the compliance not fulfilled (<100%). All the remaining years the compliance was positive, with less hake landed than was allocated.

# **MEGRIM**

The megrim analysis considers two different species (Four-spot megrim (*Lepidorhombus boscii*) and megrim (*Lepidorhombus whiffiagonis*) as they are managed together (Annex II, table 9).

Figure 35 shows how scientific advice and TAC varied within the time interval considered.



Figure 35. Megrim (Stock in Divisions VIIIc and IXa) - ICES Advice and TAC variation between 2000 and 2012 (Source: ICES, 2011b)

Scientific advice was more or less constant between 2000 and 2003. It decreased in 2004 and 2005 and increased between 2006 and 2009. From 2010 until 2012 a decrease in the TAC has been advised by the scientists and are the lowest ones within the interval of time considered.

In the beginning of the decade the TAC was set well above the ICES advice. Since then political decisions have reduced the maximum limit until 2004. In 2004 the TAC was set below scientific advice (ICES advice= 1380; TAC = 1336), and since then the imposed maximum limit was always close to scientific advice, remaining just above it until 2012. Summarizing, the political decision making has approached the scientific advice since 2004.There are no significant difference between ICES Advice and TAC for Megrims (Mann-Whitney Test: p-value = 0,238; n=13) and there is a strong positive correlation between both (Spearman's correlation: r=0.944; p value =0.000).

ICES accordance degree shows a failure on the scientific advice implementation by the EC (Figure 36).



Figure 36. Megrim (Stock in Divisions VIIIc and IXa) - ICES Accordance Degree between 2000 and 2012

The Accordance was in general negative with an exception in 2004 when TAC was set below ICES Advice. In 2000 the lowest accordance degree was registered. TAC was set 233% above the maximum recommended by ICES that year. In the next years this failure in accordance decreased although it continued to be very high. In 2004 there was 97% of accordance and since then the accordance became negative again.

Despite this negative accordance by EC, the fishery industry fulfills the maximum imposed except in 2006 and 2010 (Figure 37).



Figure 37. Megrim (Stock in Divisions VIIIc and IXa) - TAC Compliance Rate between 2000 and 2010

The fishing industry Compliance rate in the megrim's case was generally high over the time period of the study. Between 2000 and 2005 and between 2007 and 2009 total landings did not exceed the TAC. The catch increased since 2003. In 2006 the maximum limit was overshot by 3 % and in 2010 7% more than the allowable limit was landed. In general there is a good fulfillment of the Total Allowable Catch in the megrim fishery.

It is curious to observe that despite very high TAC between 2000 and 2003, total landings did not reach the allowable maximum (Figure 38). In fact, and comparing with ICES Advice, total landings were very close to the advice. This can be a sign that ICES advice was very realistic.



**Figure 38.** Megrim (Stock in Divisions VIIIc and IXa) – TAC and Total landings variation influence on SSB evolution between 2000 and 2012 (source: ICES, 2011b)

Stock state could have benefited by this situation. Regarding SSB evolution there is some relationship with total landings as it remained constant. As was mentioned before, there is a deferred behavior of SSB concerning total landings. It is easy to see in Figure 38 that when landings decrease, SSB in the next year increases, like in 2002 and 2003 respectively. Total landings had increased in 2003 and SSB value referent to 2004 was lower than the year before. This SSB negative evolution is dangerous concerning stock state. SSB should not be below total landings. This could be a result of the two megrim species being pooled in the statistics, with poor knowledge about them.

Besides TAC, there are other technical measures regulating megrim catch. Spatial and seasonal closures were implemented as a consequence of a big oil spill in 2002 by the Prestige tanker, mainly in Galicia (division VIIIc) (ICES, 2008c). Probably because of that, TACs were reduced. Total landings remained constant before and after the oil spill. This could be consequence of megrims being taken as by-catch in mixed bottom trawl fisheries which are targeting white fish such as hake (ICES, 2008c). As the hake fishery is under a recovery plan since 2006, resulting in less fishing mortality, less megrims will be caught.

However discards episodes concerning megrims are very high – between 30-60% epecially in younger ages (ICES, 2008c).

Little can be inferred about each megrim species alone - Four-spot megrim (*Lepidorhombus boscii*) and megrim (*Lepidorhombus whiffiagonis*) - with this analysis. As was described in the species biology chapter, *Lepidorhombus boscii* and *Lepidorhombus whiffiagonis* are caught with different rates. OCEANA affirms that the stock is in decline since the 80's and is overexploited, with low biomass levels and consequently low SSB as can be seen in Figure 38.

Finally, the SSB regression analysis showed that the total landings coefficient is significant, with a p-value =0,001 (t=5.24; n=11).

The Portuguese Quota varied over the time period. Portuguese landings concerning megrims were not constant too (Figure 39).



Figure 39. Megrim (Stock in Divisions VIIIc and IXa) - Portuguese Quotas and Portuguese Landings between 2000 and 2011 (Source: Batista, 2012; DGPA, 2001; INE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011) The Portuguese quota for these species is very low. Both species are not economically valuable and are little used by Portuguese consumers. In the period between 2000 and 2003 and in 2010 Portuguese landings did not exceed the Portuguese quota. Only in the period between 2004 and 2009 was the Portuguese quota exceeded by 50 tons, on average. However the difference between the means of the two variables is not statistically significant (T-test: p-value= 0.895, t=-0.13; n=11).

The Portuguese quota compliance rate within the interval time considered was positive between 2000 and 2003. Lowest compliance by the Portuguese fleet was recorded for 2004 (Figure 40).



Figure 40. Megrim (Stock in Divisions VIIIc and IXa) – Quota Compliance Degree between 2000 and 2010

The compliance degree was positive between 2000 and 2003 and in 2010, because, as was seen before, landings did not exceed what had been established. In 2010 81% of the maximum allowable catch for Portugal was landed

## **ANGLERFISH**

As for megrims, the anglerfish analysis includes two species that are managed under the same TAC. The TAC suffered a decline from 2000 to 2010 (Figure 41).



**Figure 41.** Anglerfish (Stock in Divisons VIIIc and IXa) - ICES Advice and TAC variation between 2000 and 2012 (Source: ICES, 2011b)

In 2000 the discrepancy between ICES advice and TAC was very high. Over the next three years, scientific advice increased while the TAC suffered a reduction. Between 2004 and 2010 ICES advised zero catches, but the EC set a TAC around 2000 tones. In 2011 the political decision was very close to the advice with a complete match in 2012. There is no significant difference between the two variables (Mann-Whitney test: p-value = 0.0118, n = 13). The correlation between variables is positive and strong (Spearman's correlation: r = 0.944; p - value= 0.000).

As excepted ICES Accordance is negative, excepting for 2012 (Figure 42).



Figure 42. Anglerfish (Stock in Divisons VIIIc and IXa) - ICES Accordance Degree between 2000 and 2012

In general political decisions almost never implemented what was advised by the scientists. In 2000 the TAC was 325% more than the value advised by ICES. Although this disacordance decressed in the following years, the TAC remained above the scientific advice. Between 2004 and 2010 ICES recommended that anglerfish should not be caught. However, the EC fixed a maximum limit of an average of 2000 tons over this period. Only in 2011 did the disacordange decrease and in 2012 there is a positive implementation of scientific advice by political decision makers.

TAC compliance rate shows that the situation is more serious as the fishing industry did not comply with the maximum limit fixed since 2004 (Figure 43).



Figure 43. Anglerfish (Stock in Divisions VIIIc and IXa) - TAC Compiance Rate between 2000 and 2010

Between 2000 and 2003, less anglerfish (both species: *L. piscatorius* - White and *L. budegassa*) - black bellied anglerfish) was landed than the amount established by the EC, so compliance rate was positive. The best use of TAC (TAC= 4000 tons and Total landings = 3200 tons) was recorded in 2003. Since 2004 there is a negative fulfillment of the TAC, with more anglerfish landed than was permitted, with a peak in 2005 when landings exceeded by 125% the allowable TAC (corresponding to 2500 tons more than the maximum limit allowed).

Anglerfish spp. is caught in the same mixed fisheries as hake and Neprhops. Since the Megrims' stock biomass is below the Biomass sustainable yield, they can benefit from the hake / nephrops recovery plan. It should be mentioned that anglerfish discards are known to be very low (ICES, 2011b).

TAC and Total landings variation and SSB evolution are shown in Figure 44.


**Figure 44.** Anglerfish (Stock in Divisions VIIIc and IXa) – TAC and Total landings variation influence on SSB evolution between 2000 and 2012 (source: ICES, 2011b)

As was analyzed before between 2000 and 2003, the TAC set was well above the scientific advice. However, as we can see, total landings compensate any negative effect on the stock. Nevertheless, since 2000 besides the TAC being set above the scientific advice, total landings were also above the politically established limit until 2010. A decrease in total landings can be observed since 2005. B/Bmsy has grown since 2000. Even when total landings increased (between 2003 and 2005) B/Bmsy stills increased in the next year. There was a higher increase in B/Bmsy in 2009 and 2010, probably because total landings decreased in previous years, however, between 2003 and 2008 B/Bmsy was below total landings which means that this stock was at risk. It is easy to understand why ICES advised zero catches between 2003 and 2010. The TAC increase in 2012 probably will have negative impacts on anglerfish stocks since the fishing industry can understand this as more anglerfish is available to be caught. If total landings follow the TAC increase, B/Bmsy will probably decline.

As in the case of megrims, we should be very cautious with regard the apparent growth of the stock. Within the presented B/Bmsy data there are two different anglerfish species managed together. However they are different and have different stock states and this positive stock growth does not mean that both species are increasing their biomass. Indeed, SSB of both stocks are below Bmsy (Biomass maximum sustainable yield) (ICES, 2008c). Despite the increase, the sustainable reference point is not attained.

For the multiple regression analysis concerning B/Bmsy, TAC and the equation are significant (TAC p value = 0.004; constant p-value = 0.000). Total landings do not seem to be important (p-value = 0.065).

Despite the poor situation concerning the state of the anglerfish stocks, the Portuguese fleet is complying with the allocated quota (Figure 45).



**Figure 45.** Anglerfish (Stock in Divisions VIIIc and IXa) - Portuguese Quota and Portuguese Landings between 2000 and 2011 (Source: Batista, 2012; DGPA, 2001; INE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011).

The political decision was "welcomed" by the Portuguese fishing industry. Portuguese landings were always below the Portuguese quota. Between 2000 and 2003 less anglerfish was landed in Portugal than was allowed, following the tendency of total landings compared with TAC. Since 2004 Portuguese landings were close to the allowable quota but never exceeded it. There was no significant differences between the means of the Portuguese quota and the Portuguese landings(Mann-Whitney test: p-value = 0.157; n=11).



The satisfactory quota fulfillment was quantified and is displayed in Figure 46.

Figure 46. Anglerfish (Stock in Divisions VIIIc and IXa) - Quota Compliance Rate between 2000 and 2010

There is a positive compliance rate by the Portuguese fishing industry within the interval time considered. As was mentioned above, the quota was always fulfilled and has not been exceeded. The quota compliance rate between 2008 and 2010 shows an approximation of anglerfish landed, by Portuguese fleet, and the allocated quota. This should be kept in mind so that positive compliance continues.

## **NEPHROPS**

The stock of Nephrops is in a bad state in Portuguese waters. ICES advice is available since 2003 for this stock (Figure 47).



Figure 47. Nephrops (Stock in Division IXa) - ICES Advice, TAC and Total landings variation between 2003 and 2012 (Source: ICES, 2011b)

Due to the same reasons as for the anchovy, we decided to include in this graph the total landings instead of comparing them with set TAC and SSB, as the latter is not available for this species.

Another limitation for the analysis is that Nephrops in division IXa is divided in three functional units and ICES Advice and TAC was formulated since 2003.

Scientific advice suffered several alterations since the first time it was formulated for this division. In 2003, 2004 and 2005 the advice was really low and the established TAC was well above it. In 2006, the advice increased until 2010. In 2011 ICES left this species in standby with an advice of "looking for scenarios". TAC decreased progressively throughout the interval time to a minimum value in 2011. Total landings followed the same tendency. However, until 2007 the total landings were above the set TAC and ICES Advice. Only in 2008 were the total landings below the maximum limit but above the ICES advice. In 2009 and 2010 the total landings were below both.

The situation registered between 2000 and 2007 contributed to the actual state of this species, i.e. overexploitation and depletion. I had no access to biomass data, however OCEANA refers that it is extremely low and in a critical situation. ICES advice and TAC means are significantly different (T-Test: p - value = 0.01; t = -3.0; n= 8), but there is no significant difference between mean TAC and mean total landings (T-test: p - value = 0.51; t= 0.68; n=8). It was find a strong and positive correlation between ICES Advice and TAC (Spearman's correlation: r = 0.951; p - value = 0.000).

Accordance degree between political decision and scientific advice was in general very bad (Figure 48).



Figure 48. Nephrops (Stock in Division IXa) - ICES Accordance Degree between 2003 and 2010

In 2003 and 2004, the EC established a maximum limit 1100% higher (600 tons) than the scientific advice (50 tons). Between 2006 and 2008, a great decrease in TAC was registered which increased the accordance degree despite the TAC still being above the scientific advice for that period. Finally, in 2009 and 2010, the EC implemented the scientific advice positively. One of the objectives of the recovery plan in force (reduce TAC 10% each year) since 2006 in being fulfilled with an exception in 2009.

The fishing industry compliance was not satisfactory between 2003 and 2007 (See Figure 49).



Figure 49. Nephrops (Stock in Division IXa) - TAC Compliance Rate between 2003 and 2010

The political decisions were not accepted positively by the fishing industry in the first five years that the TAC was implemented. Between 2003 and 2007 more than the allowable TAC was fished. There is again a situation where the problem of low or even non implementation of scientific advice is worsened by the non-compliance of the fishery industry. The failure to comply peak was registered in 2005 when more than 28% of the limit was landed. In 2008, 2009 and 2010 the compliance was positive and TAC was not exceeded. The recovery plan (Recovery Plan for southern hake and Atlantic Iberian *Nephrops* stocks was implemented and has been enforced since 2006 (EC 2166/2005)) is forcing a good compliance in the last year for which data is available. However, we should be cautious of this affirmation. Nephrops are a very valuable and marketable species and fishermen have the highest interest in it. And this positive compliance by fishery fleets could be influenced by the bad state of this stock. Other reasons should be taken into account such as illegal fishing or unreported landings. Other technical measures were imposed besides TAC such as minimum carapace length and number of fishing days (ICES, 2008c). Better and more selective fishing gears used by bottom trawlers (fishing boat used to catch Nephrops) optimized the correct Nephrops exploitation, i.e., Nephrops within the minimum carapace length.

Prestige's oil spill in 2002 had a negative impact on Nephrops stocks (ICES, 2011b) but due to its high market value the real fishing effort would have increased and consequently exceeded the TAC in the period between 2003 and 2007.

Concerning the Portuguese quotas and landings of Nephrops, there is a good implementation of the allocated maximum by the Portuguese fleet (Figure 50).



Figure 50. Nephrops (Stock in Division IXa) - Portuguese Quotas and Portuguese landings between 2000 and 2012 (Source: Batista, 2012; DGPA, 2001; INE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009,

#### 2010, 2011)

The Portuguese landings were always below the Portuguese quota. The Portuguese landings never exceeded 400 tons until 2010. The quota started to rise in 2000 and decreased in the following two years. In 2010 it was registered the lowest allocated quota (251 tons) and the lowest Portuguese official landings (119 tons). The means of the two variables are significantly different (Mann-Whitney test: p - value = 0.0025; n=11).

This good behaviour of the Portuguese fishing industry can be seen in the Quota Compliance Rate (Figure 51).



Figure 51. Nephrops (Stock in Division IXa) - Quota Compliance Rate between 2000 and 2010

The positive fulfilment by the Portuguese fisheries concerning the political decisions is confirmed by the positive compliance rate within the considered period of time. The compliance has the highest rates in 2003, 2004, 2005 and 2007 when landings were very close to the imposed quota (between 75% and 80% of quota utilization).

#### <u>WHITING</u>

ICES does not provide advice for the ICES whiting stock. Due to this reason it is not possible to present the scientific advice and the TAC variation graphs, nor the ICES accordance degree.

Whiting TAC and Portuguese Quota are the same, so it was decided to not present the TAC Compliance rate.

Therefor only the Portuguese quota and Portuguese landings are presented, indicating a positive behavior by the Portuguese fishing industry (Figure 52).



Figure 52. Whiting (Stock in Subarea VIII and Division IXa) - Portuguese Quota and Portuguese landings between 2000 and 2011 (source: Batista, 2012; DGPA, 2001; INE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011)

In 2000 the allocated quota was very high compared with the amount of whiting landed within the time interval time. Whiting is not a target species in the Portuguese fishery nor in the Portuguese diet, so does the Portuguese fleet probably not use too much fishing effort to catch it.

The means of the two variables are not significantly different (T-test: p- value = 0.0005; t = 5; n = 11).

As expected, Quota Compliance rate was always positive (Figure 53).



Figure 53. Whiting (Stock in Subarea VIII and Division IXa) - Quota Compliance Rate between 2000 and

2010

The high difference between allocated Quota and national landings made the Quota Compliance rate very low. The maximum rate was registered in 2010, when 19% of the possible amount allocated was landed.

The available information is insufficient to evaluate stock trends and exploitation status. Therefore, the state of the whiting stock within the Bay of Biscay and Atlantic Iberian waters ecoregion is unknown. Survey abundance index (mostly 0-group) shows an overall stable trend in the last 10 years (ICES, 2011b).

# c) DEEP WATER SPECIES

# **BLACK SCABBARDFISH**

Black Scabbardfish TACs are lower than allocated Quotas to Portugal (see annex II, table 13). The same situation is registered for Total landings and National landings. The reason is that Madeira's quota and correspondent landings were added to Portuguese quotas and landings.

ICES provided advice for black scabbardfish only since 2009. TACs have been established since 2003 and before that there was not any maximum limit for this species.

It is only possible to compare two years of scientific advice and TAC, 2009 and 2011. It was decided to not present any graph because of the lack of information. However, TAC was again set above the scientific advice. ICES advised a maximum of 2800 tons in both years (see annex II, table 13). The EC established a TAC of 3600 tons in 2009 and 3300 tons in 2010. ICES Accordance degree was negative.

TAC fulfillment by the fishing industry is very positive (Figure 54).



Figure 54. Black scabbardfish (Stock in Subarea VIII and IX) -TAC Compliance Rate between 2003 and 2009

The fishing industry never exceeded the maximum limit established by the European Commission. The highest compliance rate corresponds to 2007. The amount of black scabbardfish landed (3453 tons) corresponding to subareas VIII and IX, was close to the maximum limit (4000 tons). It should be highlighted that these total landings correspond to subareas IX and X. Madeira's catch is not included since there is no TAC for that Portuguese area and so its corresponding landings do not contribute to the total records.

The Portuguese Quota is available since 2003 as it has a TAC. However, Portuguese landings records exist before that, as can be seen in Figure 55.



Figure 55. Black scabbardfish (Stock in Subarea VIII and IX) - Portuguese Quotas and Portuguese landings between 2000 and 2011 (source: Batista, 2012; DGPA, 2001; INE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011)

In the first two years since the quota was established, the Portuguese fishing industry did not respect the allocated quota. In fact in 2003 and 2004 Portuguese landings were higher than the quota but the situation had inverted in 2005. It is curious that it was not landings that decreased too much but the allocated quota that increased considerably. In 2004 the Portuguese quota was 4000 tons. In 2005 it had increased to 8231 tones, more than the double of the year before. Portuguese Quota and Portuguese landings differences are significantly different (T-test: p-value of 0-0002 t = -4.5; n = 8).

Quota compliance rate as an indicator of fishing industry fulfillment in displayed in Figure 56.



Figure 56. Black scabbardfish (Stock in Subarea VIII and IX) - Quota Compliance Rate between 2003 and

2010

Quota compliance rate was negative in 2003 and 2004 and positive since then until 2009. The lack of fulfillment in 2003 by the Portuguese fishing fleet (63 886 tons) overshoots 60% of the Portuguese maximum limit (4 000 tons).

The main problem of this species as a deep water species is that its stock's state is not well known. The fishing industry should be very cautious when is targeting back scabbardfish as this is a long lived species that takes more time to recover than the small pelagic and demersals.

### **BLACKSPOT SEABREAM**

Blackspot Sea bream has three management areas of which two correspond to Portuguese waters. It was decided to analyze them separately since they have different TACs.

Both areas did not have ICES advice before 2009. Scientific advice and TAC are comparable only in 2009 and 2010. In Subarea IX ICES advised 500 tons in 2009 and 2010. EC decided a TAC of 918 and 780 correspondingly. In Subarea X scientific advice was 1050 tons. The political decision was a bit higher, 1126

tons. As a comparison for only two years is available, graphs of scientific advice, TACs and landings and ICES accordance degree will not be presented, even though negative ICES accordance degree perceptible for both subareas.

Despite the lack of information about SSB, TAC and total landings (in tons) variation are presented in order to gain a better idea of what is going on in the same species in different areas.

Blackspot seabream TAC was established since 2003 in both subareas. In subarea IX, the TAC remained the same between 2003 and 2006. In 2007 it decreased, with the lowest TACs set in 2009 and 2010 (Figure 57).



Figure 57. Red Seabream (Stock in subarea IX) - TAC and Total landings variation between 2000 and 2010 (source: ICES, 2011c)

Although total landings corresponding to this division are not high, they have been increasing along time. Total landings decreased between 2000 and 2003 but since then increased until 2009. Nevertheless, total landings never overshoot the maximum limit imposed by the European Commission. This makes that the TAC compliance rate always positive in the period for which data was available (Figure 58).



**Figure 58.** Blackspot Seabream (Stock in subareas IX) - TAC Compliance Rate between 2003 and 2009 In this case the compliance grew from 2003 until 2009. In 2009 the amount of Blackspot seabream landed (718 tons) was closer to the maximum limit allowed (918 tons).

Regarding the Portuguese situation concerning this stock, national landings corresponding to this division were almost always below the allocated quota (Figure 59).



Figure 59. Blackspot Seabream (Stock in subareas IX) - Portuguese Quota and Portuguese landings between 2001 and 2011 (Source: Batista, 2012; DGPA, 2001; INE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011)

The amount of Blackspot seabream landed in Portugal corresponding to Portuguese subarea IX was below the allocated quota. Portuguese landings increased between 2000 and 2003 and between 2008 and 2010.

The Portuguese allocated quota was maintained in 2003 and 2004. In 2005 the allocated quota suffered a reduction, remaining the same until 2007 before increasing again in 2008 and decreasing thereafter.

Portuguese Quota and landings are significantly different (T-test: p-value= 1.87 x 10<sup>-5</sup>; t = 10; n = 8).

Quota compliance was always positive (Figure 60).



Figure 60. Blackspot Seabream (Stock in subareas IX) – Quota Compliace Rate between 2003 and 2011

As displayed above, the Portuguese quota was not overshot, with the Portuguese fishing industry fulfilling the legal allocated amounts. The compliance rate is satisfactory. The highest compliance rate was in 2007 with 80% of compliance. The official amount landed those years was 185 tons when the maximum limit was fixed at 230 tons.

Blackspot seabream has highest importance in Azores which corresponds to a different stock.

Subarea X has a different stock of Blackspot seabream. Corresponding TAC and recorded landings are different (Figure 61). The allowable catch fixed since 2003 remained the same until 2010 (1 116 tons).



Figure 61. Blackspot SeaBream (Stock in Subarea X (Azores)) - TAC and Total landings variation between 2000 and 2010 (source: ICES, 2011c)

This species has a high value in the Azores. Total landings are very close to the maximum limit. Since TAC started to be set, total landings have decreased. The lowest amount landed since there is a limit was in 2006 (958 tons).

TAC compliance rate for this stock was always positive (Figure 62).



Figure 62. Blackspot SeaBream (Stock in Subarea X (Azores)) - TAC Compliance Rate between 2003 and 2009

The fishing industry always fulfilled the maximum limit. It was in 2006 that the TAC compliance rate was the lowest (84%) and in 2007 the highest rate of 96% compliance was recorded Portuguese landings were very variable over this time period (Figure 63).



Figure 63. Blackspot Sea Bream stock subarea X (Azores) Portuguese Quota and Portuguese landings variation (Source: Batista, 2012; DGPA, 2001; INE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010,

### 2011)

The allocated quota was the same between 2003 and 2010 and had a little increase in 2011. For this stock the quota is only 20 tons less than the TAC. This means that this species is almost all fished by the Portuguese fleet in the Azores. Between 2000 and 2002 an increase in total landings was registered In 2003 and 2004 there was a decrease in the amount of blackspot seabream landed and in 2005 landings increased considerably until 2008, to values of 1089 tons. Since then a decrease in total landings has been recorded until 2010. The two variables are significantly different (T-test: p-value = 0.014; t = 3.2; n = 8).

Quota compliance was always positive (Figure 64).



Figure 64. Blackspot SeaBream (Stock in Subarea X (Azores) - Quota Compliance Rate between 2003 and 2010

Quota compliance increased from 2003 to 2008, with the fishing industry using the fishing opportunity better in recent years. The amount landed was close to the maximum available. A slight decrease was recorded in 2009 and 2010. In addition to the high value of this species in the Azores, the fishing industry had a positive performance, never overshooting the limit. However the lack of information about stock state and its vulnerability to overfishing due to its long life cycle, could put at risk the health of the stock.

# **5. GENERAL DISCUSSION**

For all stocks analysed, the TAC was almost always above the ICES scientific advice. The total landings were also often above the established TAC.

This is in fact a cumulative problem. Adding to this, the amounts of discards and unreported fish that are not registered and that should be part of official landings statistics are not known. So probably this problem is bigger than we think, with many implications for the ecosystem. Concerning predator-prey relationships, many problems can be highlighted, such as: shifts in food-web structure, effects on body-size distributions resulting in fauna dominated by small body-size individuals; effects on genetic selection, for example earlier age-at-maturity; reduction of habitat complexity, effects on non-target species as birds and cetaceans (Kaiser *et al.*, 2002). This general analysis will look at the functional groups of species: pelagic, demersal and deep waters species.

Regarding the pelagic resources exploited in Portuguese waters (horse mackerel, blue jack mackerel, mackerel, anchovy, blue whiting), the Portuguese quota was always respected. Official Portuguese landings never exceeded the maximum amount allocated to Portugal.

It is worth mentioning that mackerel and blue whiting belong to the pelagic group, but ICES considers them widely distributed species, putting them in a separate group (Widely Distributed and Migratory Stocks).

In 2005 the blue whiting was considered overexploited (MADRP-DGPA, 2007) and in fact the TAC suffered a reduction since it was established (2006) and total landings were reduced too.

Mackerel SSB has increased during the considered period but total landings did not follow this pattern.

The blue jack mackerel is a particular stock only exploited by the Azorean fleet, and the Quota that corresponds to the TAC is exploited entirely by the Azorean fleet. Although there is no information available about SSB, landings have increased since 2000 until recently (2010) and it is known that there is an

uncounted amount that is used as bait (ICES, 2011b). This misreported amount is known to be high but should be quantified and the implications for the stock understood.

In the case of sardines, included in the pelagic group, although there is no TAC, the total landings sometimes exceed the scientific advice. Thus, nothing can be said about the political decision making, but that the fisheries industry does not always respect the scientific advice, which can have negative consequences in this highly consumed resource.

Analysing the trends in SSB (when available) in pelagic resources in Portuguese waters (Blue whiting, Sardines and Horse Mackerel), it was found this had decreased in recent years. However, the total landings do not always follow the same tendency except for the blue whiting. Mackerel total landings fluctuated and SSB has increase along the considered. For the species without available SSB (Anchovy and Blue jack mackerel) the total landings decreased and increased respectively in the period last years.

It is known that the analysis of SSB is not sufficient to analyse the state of the fisheries. Other issues like recruitment and fishing mortality have their weight in these issues and are all interconnected.

Pelagic fishes are more difficult to manage, as their abundance varies depending on several factors: environmental factors habitat, morphology, biology, behaviour, ecology, population dynamics, vulnerability to fishing gears, interannual and interdecadal fluctuations (Borges *et al.*, 2003; Fréon *et al.*, 2005).

The pelagic species studied can be divided into two groups: the small pelagics and the medium sized pelagics. The first ones are in the first stages of the food web and the second ones are in an intermediate trophic level.

However, as a whole, the pelagic species' importance is vital because their variability influences the top predators (hake, anglerfish, etc.). If they are overexploited or have low recruitment, the other fisheries and the higher levels of the trophic web could be at risk.

TACs as a management measure are probably not the best way to maintain the sustainability of pelagic fisheries. Limiting the amount of fish to be caught does not solve the problem of poor selectivity of pelagic fishing gears like purse seine (Fréon, *et al.*, 2005). Neither do they avoid possible genetic alterations such

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as fast maturity in order to increase and have successful recruitment. This alteration can result in maturity before the minimum size limit allowable for catch. This collides with a size limit management measure that due to the same reason cannot be a good management measure alone.

Management measures in this group of fisheries should imply a short and long term management. The high variability along time (even in a short period like 1 year) does not allow short-term predictions (Fréon *et al.*, 2005), and even target reference points that allow a steady state assumption are not applicable in small pelagic fisheries due to high natural variation (Fréon *et al.*, 2005).

The fisheries are also connected, as it is the case of sardines and anchovy fisheries. Both are caught with purse seine nets and are prey of mackerel and horse mackerel. Thus, there is a high dependency on this relationship between these four species in the pelagic system and dynamic Portuguese waters.

Horse mackerel is caught by different fishing gears (bottom trawl, purse seine and artisanal (ICES, 2011e) which implies another problem. The bottom trawl although it mainly targets adults, destroys habitat and increases the catch of non-target species. On the other hand, the purse seine mainly targets juveniles, which can put at risk the future of the stock.

There are two more pelagic species, but classified as widely distributed, that are caught mainly with pelagic trawl (ICES, 2011b). In the case of blue whiting, the European Commission sets a TAC that is always above the scientific advice (see annex), and for mackerel the TAC was set above the ICES Advice in 2003 and from 2005 to 2011, the last year of available data (see annex.). In both species the fishery industry did not always respect the maximum limit. Analysing Portugal's specific situation, the allocated quota was always fulfilled satisfactorily concerning these two species.

#### **DEMERSAL**

For the demersal resources caught in Portuguese waters (hake, nephrops, anglerfish, megrims and whiting) and for the time period that data was available, the TACs were set well above the scientific advice except for whiting, for which there is no scientific advice due to lack of sufficient information. The European

Commission decided to increase the fishing possibility, probably due to external pressures as these species have a high commercial value.

The fishing gears used to catch these species are the same. Hake is caught by multi gear fleet but mainly by a trawl fleet in mixed fisheries together with megrims, anglerfish, blue whiting, horse mackerel, mackerel, and crustaceans such as Nephrops (ICES, 2011b).

The hake stock within Portuguese waters was classified in 2005 as overexploited and with low reproductive capacity (MADRP-DGPA, 2007). As can be seen in Annex II, table 8 the TAC always exceeded the scientific advice and hake landings almost always exceeded the established TAC. This deserves particular attention as this species is important and valuable in the fishery market and, as a top predator, it will influence the dynamics and abundance of others species like megrims, anglerfish, blue whiting, horse mackerel, mackerel and sardines, because hake eat them (ICES, 2011b).

It is not only hake that is in a particular threatened situation. Nephrops, anglerfish and megrims were classified as overexploited (OCEANA, 2011; M.C.S., 2012) and with low reproductive capacity or close to collapse, as was the case of Nephrops (MADRP-DGPA, 2007).

ICES advice was zero catch in 2003 for hake and in 2004 for anglerfish. Megrim suffered a slight decrease in the advice in 2004. However, the EC always set a TAC even when the advice was zero and, in the case of anglerfish and hake, the amount landed was higher than the maximum limit, exacerbating the overexploitation state. Nephrops, that were close to collapse in 2005 (MADRP-DGPA, 2007), benefited from scientific advice and consequently a TAC that, despite being set above the ICES advice, regulates the total landings, decreasing the amount over time (See annex). Other interpretation could be that of reduced availability of the species in nature. However, with the fishing gear and technology used nowadays, it is thought that if there was no regulation, the amount landed would be the same until collapse.

The recovery plan for hake and Nephrops agreed on by the EU in 2005 aimed to reduce fishing mortality and recover the SSB by 2016. The main elements in the plan are a 10% reduction in F and 15% constraint on TAC between these years (ICES, 2011b). The plan has been enforced since January 2006 and will

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benefit other species like megrims and anglerfish, as these are caught together with hake and Nephrops. However the plan has not yet been evaluated.

Looking at annex II, table 8 we can see that the TAC has not been reduced since 2006. It has actually increased with the exception of that particular year. The reduction of F was also not executed. Only in 2010, did F decrease more than was required. Since hake and Nephrops are caught in a multispecies fisheries, the management measures should not focus on catches (Jardim *et al.*, 2010) as they force discarding and unreporting (Jardim *et al.*, 2010). On the other hand, high overproduction as a consequence of high recruitment is a problem too, because once again if fish are caught, they cannot be landed.

The importance of the whiting market is secondary. Even though the TAC had been set and reduced along the considered period, the total landings are well above the established limit.

Regarding the compliance of the Portuguese fishery industry concerning the demersal fisheries, the anglerfish and Nephrops quotas in the considered period was never exceeded, which is very satisfactory. For megrims and hake, the scenario is not the same. In some years the quota was exceeded, reaching high percentages above the allowable limit in megrims. However, the megrim quota is very low, so in a context of multispecies fisheries it is very difficult to manage this situation and respect the limit. Regarding the Portuguese catch of whiting, the allocated limit was always respected and Portuguese landings were very low, which might means that this species is mainly fished by other international fleets.

#### DEEP WATER SPECIES

In this group, two species were studied: black scabbard fish and Blackspot seabream. Both are important and valuable target species in deep water fisheries. They are fished with long lines but red sea bream can be caught with hand lines too.

ICES advised the status quo for scabbard fish fisheries before 2009. Thus nothing can be said about the EC decision, as there is no concrete scientific advice reflecting a limit amount. Only in 2009 was advice given in terms of a maximum limit and the EC did not follow it.

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In the case of red sea bream before 2009, the scientific advice was given for many areas together and TAC was set separately for two different Portuguese sub-areas (IX and X). So it would be a mistake to cast any judgment. However, since 2009 ICES gave specific advice for Portuguese areas separately and the EC set a TAC slightly above.

Before 2003, the EU did not provide any TAC for scabbard fish besides scientific advice. For red sea bream the same happened in sub-area IXa and X. However, the fishery industry respects the maximum limit for both species. Within the considered period, more scabbard fish or red sea bream than the maximum allowed were never landed The Portuguese fishing industry never exceeded the allocated quota regarding both these species. The main problem of these species, and many others also classified as deep water species, is that there is no reliable data that can be used to predict sustainable fishery activity (ICES, 2011c).

Despite these two species being deep water species, they are considered to be medium lived species. However, the exploitation in not controlled and consequently there is less opportunity to reproduce and maintain the stock within safe biological limits. Particular attention should be given to red sea bream because of its low productivity and their change of sex from male to female at ages of 4 to 6 (ICES, 2011c).

In order to understand which group of species differs the most between the European Commission decision and the ICES scientific advice, please see Figure 65.



Figure 65. TAC – ICES Advice rate(%) (red points: The values of TAC-ICES Advice in percentage of each year for the period between 2000 and 2010 for each species referred; blue line: Represent the confidence interval within which the sample mean is with 95%confidence)

We analysed the species for which there was an ICES Advice and a TAC available. Deep waters species were not included because there is only 3 years of ICES advice within the considered period.

In Figure 65 we can see a high variation of the difference (%) in Nephrops. For this species, during the considered period and for the years we have data, the EC took several contradictory decisions. On average for this species the EC set a TAC 424% above the scientific advice.

To better understand what is going on with other species we the same figure is reproduced but with a different Y-axis scale (Figure 66).





line: Represent the confidence interval within which the sample mean is with 95% confidence)

Despite having lost some information for Nephrops in Figure 66, it is easy to see that every TAC (pelagic and demersal) was always set above scientific advice, as mentioned before.

In the pelagic species here represented (horse mackerel, anchovy, mackerel and blue whiting) the mean % of the differences was lower than in demersal species. However, we should be cautious in the analysis because looking at the demersal species red points we can see that, in general, they are below their mean. Only in a few years did the EC increase the maximum limit so much that it actually increased the mean of the % of the difference.

Analysing the variation of the difference between the amount of fish landed (total landings) with what was established by the European Commission ITAC) for each species studied (except for sardines as they do not have a TAC) we ended up with some interesting findings (Figure 67).

The main idea with this figure is to show the differences between the behaviour of the fishing industry with regard to the pelagic, demersal and deep water species.





The variation between the two variables in the plot is represented by the blue vertical line. Displayed in red are the data values used in this analysis (total landings - TAC for each year in each species).

The first five species are pelagic and it is curious to see that the variation plot is below zero which means that the amount landed of these species was not higher than the TAC. For each of these pelagic species the mean varies due to the different dispersion of red points (Total landings - TAC in each year of the considered period). It is more perceptible in Figure 68 below.





line: Represent the confidence interval within which the sample mean is with 95% confidence)

There is a different scenario for demersal species, and hake deserves to be highlighted. Hake landings were almost always above the allowable maximum limit (as was comment above).Megrim and anglerfish show a high variation in the differences, with mean below zero, meaning that on average landings of these two species were below the limit. For deep water species there is almost no variation, with values below zero, meaning that the amount landed is below the maximum limit.

Demersal species show a higher variation of % of difference of their landings against the TAC. This is probably because the fishing gears used to catch these species are more diverse, with a higher probability of by-catch, increasing the catch of non-target species. Pelagic species variation is negative, which means that the TAC was never exceeded (mean is negative for all pelagic represented) in this group within the considered period (see Figure 68 that represents a zoom of Figure 67).

In the case of deep water species, the mean of the % difference was always negative and the plot is very narrow due to low dispersion of the red points. A more difficult access to fish these species is one of the reasons for high differences not appearing.

Thus to have an overall perspective of how Portuguese fisheries evolved within the interval time considered, we summed up all quotas and all landings for all species (except sardines as this species has no quota). Looking at Figure 69 it is quite clear that although allocated quotas to Portugal oscillate, the total amount of fish landed was more or less constant.



Figure 69. Portuguese Quotas and Portuguese landings (all species subjected to TAC) (Source: Batista,

2012; DGPA, 2001; INE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011)

Portuguese quotas peaked in 2005. Since then the sum of all quotas decreased until 2011. Regarding Portuguese landings records, a slight decrease was registered since 2007. However the low variation over time should be highlighted. The first impression is that the Portuguese fleet probably does not have more fishing capacity despite having fishing opportunity. The Portuguese fleet is old (mean age of fishing vessels = 26.2 years ) and 91% of the fleet in less than 12 meters in length (INE, 2011; MADRP-DGPA, 2007), limiting the engine power and the range of the fishing vessels.

But this is only one of the possible explanations for these studied species that are subjected to TAC. As referred in the last annual report of INE, there was a slight increase of fish landed in Portuguese fish harbors in 2010 compared to 2009 and a decrease in 2009 compared to 2008 (INE, 2010, 2011).

Sardine is the "Queen species" of Portuguese fisheries as it is the species with the highest tonnage landed in Portugal. If we include Sardines in the analysis we confirm the information of the INE reports (Figure 70).



**Figure 70.** Portuguese Quota and Portuguese landings (all species subjected to TAC + Sardines) (Source: Batista, 2012; DGPA, 2001; INE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011)

As it is not subjected to TAC and Quota, the variation observed in the first figure (Figure 69) does not represent what is going on in Portuguese fisheries as a whole but only for species subjected to a TAC/allocated quota with the additional limitation that some species were rejected and not considered in this study for the reasons explained in Methodology chapter.

In fact Portuguese fisheries are high dependent on sardine fisheries. Even knowing that there are many more species landed in Portuguese harbors, sardines represent around 38% in weight of all fish landed in Portugal (within the considered period) (Figure 70).

The methodology used in this study has some weaknesses and limitations. As has been referred to along this thesis, the real amount caught of some species is not reflected by official total landings that ICES provided in the advice sheets. Another problem is that official total landings and landings provided by INE do not show the amount of unreported fish.

Different gears used in surveys even in the same species, bring an inaccurate stock assessment which increases the possibility of wrong analysis and interpretations and, even more problematic, wrong political decisions. Also, I had no access to data records of Portuguese fleet landings in international harbors. This may be highly significant for some species such as *N. norvegicus*.

There are some changes in the criteria concerning advice and quotas in some species. For example for one species sometimes the stock advice was given for an area for one year and in the next year other areas were included in the ICES advice. All these factors may have some influence in the analysis done in this project but it was not possible to include all them due to lack of information and time.

# 6. CONCLUSIONS AND FINAL REMARKS

In this project, for all the species analysed, the main deviation found was the non-implementation of scientific advice given by the ICES. The fishing industry had a different behaviour in some cases. In general, the set TAC was exceeded much more in demersal and deep water species than in pelagic species. However, the problem starts when the scientific advice is not respected, and political and economic reasons are behind this.

In the case of deep waters species, the lack of respect for the recommendations and maximum limit imposed is considered particularly problematic, as the life cycle of these species is longer than that of other species, their rates of reproduction are low and the lack of information about the stocks of these species increases the risk of overexploitation (Batista *et al.* 2009). In the case of demersal species, some species like hake and *Nephrops* really need to be well managed immediately. The recovery plan in force is not being executed.

Over the years ICES changed the way recommendations are made, as the implementation by management authorities was a failure. Nowadays, the effort recommendations highlight the reduction rather than the allowable catch. Nevertheless there is clear evidence that management measures have to be adapted due to bad results of the actual measures. However, effective and serious workable measures are still missing, especially in multispecies fisheries, as in the case of the Portuguese fisheries.

The multispecies fisheries in Portugal continue to be an unsolved reality. TAC and consequent quotas are set independently with no consideration of species relationships and productivity, and this definitely has to be revised and studied as stated already for general purpose by Pauly *et al.*, 2005.

The science has to be improved in order to develop other models that take into account multispecies assessments (Rocha *et al.*, 2008). Of course, management measures will be more costly and hard to implement (Sutinen, 1999), however, there is an evident necessity to invest in it to preserve aquatic resources and increase economic performance without compromising the resources future. The ecosystem approach is highlighted here because the multispecies fisheries reflect how the ecosystems are an

integrated and dynamic relation between several factors: habitat, species, environmental factors, anthropogenic impacts, etc.

The problem of fisheries management is not just about species, fleet or *métier* issues. Often the differences in productivity can be caused by other factors such as different skills, capital, investment of governments and private enterprises (Andersen et al., 2009). The quotas exchange minimizes the problem allowing a better adaptation of member countries species interests and probably optimizes the available exploitable resources.

An adjustment of the environment, social and economic parts in the resources management has to be made. The political side has to be included to minimize conflicts and for safety reasons (Wattage *et al.*,2005). However, political issues are most of the times based in economic and social interests, which refute the environment's importance.

As Wilson said in his book of "The paradoxes of transparency" (2009), the science is important and does matter but is not decisive because fisheries management is fundamentally a political activity rather than a technical one.

But there is some hope. It was proposed a new Common Fisheries Policy reform in 2011. It will be analyzed along this current year and in 2013 will be inforce (European Commission, 2012).

There are several interesting proposals but i would like to highlight some of them:

- Reduce overfishing favoring sustainable management, because in fact more than 88% of the stocks exploited in Community waters exceed the stocks's renewal capacity;
- Bring stock to sustainable level maximizing the long term yield;
- Multiannual plans based on ecosystem approach and MSY bringing the stock to sustainable level, maximizing the long term yield. In this point it is included the multispecies fisheries as they more difficult to be managed than a single stock. The most vulnerable stock will determines the limits of exploitation for all other fish taken in the same fishery. It is the only possibility to ensure that MSY is reached for all stocks in a multispecies fisheries. ICES is working on the MSY rates of each stock
alone in order to establish the corresponding fishing opportunities in a mixed fisheries with more accurate data;

- Simplify rules and decentralize management. It will be included a system of transferable fishing concessions (TFCs). Maybe this will be an effective tool for vessel owners to plan their fishing activity along market developments, allowing land all catches and plan their investments;
- Ban on discards;
- Beneficiate small scale fisheries as fishing communities development depend directly on fisheries;

In conclusion, the proposed objectives for this thesis were all fulfilled.

- 1. The recent history of TAC and Quotas within Portuguese fisheries was evaluated;
- 2. Trends for each species alone and by groups were identified;
- 3. The match/mismatch between Scientific Advice and Political Decision was analyzed;
- 4. The match/mistmatch between the Fishing industry and European commission decisions was analyzed;
- 5. Some reasons responsible for the malfunctioning of the TAC system in Portuguese fisheries were identified.

As a final objective I would like to present some operational suggestions and recommendations to improve fisheries management:

- More fiscalization in the fishery industry and effective enforcement of fiscalization when quotas have been exhausted ;
- More investment in knowledge of species and their ecosystem;
- Urgent application of a multispecies approach;
- Develop multispecies models based on environmental and food web models;
- Adoption of a fishing pattern where by-catch of recruits and undersized fish is avoided, e.g. banning some beam-trawling in coastal areas;

- Implementation of effective control measures and better fishing practices to avoid undersized catch by fishermen and misidentification by authorities (Ribeiro, Ramos, & Santos, 1999); implementation of penalties when undersized catch exceeds an established amount;
- Monitor and quantify the bycatch;
- Develop training activities for fishing harbour authorities in order to avoid misidentification and under identification of species (Feijó *et al.*,2008; Rocha *et al.*, 2008);
- More supervision when a species quota has been reached. It is common that fishermen use another name to a species to avoid penalties due to overquota (Santos pers. Comment.);
- More and effective supervision to avoid Implementation of more measures of direct control of fishing effort (days at sea, fishing hour, etc);
- Allow the discarding of potentially marketable fish (already dead even when quotas for one species in an area have been exhausted before other species caught together in a mixed fishery (Shepherd, 2003);
- Artisanal and sport fisheries are always neglected in this context, however they represent in some countries and/or in some places an important source of income and contribute to the alterations on habitats, environment, species dynamic, etc. The species biology, fisheries, and environment knowledge should be increased and promoted. Workshops and positive incentives is the best way to achieve the fulfilment.
- A real cooperation, especially with Spain, regarding the fishing of some species. Spain has a powerful fleet and if there is an adjustment of interests between of two countries, probably the environment, the economic and the social income will be better for both.
- European and international organizations should definitely implement their commitments to the sustainable exploitation of fishery resources and not contradict themselves when they have to implement management measures.

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ANNEXES

## **ANNEX I: SPECIES BIOLOGY**

## HORSE MACKEREL

Trachurus trachurus, known as Atlantic horse mackerel, belongs to Peciformes order and Carangidea family (Froese & Pauly, 2012) and trachurid sub-family (S. Garrido & Murta, 2011) and is the second most important species in Portuguese fisheries (after sardines)(Costa, 2004).

It is a pelagic –neritic fish that feeds on fish, crustaceans, and it diet varies seasonally (Garrido & Murta, 2011). Euphasiids and copepods are the most important preys for horse mackerel (Cabral & Murta, 2002; Garrido & Murta, 2011; Garrido et al.,2008) and cephalopods (Froese & Pauly, 2012). The feeding intensity is higher in spring, summer and autumn (when the euphasiids availability is higher (Garrido *et al*, 2008; Garrido & Murta, 2011) especially during the peak of spawning (Cabral, and Murta, 2002; Garrido et al., 2008), Latitude is another factor that influences feeding intensity that is higher in Algarve and northwest coast of Portugal (Garrido et al, 2008; Garrido & Murta, 2011).

Its mainly distribution is over the continental shelf of the Northeast Atlantic (from Norway to Senegal) and in the Mediterranean and Black Seas (Garrido, et al, 2008; Garrido & Murta, 2011; Murta *et al.*, 2008)

As morphologic characteristics it has an elongated, fairly compressed body, a large head and the posterior end of upper jaw reaching the anterior margin of eye; Adipose eyelid well developed and a distinct notch on posterior margin of opercle. Pelvic fin moderate in size, originating below end of pectoral fin base. There is no color distinctive markings except for small, black opercular spot and upper part of body and top of head dusky to nearly black or grey to bluish green (FAO, 2012b)

Horse mackerel is a long lived species, with a common length of between 15 and 30cm, and can reach 10 cm in length in 6 months. As an adult it has a great migratory capacity (Abaunza et al., 2003; Abaunza et al., 2008). The spawning period is up to 8 months but varies accordingly to the species 'distribution (Garrido *et al*, 2008).

Trachurus trachurus lives near the bottom and mid-water during the day, whereas during the night they form a layer just off the seabed (FAO, 2012). Although horse mackerel is a pelagic species its diet it is typically of a benthic species, feeding on organisms caught close to the bottom (Murta *et al.*, 2008)

Its larval phase may last a month, as inferred from the interval of time between the spawning and the abundance peaks of post larvae (Abaunza, *et al.,* 2008).

In the west and north coast of the Iberian Peninsula there is one horse mackerel stock (Abaunza *et al.,* 2003, Abaunza *et al.,* 2008; Garrido et al, 2008), known as the southern stock in the ICES definition (ICES,

2011f). The stocks separations are based on circumstantial evidences such as egg distributions of the fishery (Murta, 2000).

However, results of the HOMSIR project suggest that the horse mackerel of the south of the Bay of Biscay have common characteristics with the horse mackerel of further north in the Atlantic (Abaunza *et al.*, 2008)

However, the ICES advice is only for the southern horse mackerel (ICES, 2011b). Horse mackerel is caught in mixed fisheries (ICES, 2011b), by bottom trawlers. They are also caught by purse seine and artisanal fleets (Garrido *et al*, 2008). It depends on the others species availability *and namely other species of horse mackerel, T. picturatus.* Traditionally the exploitation of horse mackerel is on juvenile ages (ICES, 2011f)

## **BLUE JACK MACKEREL**

Blue jack mackerel (*Trachurus piscatorius*) is another element of the horse mackerel family and is the only *Trachurus* species found around the Azores.

*Trachurus piscatorius* belongs to the Carangidae family and is a pelagic species that lives in deep waters, around 370 meters deep (ICES, 2011b; Vasconcelos *et al.*, 2006). It is confined to neritic zones within island shelves, banks, seamounts and open waters around islands. It is a schooling species that migrates between the coast of the Sahara and the offshore seamounts (Vasconcelos *et al.*, 2006; Froese & Pauly, 2012; ICES, 2011b).

In the Azores this species is considered a single biological stock (ICES, 2011b).

The Blue jack mackerel spawning period is between January and February (ICES, 2011b). This species feeds mainly on crustaceans (Froese & Pauly, 2012).

The Blue jack mackerel is targeted by artisanal fleets using nets (purse-seine nets) during the night. The fishery takes place near the coast (ICES, 2011b) Vasconcelos *et al*, 2006) Larger specimens are caught in multispecies fishery for deep-water species by several different gears (hooks and lines) (ICES, 2011b).

There is little information about this species but ICES advises precautionary measures, i.e., catches should not be allowed to increase in 2012 (ICES, 2011b).

Official landings may not represent the true catches because discards and fish used as bait are not accounted for. It is known that the catch is higher than indicated by landings per unit effort. (ICES, 2011b).

## **SARDINES**

Sardina pilchardus it is a small clupeoid (belongs to Clupeiformes order, Actinopterygii family (Froese & Pauly, 2012) and it is distributed in the Northeast Atlantic from Celtic Sea and North Sea to Mauritania and Senegal and also present across the western and northern Mediterranean Sea (Rocha *et al.*, 2011; Silva *et al.*, 2009). Biologists think that these limits are possibly related to the average water temperature, since the sardines need temperatures between 10 and 20 °C (Rocha *et al.*, 2011).

Sardines (*Sardina pilchardus*) it is an omnivorous predator able to feed on phytoplankton and zooplankton and is prey for other fishes and marine mammals species (ICES, 2011e) It is a pelagic, and coastal species, usually at 25 to 55 or even 100 m by day, and rises up to 10 to 35 m at night (FAO, 2012b).

As morphological features sardines have a sub cylindrical body, belly rather rounded (but body more compressed in juveniles), the hind margin of gill opening smoothly rounded, pelvic fin insertion well behind dorsal fin origin; last two anal fin rays enlarged and a series of dark spots along upper flanks, sometimes with a second or even third series below.(FAO, 2012)

Sardines spawning in the northwestern Iberian peninsula is from January to June, but with a higher abundance of eggs and larvae in March–April (Guisande *et al.*, 2004) at 20 to 25 m, near the shore or as much as 100 km out to sea (FAO, 2012). Sardines have been found to ingest their own eggs, which can act as a density dependent control mechanism. (Silva *et al.*, 2006).

Its recruitment success in western coastal waters of the Iberian peninsula is affected by wind speed and direction and oceanographic conditions, during the spawning period (Guisande *et al.*, 2001; Rocha *et al.*, 2011) Recruitment hotspots coincide with areas with significant river flow and physical processes that influence the distribution of eggs and larvae and consequently the recruitment success (Silva *et al.*, 2009). Atlanto-Iberian sardine stock maturation is around 12 to 15 cm.

Sardines, one of the most important species of pelagic fish in northwest of Iberian peninsula (Borges *et al.*, 2003; Guisande *et al.*, 2001)), are considered to belong to a single stock within Atlantic European waters, for assessment purposes. This stock is delimited by the French/Spanish border in the north and by the Strait of Gibraltar in the south (ICES Division VIIc and IXa) based on biological characteristics (Silva *et al.*, 2009).

Its exploitation is done mainly by purse-seine fleets (ICES, 2011e; Rocha *et al.*, 2011; Silva *et al.*, 2006; Silva et al., 2009). which is regulated directly by Spain and Portugal (Rocha *et al*, 2011). The highest catches are in summer and autumn. For Portuguese fisheries sardine is the main target species but other species such as mackerel and anchovy are also landed.(ICES, 2011e) The purse seiners have low bycatch of non-target species and low impact on other marine species such as cetaceans and seabirds. However, the effect of the sardine fishery on the pelagic ecosystem of the Atlantic Iberian waters has not been

evaluated, but some alterations of prey-predator relationships can be expected when there is some modification in sardine abundance, size structure and behavior (ICES, 2011b).

*Sardina pilchardus* is not subjected to any international TAC. The stock is managed by Portugal and Spain directly through minimum landing size, maximum daily catch, days fishing limitations and closed areas (ICES, 2011b; Rocha *et al*, 2011). Adding to this ICES recommends implement precautionary management (Rocha. *et al*, 2011).

## **ANCHOVY**

Anchovy (Engraulis encrasicolus) is a Clupeoid and short-lived species (Froese & Pauly, 2012).

This species is concentrated in two main areas: Bay of Biscay and Gulf of Cadiz, the main nucleus of Atlanto-European Anchovy, however there is a residual coastal population along the Iberian coast. There is a very well established independence between population in division IXa south and the north part of division IXa (ICES, 2008b). As a short lives species, with high natural mortality, consequently highly dependent on the recruitment, it is very sensitive to environmental physical conditions/influences (hydrodynamic, temperature, food availability) that affects survival in their early life stages and possible failures in the recruitment (Ruiz *et al.*, 2009)

Spawning takes place between April and November with a peak in the summer and the mature period is reached at age 1 and age-groups 1 and 2 constitute the bulk of the catches and the population. (Barange *et al.*, 2008; Froese & Pauly, 2012) The eggs float in the upper 50meters and hatch after 24 to 65 hours (FAO, 2012b)

After the spawning period anchovy migrates to north in summer and autumn and back in winter (FAO, 2012b; Froese & Pauly, 2012). Its diet base is plankton especially copepods, cirrepede and mollusk larvae, and fish eggs and larvae (FAO, 2012b; Froese & Pauly, 2012).

Anchovy is a prey species for other pelagic and demersal species, and for cetaceans and birds. Thus. it plays an important role in the food web of some stocks.

This species can reach 20 cm length.

In division IXa South, where this species can find the favorable conditions for recruitment, the fisheries for anchovy take place by purse-seiners and in the northern part fleets usually target sardines, and only take anchovy when it is abundant (ICES, 2011b, 2011e)

The advice for anchovy takes into account mainly the Divison IXa South where the majority of the catches are taken.

Some regulatory management measures are in force for this species. In Portugal and Spain there are two and three months of closure respectively. Adding to this there is a Marine Protected Area close to the estuary of the Guadalquivir river, a zone that plays an important role as a nursery area for fish (ICES, 2008b).

## MACKEREL

Scomber scombrus, known as Mackerel or Atlantic Mackerel is a pelagic species from the Scrombidae family (Froese & Pauly, 2012).

Mackerel abundance is high in cold and temperate shelf areas, and during the winter time it can be found in deeper waters. In spring time they move to inshore areas (Froese & Pauly, 2012).

Mackerel diet is composed of zooplankton and small fish, feeding mainly during the day.

*Scomber scombrus* is assessed as a single stock, However it is composed of three spawning components North Sea, southern and western component (Froese & Pauly, 2012; ICES, 2011c) The first one is completely distinct to the second and third respectively (ICES, 2011c) After spawning, feeding activity is very high (Froese & Pauly, 2012) with the mackerel undergoing a summer feeding migration (ICES, 2011c).

The catches have been too high since 2008 due to absence of comprehensive international agreements on the stock exploration, as illustrated by the ongoing mackerel disagreement concerning the new Icelandic fishery (ICES, 2011c)

This species is caught mainly for human consumption. The Portuguese component corresponds to southern component (ICES Divisions VIIIc and IXa) that is about 19% of all the area where the mackerel is present (ICES, 2011c).

### **BLUE WHITING**

Blue whiting (*Micromesistius poutassou*) is a semi-pelagic species (Hvingel & Campbell, 2011).

It is migratory and widely distributed. This gadoid species has high commercial value (Heino & Godø, 2002; Pálsson, 2005). In the eastern part of the north Atlantic there are high concentrations along the continental shelf edge between 100 and 600m (ICES, 2011c), although they may also visit surface waters during its diurnal vertical migrations (Heino & Godø, 2002).

The spawning area is along the shelf edge on banks west of the British Isles (ICES, 2011c; Pedersen *et al.*, 2011) However north and south parts of spawning area are partially separated due to the drift patterns of the larvae (Heino & Godø, 2002). Its spawning age is about 2-4 and the size of 19-24cm (Heino & Godø, 2002).

The nursery area is supposed to be in the Norwegian Sea (ICES, 2011c) Perdersen, et al., 2011)

The main oceanic distribution is considered to represent a single stock and is managed

accordingly (Heino & Godø, 2002). However, some ongoing studies suggest that there is likely to be more than one stock in the Northeast Atlantic (Dolgov, Johannesen, Heino, & Olsen, 2010; ICES, 2011c).

Concerning blue whiting feeding habits, zooplankton (crustaceans particularly large individuals (Heino & Godø, 2002), as euphasiids and copepods (Cabral & Murta,., 2002) and small fish are its preference. Blue Whiting feeds in the same areas as herring and mackerel. It should be highlighted that blue whiting plays an important role in the pelagic ecosystems as both predator and prey.(ICES, 2011c).

Blue whiting are an important source of food of many marine mammals across the whole of their geographical range, such as common dolphins off Portugal (Partnership, 2011).

In the last three decades blue whiting size stock has fluctuating substantially (Pálsson, 2005).

In the Portuguese division IXa (Azores) and near the seamounts north of the archipelago, blue whiting occur in reasonable numbers (Heino & Godø, 2002) and are usually is taken as a byctach in a mixed trawl fisheries. (ICES, 2011)

This species is under a management plan that was agreed by Norway, the EU, the Faroe Islands, and endorsed by NEAFC in November 2008. The management plan is consistent with the precautionary approach that ensures the harvest within safe biological limits and *provide for fisheries consistent with maximum sustainable yield, in accordance with advice from ICES.* (ICES, 2011c). Concerning this long term management plan, "TAC" means the sum of the coastal State TAC and the NEAFC allowable catches(ICES, 2011c).

### Hake

European hake (Merluccius merluccius) is widely distributed species over the northeast

Atlantic shelf, from Norway to Mauritania (Abaunza *et al.*, 2001; Castillo *et al.*,2005; ICES, 2008b). There is a high density area of hake from the British Islands to the south of Spain (ICES, 2008b)

It is a demersal species of medium-large size (140 cm) and weight (15kg). It lives mostly between 70 and 370m deep, although can be found in shallower and deeper waters. It is known to undertake vertical migration. Hake are in the bottom during the day and in a shallower position during the night (ICES, 2008b;Bartolino Colloca *et al.*, 2008; Froese & Pauly, 2012).

*Merluccius merluccius* spawning period is from February (peak period (ICES, 2011b) until July along the shelf edge, with the main spawning areas from the Bay of Biscay to the south and west of Ireland. Although the reproduction is not well known, males reach the first maturity at 3,4 years old and 39 cm, lower than females that are mature at 4.2 years old and 47cm (ICES,2011b, 2011g).

It is a top predator (ICES, 2011b) Cannibalism on juveniles by adults is known in this species (Cabral & Murta, 2002; ICES, 2008b). Adult hake feed on blue whiting and other gadoids, sardines, anchovy and other small pelagic fish (ICES, 2008c, 2011g); so it has implications on the survival of these species. Hake feeds also on crustaceans (Cabral & Murta, 2002).

It is assumed by ICES since 70s that there are two different stock units of hake in European waters. However there is no biological basis for this current definition of northern and southern hake. (Abaunza *et al.*, 2001; Castillo *et al.*, 2005; ICES, 2011b; Piñeiro & Saínza, 2003).

The Portuguese fleets catch hake using multi-gear fleet, trawl and artisanal in mixed fisheries together with megrim, anglerfish, blue whiting, horse mackerel, and crustaceans (ICES, 2008c, 2011b, 2011g).

Hake economic value in Europe is high (Abaunza *et al.*, 2001; Jardim *et al.*, 2009; Piñeiro & Saínza, 2003) compared with other markets, so this species is characterized by low catches and high market prices (Castilho *et al.*, 2005)

Hake in under a recovery plan approved 2005 and is in force since 2006. Recovery of the stock to a spawning stock biomass above 35000 tons by 2016 and reduction of fishing mortality to 0,27 (10% each year until reaching this value) are the main objectives of this recovery plan (ICES, 2008b; Jardim *et al.*, 2009). One of the big failures concerning this plan is that ICES did not evaluate the whole plan. Only some elements of this recovery plan have been evaluated in 2010 (ICES, 2011b).

#### MEGRIM

Megrims are flatfishes, part of Scophthalmidae family (Froese & Pauly, 2012). There are two of these demersal species found around the coast of the Iberian Peninsula (Santos, 1995) the four-spotted megrim *Lepidorhombus boscii* and the megrim *Lepidorhombus* whiffiagonis) (Morte, Redón, & Sanz-Brau, 1999).

Concerning their distribution, although both stocks are distributed in the same divisions (VIIIc and IXa), Megrim (*L. whiffiagonis*) has the highest abundance in division VIIIc and Four-spot megrim (*L. boscii*) is

more abundant in Portuguese waters (Santos, 1995). The two species have different bathymetric preferences: *L. boscii* has a preferential depth range around 100 to 450 m with muddy or sandy-muddy bottom (Landa & Piñeiro, 2000; Vassilopoulou, 2000) and *L. whiffiagonis* around 50 to 300 m (ICES, 2011g).

Megrims spawn between January and April with a peak period in February/March (ICES, 2011b); Santos, 1995). Its diet is composed mainly of crustaceans (ICES, 2011g).

Megrim are caught in mixed bottom trawl fisheries targeting demersal fish: four spot megrim, southern hake, anglerfish and Nephrops (ICES, 2011b; Landa & Piñero, 2000; (Landa *et al.*, 2002) The minimum landing size is 20 cm (ICES, 2008c). Megrims are being affected by the Recovery Plan in force for Southern hake and Iberian Nephrops. This will reduce fishing pressure on megrims (ICES, 2011b, 2011g, 2011e).

Depending on the area and depth there are different proportions on catches of the two different species. (Landa *et al.*, 2002).

One of the biggest problems concerning both species (*L. whiffiagonis* and *L. boscii*) is that they are not landed separated, so ICES gives the advice for both species together (ICES, 2011b), and EC follows the same principle. As for anglerfish, it is impossible to manage adequately each species. Both species have different status, i.e., *L. whiffiagonis* is the stock in poor conditions in terms of SSB but currently not overexploited in relation to FMSY, while for *L. boscii* the SSB is slightly increasing but currently overexploited in relation to the Fmsy reference point (ICES, 2011a).

Another problem is the discards that sometimes are as high as 65% of the individuals caught (ICES, 2011g).

## **ANGLERFISH**

The Anglerfish species are included in one out of five suborders remaining to the order Lophiiformes (Pisces: Toeleostei), that includes 65 genera and 18 families (Fariña et al., 2008)

Black bellied anglerfish (*Lophius budegassa*) and white anglerfish (*Lophius piscatorius*) are very important species in Europe fisheries (Duarte *et al.*, 2001; Landa *et al.*, 2008) and are assessed annually by the ICES Working Group on the Assessment of Southern Shelf Demersal Stocks. They are present in Portuguese waters, i.e. in division IXa and they are very similar, butcan be distinguished by the color of the peritoneum (*L. budegassa*, black and *L. piscatorius*, white) or by the number of rays in the second dorsal fin (*L. budegassa*, 9-10 and *L. piscatorius*, 11-12) (Duarte *et al.*, 2011).

They are long-lived species, late to mature and live in sand and muddy bottoms (Froese & Pauly, 2012). Anglerfish name comes because they possess a fishing lure at the tip of the specially modified dorsal ray,

with which they can entice prey (MSC, 2012). They typically have a compressed morphology of the head and body, a wide and cavernous mouth, thin skin and absence of scales and swim bladder (Fariña *et al.*, 2008). Their gill openings extend below and behind pectoral fin base and the color in preservative highly variable, uniform or mottled light to very dark brown above, white below (FAO, 2012b).

Their life is initially pelagic, staying in the water column as eggs and larvae and shifting to a benthic existence as juveniles from shallow inshore waters to 500m (FAO, 2012). The fertilization is external and the spawning period is from February until July (FAO, 2012)

Anglerfish are opportunistic and non selective feeders. They usually feed on fishes.(Fariña *et al.*, 2008, FAO, 2012;(Froese & Pauly, 2012)-;

Lophius budegassa and Lophius piscatorius and others anglerfish have been bycatch in mixed fisheries but their economic value has increased together with the overexploitation (Fariña *et al.*, 2008). These two species are caught together by bottom trawlers and gillnet fisheries being part of mixed fisheries (anglerfish is caught usually with hake, Nephrops and megrims), while it is also a by-catch of the trawl fishery targeting hake or crustaceans (ICES, 2008c, 2011g) Landa *et al.*, 2008). Thus, they are subjected by a combined TAC (ICES Advice, 2011). There is a minimum landing weight of 500g fixed by the Council Regulation (EC) No.2406/96 (ICES, 2011b).

The current stock of European anglerfish is unknown due to the lack of information concerning their biology, migratory patterns and movements (Landa *et al.*, 2008). This information is important in order to reduce uncertainties concerning the stock for a better fisheries assessment and management (Landa *et al.*, 2008)

Adding to this, it is very difficult to manage the two species separately because they are recorded together in the landings statistics and that are subjected to a common TAC. Consequently the two stocks have different status. *L. piscatorius* is in poor condition and constitutes about 70% of the total anglerfish landings (ICES, 2011g). This implies that the advice depends on the stock in poorer condition.

#### NEPHROPS - NEPHROPS NORVEGICUS

Norway lobster (*Nephrops norvegicus*) is a marine decapods crustacean (Campbell *et al.*, 2009; Smith & Jensen, 2008). It is benthic and sedentary, non migratory in the juvenile and adult phase, with a pelagic larval phase (ICES, 2008c; Smith & Jensen, 2008) It lives in a muddy habitat which means that the species distribution is defined by particular sediment conditions (ICES, 2011b; FAO, 2012, Castro *et al.*, 2003; Campbell *et al.*, 2009). This species give one of the most valuable revenues for the trawl fleet (ICES, 2008b; FAO, 2012, Campbell *et al.*, 2009).

*Nephrops norvegicus* males, when reaching sexual maturity, moult more frequently than females. Consequently, males grow faster than females (ICES, 2008c); Smith P. and Jensen A., 2008). Males first maturity is at 2,8cm carapace length and females at 3cm carapace length (ICES, 2008b). Other characteristics concerning females are that they remain inside their burrows during the incubation period (between August and February), which makes them less available to fishing gear (ICES, 2008b;,Smith & Jensen, 2008).

The maximum size is around 8cm, corresponding to a weight of approximately 400 g. The reproduction period varies lattitudinally (Pochelon *et al*, 2009) but in general the Nephrops spawning period is from August to November in deep waters. Females carry the eggs after spawning for a period of 3 to 4 months before larvae hatch (ICES, 2008b; Pochelon *et al.*, 2009). The larvae phase is short before settlement in the mud grounds (ICES, 2008b) at depths ranging from 200 to 800m off the Portuguese coast (Cardador *et al.*, 2007).

Nephrops are omnivorous but have their preference in polychetes, mollusks, crustaceans and echinoderms (ICES, 2011g).

Nephrops are managed and assessed within functional unit (FU) rather than the ICES division level (ICES, 2011b). In division IXa (Portuguese division) there are five functional units: FU 26 (West Galicia); FU 27. (North Portugal); FU 28 (Alentejo, Southwest Portugal); FU 29 (Algarve, South Portugal) and FU 30 (Gulf of Cádiz).(ICES, 2011g). All The five FUs are managed with one TAC value for the whole area (Cardador *et al.*, 2007).

In FU 26 and 27 (West Galicia and North Portugal), Nephrops is caught as a bycatch in a mixed bottom trawl fishery in North and Northwest Iberian Atlantic. In these areas the target species are hake, anglerfish, megrim, blue whiting, mackerel and horse mackerel and cephalopods (ICES, 2008c, 2011g).

The fishery has it's highest yields in spring and summer. However, the fishery takes place all over the year (ICES, 2011g).

It should be highlighted that in these functional units the stock was in at an extremely low level in 2008, and OCEANA affirms that it still is. ICES working group considered that the recovery plan probably is not enough to recover the stock, so probably strong measures should be considered in the future (ICES, 2008c).

Within functional units 28 and 29 corresponding to Southwest and South Portugal, Nephrops are taken by a multi species and mixed bottom trawl fishery (ICES, 2008c; Cardador *et al.*, 2007).

The Functional unit 30 corresponds to Gulf of Cadiz, where Nephrops are caught in a mixed fishery. The highest yields and landings from this FU are from April to September. In 2008 the stock was about half of its level compared with the early nineties (ICES, 2008c). However the survey in 2008 indicates an increase in

abundance but this indicator can not be interpreted independently (ICES, 2008c). The stock is considered fully exploited (OCEANA, 2011).

Since January 2006 there is a recovery plan for Iberian Nephrops and the main objective of this plan is to rebuild the stocks within 10 years, reducing 10% of fishing mortality (F) relative to the previous year and setting the TAC accordingly (ICES, 2008c)

The latest ICES advice for Nephrops stocks was is 2010 and is biannual, so it is valid for 2011 and 2012 (ICES, 2011b).

The current Nephrops management within Division IXa does not ensure that local effort is sufficiently limited to avoid depletion of this resource in functional units. Vessels can move freely between grounds, so there is limited control and this has historically resulted in inappropriate harvest rates from some areas (ICES, 2011b)

There is also the introduction of two boxes in Division IXa and in the period of higher catches (May-August) these boxes are closed for Nephrops fishing (ICES, 2008c).

## <u>Whiting</u>

Whiting (*Merlangius merlangus*) is a species of the Gadidae family. It is very similar and close to cod-like fishes (ICES, 2011a).

*Merlangius merlangus* feeds on many commercially important species of crustaceans and fish (Singh-Renton & Bromley, 1999) and has cannibalistic characteristics, feeding on its own offspring (ICES, 2011a). Whiting has a preference for bottom prey at night and pelagic and free swimming prey in daytime (ICES, 2011a).

This species is distributed in the North east Atlantic from the northern coast of Portugal to Iceland (Milic & Kraljevic, 2011; Tobin *et al.*, 2010). Whiting is also present in the Mediterranean Sea, Black Sea, Aegean Sea, Adriactic Sea and South-western Barents Sea (ICES, 2011a).

Whiting can be found near the bottom around 10 to 200 deep, moving into midwater to find its prey.(ICES, 2011a).

It is a slow growing species. Females grow to a larger sizes than males (ICES, 2011a). Their sexual maturity is reached when they are around two years old (ICES, 2011a). The spawning period takes place between February and June (Tobin *et al*, 2010). The life cycle starts with a pelagic phase that may last 6 months and after that the juveniles migrate to shallow inshore waters (Tobin *et al*, 2010).

Whiting is usually taken in a mixed demersal fishery (ICES, 2011a, 2011b) and is a species of secondary commercial importance that is caught throughout the Nort Sea (ICES, 2011a).

There is insufficient information to evaluate Whiting stock status within Division IXa. Nevertheless based in precautionary approach, ICEs advises that catches should not be allowed to increase.(ICES, 2011b).

## BLACK SCABBARDFISH

*Aphanopus carbo whose common name is* Black Scabbardfish, belongs to bentho-pelagic category of deep waters species (Bordalo-Machado & Figueiredo, 2009; Perera, 2008) form the Trichiuridae family (Figueiredo et al., 2003; Froese & Pauly, 2012; Perera, 2008) Fishbase, 2012; Figueiredo et al., 2003; Perera, 2008).

Northeast Atlantic slopes around islands groups and seamounts are the main habitats of this species. In Portugal, it occurs in the continental shelf and Madeira Island (Bordalo-Machado & Figueiredo, 2009) at depths from 200 to 2300 (Vieira *et al.*, 2009).

The Black scabbardfish has an elongated body and carnivorous fang like teeth (Perera, 2008). Despite being a deep water species, it shows a fast growth, with maturation around 3 to 4 years old (Machete *et al.,* 2011) which corresponds to 80 to 100 cm length (Bordalo-Machado *et al.,* 2009; Froese & Pauly, 2012).

Little is known about the black scabbardfish life cycle (Bordalo-Machado *et al.*, 2009; Figueiredo *et al.*, 2003; . Silva, 2009).

However it is known that its longevity ranges from 12 to 24 years and it can grow to 1045cm total length (Bordalo-Machado & Figueiredo, 2009; (Machete *et al.*, 2011). Specimens of 145 cm length have been reported (Froese & Pauly, 2012) Black scabbardfish perform an extensive migration throughout the Northeast Atlantic University of (IESUI, 2010).

The main spawning areas are off Madeira and Canaries Islands (Bordalo-Machado *et al.*, 2009; Silva *et al.*, 2009), and the spawning period is between October and December (Silva *et al.*, 2009).

Eggs and larvea are pelagic and juveniles are mesopelagic. They migrate to midwater at night feeding on crustaceans, cephalopods and fishes (Froese & Pauly, 2012) Bordalo-Machado *et al.*, 2009; Froese & Pauly, 2012)..

The adult diet consists of squids, fish and crustaceans (Bordalo-Machado & Figueiredo, 2009). The lack of management measures had caused declines in Black scabbardfish abundance in some areas of the Northeast Atlantic, motivating the implementation of a TAC in 2003 (Machete *et al*, 2011).

In the Azores this species can be found between 800 and 1500 meters depths but it is not targeted by local fishers due to low market price (Machete *et al.*, 2011). But it is in Madeira that this species has a high value and is caught mainly by specialized deep water longlines (Froese & Pauly, 2012). The other longline fishery established in Portugal targeting this species is on the mainland in Sesimbra (Figueiredo. *et al.*, 2003).

At present Black scabbardfish is one of the most important commercial deep water resources. Regarding black scabbardfish, the exploitation state motivates the establishment of a biannual quota regime by European Union (Bordalo-Machado *et al.*, 2009)

### **BLACKSPOT SEABREAM**

*Pagellus bogaraveo*, known as the blackspot seabream and also as the Red sea bream, is a hermaphroditic member of Sparidae family (Lorance, 2010).

It is a demersal species which is found in the Atlantic from Norway to Cape Blanco, Madeira and the Canaries (Silva, 2009).

Blackspot seabream was classified as a depleted species between 1972 and 2002 (Lorance, 2010), with a decrease in length over the years (Erzini, Salgado, & Castro, 2006)..

Blackspot seabream habitat is found on the continental shelp and slope, down to 700m and on seamounts (Lorance, 2010).

Spawning takes place in shallower waters (Lorance, 2010) and larvae are planktonic (Silva, 2009). Juveniles prefer the coast (Lorance, 2010; Silva, 2009).

Adults can be found on rocky, sandy and muddy bottoms down to 700 in the Atlantic (Silva, 2009). This species grow to 70cm standard length and can weigh 4kg (Froese & Pauly, 2012; Lorance, 2010).

The Blackspot seabream is mainly carnivorous, preferring small organisms such as fishes, crustaceans and mollusks (Froese & Pauly, 2012), depending on distribution area and prey availability (Silva, 2009).

Its mains characteristic is that it is protandric hermaphrodite, i.e., most individuals are first functional males and then develop into functional females (ICES, 2011c; . Silva, 2009). However a percentage of the population never changes sex and this is known as gonochoric hermaphroditism (Lorance, 2010; Silva, 2009). Sex inversion is possitively related with fish age rather than size (Froese & Pauly, 2012) and usually takes place when the fish are 4 to 6 years old (ICES, 2011c),corresponding to an average length around 30 cm (Froese & Pauly, 2012). Blackspot seabream males mature at an average length of approximately 27.7cm and females at 34,6cm, corresponding to fish 5 and 8 years old, respectively (Silva, 2009). The spawning period varies but in general in areas Xa2 and IXa, the spawning takes place from January/February to April/May (Froese & Pauly, 2012; Silva, 2009).

Although the stock is considered the same, ICES separates it into three different components of which two are within Portuguese jurisdiction: area IX, and c) area X (Azores region) (ICES, 2008d). Taking into account the effective genetic differences between Azores (ICES areas Xa2) and mainland Portugal (ICES area IXa), and combining the known distribution of the species by depth, it is possible to predict that area X component can probably be considered as a separate assessment unit (ICES, 2008d).

This species is subjected to a Regional Fishing Plan with some management measures such as a fishing closure. ICES Divison IXa is considered in this plan (ICES, 2011c). Other management measures considered are: a minimum landing size (33 cm length, maximum hooks per line, maximum number of lines per boat, etc. (ICES, 2011c).

Main catches of subareas IXa correspond to Spain, and that is why the allocated quota for Portugal within this subarea is so low.

On the other hand the Blackspot seabream in Azores is only caught by the Portuguese fleet that uses bottom longlines to target this species (ICES, 2008d, 2011c). This division does not have any fisheries management plan however, should which would be important for conserving females (ICES, 2011c).

Unfortunately, this species is considered commercially extinction in Cantabrian Sea and Mediterranean as a consequence of over-fishing and/or recruitment failure, and the same could happen in Portuguese fishing grounds.(Silva, 2009).

# **ANNEX II: DATA TABLES**

Species	Year	ICES Advice (tons)	TAC (tons)	Portuguese Quota (tons)	Portuguese landings (tons)	Total landings (tons) *1	SSB (tons)	ICES Accordance degree (%)	TAC compliance Rate (%)	Quota Compliance Rate (%)	TAC - ICES Advice (%)	Total landings - TAC (%)
	2000	59000	68000	30950	14092	26160	299580	-15	38	46	15	-160
	2001	54000	68000	30950	13693	24911	298260	-26	37	44	26	-173
	2002	34000	57500	26174	14189	22506	294960	-69	39	54	69	-155
	2003	49000	55200	27653	11147	18887	286450	-13	34	40	13	-192
	2004	47000	50000	23536	12971	24485	281340	-6	49	55	6	-104
	2005	25000	50000	24786	13228	22689	289240	-100	45	53	100	-120
Horse	2006	25000	50000	23536	14342	23895	297380	-100	48	61	100	-109
macherer	2007	25000	50000	25036	14607	22787	280220	-100	46	58	100	-119
	2008	25000	57800	28442	9250	22993	259100	-131	40	33	131	-151
	2009	25000	57800	25668	10723	25726	246420	-131	45	42	131	-125
	2010	25000	31100	25538	11647	27217	241400	-24	88	46	24	-14
	2011	25000	29585	24385	-	-	238339	-18	0	-	18	-
	2012	30800	30800	-	-	-	-	100	0	-	0	-

 Table 2. Horse Mackerel: Division IXa, Southern Stock

Species	Year	ICES Advice (tons)	TAC (tons)	Portuguese Quota (tons)	Total landings (tons) *1	TAC compliance Rate (%)	Total landings - TAC (%)
	2000	_	5000	5000	1713	34	-192
	2001	_	5000	5000	1965	39	-154
	2002	_	4000	4000	2512	63	-59
	2003	_	3200	3200	2909	91	-10
	2004	_	3200	3200	2546	80	-26
Dhua la ala	2005	No	3200	2560	2818	88	-14
Blue Jack Mackerel	2006	increase	3200	3200	2976	93	-8
macharon	2007	in catch	3200	3200	2982	93	-7
	2008	_	3200	3200	4743	-48	33
	2009	_	3200	3200	4939	-54	35
	2010	_	3072	3072	3221	-5	5
	2011	_	3072	3072	-	-	-
	2012		-	-	-	-	-

 Table 3. Blue Jack Mackerel: subdivision Xa2

Species	Year	ICES Advice (tons)	TAC (tons)	Portuguese Quota (tons)	Portuguese landings (Tons)	Total landings (tons) *1	SSB	ICES Accordance degree (%)
	2000	81000			62555	85786	263000	-6
	2001	88000			65197	101957	305000	-16
	2002	95000			63731	99673	444000	-5
	2003	100000			64016	97831	454000	98
	2004	128000			51250	98020	454000	77
	2005	106000	<b>T</b> I	<b>T</b> I	50560	97345	369000	92
Sardines	2006	96000	no TAC	I nere is no Quota	48096	87023	586000	91
	2007	114000		Quola	58201	96469	566000	85
	2008	92000			65330	101464	420000	-10
	2009	71000	_		55159	87740	316000	-24
	2010	75000			58120	-	317000	-
	2011	75000	-		_	-	-	_
	2012	36000	-		_	-	-	_

## Table 4. Sardines: Division VIIIc and IXa

## Table 5. Anchovy: Division IXa

Species	Year	ICES Advice (tons)	TAC (tons)	Portuguese Quota (tons)	Portuguese landings (Tons)	Total landings (tons) *1	ICES Accordance degree (%)	TAC compliance Rate (%)	Quota Compliance Rate (%)	TAC- ICES Advice (%)	Total landings - TAC (%)
	2000	4600	10000	2220	309	2502	-117	25	14	117	-300
	2001	4900	10000	1220	853	9098	-104	91	70	104	-10
	2002	4900	8000	1174	914	8806	-63	-10	78	63	9
	2003	4700	8000	1174	477	5269	-70	66	41	70	-52
	2004	4700	8000	2674	647	5844	-70	73	24	70	-37
	2005	4700	8000	3654	124	4515	-70	56	3	70	-77
Anchovy	2006	4700	8000	4074	107	4491	-70	56	3	70	-78
	2007	4800	8000	3174	108	6454	-67	81	3	67	-24
	2008	4800	8000	4174	334	3508	-67	44	8	67	-128
	2009	4800	8000	4174	71	3013	-67	38	2	67	-166
	2010	4800	8000	4174	129	3210	-67	40	3	67	-149
	2011	see scenario	7600	3965	-	-	-	-	-	-	-
	2012	-	8360	4362	-	-	-		-	-	-

Species	Year	ICES Advice (tons)	TAC (tons)	Portuguese Quota (tons)	Portuguese landings (Tons)	Total landings (tons) *1	SSB (tons)	ICES Accordance degree (%)	TAC compliance Rate (%)	Quota Compliance Rate (%)	TAC - ICES Advice (%)	Total landings - TAC (%)
	2000	642000	612000	3610	2185	665000	2.68453	95	-9	61	-5	8
	2001	665000	670000	3570	3085	660000	2030317	-1	99	86	1	-2
	2002	694000	683000	3582	2908	685000	1682344	98	100	81	-2	0
	2003	542000	583000	2903	2673	600000	1685899	-8	-3	92	8	3
	2004	545000	532000	2913	2367	587000	1765752	98	-10	81	-2	9
	2005	370000	422000	2878	2397	447000	2187884	-14	-6	83	14	6
Mackerel	2006	430000	444000	3044	2614	318000	2335167	-3	72	86	3	-40
	2007	449500	502000	3243	2619	558000	2543583	-17	-11	81	12	10
	2008	402500	458000	3053	2378	420000	2803086	-14	92	78	14	-9
	2009	510500	605000	4586	1751	442000	3144025	-19	73	38	19	-37
	2010	549500	885000	3830	2361	809000	2992033	-61	91	62	61	-9
	2011	600500	959000	4746	-	-	2907519	-60	-	_	60	-
	2012	-	_	5051	-	-	_	-	-	-	-	-

 Table 6. Mackerel: Northeast Atlantic widely distributed species

## Table 7. Blue whiting: Widely distributed Species (Combined Stock) (Subareas I-IX, XII and XIV)

Species	Year	ICES Advice (tons)	TAC (tons)	Portuguese Quota (tons)	Portuguese landings (Tons)	Total landings (tons) *1	SSB (tons)	ICES Accordance degree (%)	TAC compliance Rate (%)	Quota Compliance Rate (%)	TAC- ICES Advice (%)	Total landings - TAC (%)
	2000	800000	-	10800	2068	1412450	4214660	-	-	19	-	-
	2001	628000	-	10700	1648	1771810	4627040	-	-	15	-	-
	2002	0	-	5583	1595	1556950	5646910	-	-	29	-	-
	2003	600000	-	6083	2574	2365320	6968500	-	-	42	-	-
	2004	925000	-	21993	4192	2400790	6988560	-	-	19	-	-
Dhuo	2005	1075000	-	26845	5125	2018340	6541080	-	-	19	-	-
Whiting	2006	1500000	2100000	11699	2430	1956240	6479670	-40	93	21	40	100
g	2007	980000	1847000	9483	2447	1612270	5390440	-88	87	26	88	100
	2008	835000	1250000	6421	4210	1251850	4180920	-50	100	66	50	100
	2009	384000	606000	3031	2039	634978	3229070	-58	-5	67	58	100
	2010	540000	548000	2774	1475	539539	3043490	-1	98	53	1	100
	2011	40000	40000	483	-	-	2369530	100	-	-	0	-
	2012	391000	391000	2772	-	-	-	100	-	-	0	-

Species	Year	ICES Advice (tons)	TAC (tons)	Portuguese Quota (tons)	Portuguese landings (Tons)	Total landings (tons) *1	SSB (tons)	ICES Accordance degree (%)	TAC compliance Rate (%)	Quota Compliance Rate (%)	TAC - ICES Advice (%)	Total landings - TAC (%)
	2000	7700	8500	3195	2978	7900	9700	-10	93	93	10	-7
	2001	8500	8900	2660	2968	7600	10000	-5	85	112	5	-15
	2002	8000	8000	2859	2543	6700	10400	100	84	89	0	-16
	2003	0	7000	2490	1940	6700	10300	-100	96	78	100	-4
	2004	0	5950	2057	1948	6900	10400	-100	116	95	100	16
	2005	0	5968	1867	1965	8300	10900	-100	139	105	100	39
Hake	2006	0	6661	2202	2219	10800	12400	-100	162	101	100	62
	2007	0	6128	1990	2235	14900	14700	-100	243	112	100	143
	2008	0	7047	2120	2036	16800	15100	-100	238	96	100	138
	2009	0	8104	2480	2161	19200	17200	-100	237	87	100	137
	2010	4900	9300	2727	2361	15700	18700	-90	169	87	90	69
	2011	9900	10695	3472	-	-	27700	-8	-	-	8	-
	2012	14300	12299	-	-	-	-	86	-	-	-14	-

## Table 8. Hake: division VIIIc, IX and X and CECAF 34.1.1

Table 9. Megrims : COMBINED SPECIES: Four-spot megrim (Lepidorhombus boscii) and megrim (Lepidorhombus whiffiagonis) division VIIIc

and IXa

Species	Year	ICES Advice (tons)	TAC (tons)	Portuguese Quota (tons)	Portuguese landings (Tons)	Total landings (tons) *1	SSB (tons)	ICES Accordance degree (%)	TAC compliance Rate (%)	Quota Compliance Rate (%)	TAC - ICES Advice (%)	Total landings - TAC (%)
	2000	1500	5000	225	151	1294	4768	-233	26	67	233	-286
	2001	1610	5000	204	129	1106	4183	-211	22	63	211	-352
	2002	1550	4000	173	132	837	4622	-158	21	77	158	-378
	2003	1550	2400	221	186	1010	4949	-55	42	84	55	-138
	2004	1380	1336	106	182	1155	4723	97	86	-72	-3	-16
	2005	1090	1336	166	214	1130	4880	-23	85	-29	23	-18
Megrims	2006	1200	1269	139	236	1302	5338	-6	-3	-70	6	3
	2007	1400	1440	184	236	1259	5406	-3	87	-29	3	-14
	2008	1400	1430	180	189	1113	5775	-2	78	-5	2	-28
	2009	1400	1430	209	222	1218	5253	-2	85	-6	2	-17
	2010	900	1287	255	206	1380	5514	-43	-7	81	43	7
	2011	890	1094	135	-	-	5780	-22	-	-	23	-
	2012	860	1214	-	-	-	-	-41	-	-	-	-

Table 10. Anglerfish : Blackbellied anglerfish and White anglerfish (combined stock) (Division VIIIc and IXa)

Species	Year	ICES Advice (tons)	TAC (tons)	Portuguese Quota (tons)	Portuguese landings (Tons)	Total landings (tons) *1	B/Bmsy	ICES Accordance degree (%)	TAC compliance Rate (%)	Quota Compliance Rate (%)	TAC - ICES Advice (%)	Total landings - TAC (%)
	2000	1600	6800	1180	835	2600	0,38	-325	38	71	325	-162
	2001	2800	6000	1130	587	1800	0,33	-114	30	52	114	-233
	2002	3500	4800	923	495	1800	0,35	-37	38	54	37	-167
	2003	3200	4000	855	635	3200	0,43	-25	80	74	25	-25
	2004	0	2300	411	405	4100	0,47	-100	-78	99	100	44
	2005	0	2000	334	310	4500	0,48	-100	-125	93	100	56
Anglerfish	2006	0	2000	310	250	4100	0,49	-100	-105	81	100	51
	2007	0	2000	375	256,9	3600	0,51	-100	-80	69	100	44
	2008	0	2000	337	301,2	3300	0,52	-100	-65	89	100	39
	2009	0	1800	328	307,8	3000	0,63	-100	-67	94	100	40
	2010	0	1500	277	277,7	2400	0,87	-100	-60	100	100	38
	2011	1500	1600	260	-	-	1,2	-7	-	-	7	-
	2012	3300	3300	-	-	-	-	100	-	-	-	-

## Table 11. Nephrops: Functional Units (Division IXa – Functional Ulnits: 26, 27, 28, 29, 30)

Species	Year	ICES Advice (tons)	TAC (tons)	Portuguese Quota (tons)	Portuguese landings (Tons)	Total landings (tons) *1	ICES Accordance degree (%)	TAC compliance Rate (%)	Quota Compliance Rate (%)	TAC- ICES Advice (%)	Total landings - TAC (%)
	2000	-	-	1125	207	-	-	-	18	-	-
	2001	-	-	900	275	-	-	-	31	-	-
	2002	-	-	600	352	-	-	-	59	-	-
	2003	50	600	450	354	718	1200	-20	79	1100	16
	2004	50	600	450	336	650	1200	-8	75	1100	8
	2005	50	540	405	323	690	1080	-28	80	980	22
Nephrops	2006	250	486	364	246	539	194	-11	68	94	10
	2007	250	437	328	246	496	174	-14	75	75	12
	2008	250	415	344	200	363	166	87	58	66	-14
	2009	400	374	280	128	267	93	71	46	-7	-40
	2010	400	337	251	119	250	84	74	47	-16	-35
	2011	see scenrio	303	202	_	-	-	-	-	_	-
	2012	-	273	205	-	-	-	-	-	-	-

Species	Year	ICES Advice (tons)	TAC (tons)	Portuguese Quota (tons)	Portuguese landings (Tons)	Total landings (tons) *1	TAC compliance Rate (%)	Quota Compliance Rate (%)	Total landings - TAC (%)
	2000		2640	2640	77	1746	3	3	-51
	2001		2100	2100	38	2592	2	2	19
	2002		1700	1700	42	2634	2	2	35
	2003		1360	1360	44	2532	3	3	46
	2004		1020	1020	75	2307	7	7	56
	2005		816	816	77	2173	9	9	62
Whiting	2006		653	653	107	2029	16	16	68
	2007		653	653	107	2024	16	16	68
	2008		653	653	97	1059	15	15	38
	2009		653	653	111	1467	17	17	55
	2010		588	588	112	2258	19	19	74
	2011		588	588	-	-	-	-	-
	2012		-	-	_	-	_	-	-

Table 12. Whiting: Subareas VIII and Division IXa
Species	Year	ICES Advice (tons)	TAC (tons)	Portuguese Quota (tons)	Portuguese landings (Tons)	Total landings (tons) *1	TAC compliance Rate (%)	Quota Compliance Rate (%)	Total landings - TAC (%)
Black scabbardfish	2000	-	-	-	-	2371	-	-	-
	2001	-	-	-	6752	2744	-	-	-
	2002	-	-	-	6565	2692	-	-	-
	2003	-	4000	4000	6386	2630	66	-60	-52
	2004	-	4000	4000	6023	2363	59	-51	-69
	2005	-	4000	8231	6267	2746	69	76	-46
	2006	-	4000	8201	5446	2674	67	66	-50
	2007	-	4000	8161	6378	3453	86	78	-16
	2008	-	4000	9058	6710	2602	65	74	-54
	2009	2800	3600	7641	5911	2601	72	77	-38
	2010	2800	3300	8099	5354	-	-	66	-
	2011	2800	-	7847	-	-	_	-	-
	2012	-	-	-	-	-	_	-	-

Table 13. Black scabbardfish: Subareas VIII and IX

Source: (Batista, 2012; DGPA, 2001; ICES, 2011b; INE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011)

Specie	Year	ICES Advice (tons)	TAC (tons)	Portuguese Quota (tons)	Portuguese landings (Tons)	Total landings (tons) *1	TAC compliance Rate (%)	Quota Compliance Rate (%)	Total landings - TAC (%)
Blackspot seabream	2000	-	-	-	-	421	-	-	-
	2001	-	-	-	97	374	-	-	-
	2002	-	-	-	111	359	-	-	-
	2003	-	1271	271	141	471	37	52	-170
	2004	-	1271	271	170	480	38	63	-165
	2005	-	1271	230	129	494	39	56	-157
	2006	-	1271	230	140	544	43	61	-134
	2007	-	1080	230	185	592	55	80	-82
	2008	-	1080	253	158	602	56	62	-79
	2009	500	918	196	124	718	78	63	-28
	2010	500	780	186	105	-	-	56	-
	2011	500	-	155	_	-	-	_	-
	2012	-	-	-	-	-	-	-	-

Table 14. Blackspot Seabream: Subareas IX and X

Source: (Batista, 2012; DGPA, 2001; ICES, 2011b; INE, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011)