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RESEARCH FOR PECH COMMITTEE - SARDINE FISHERIES: RESOURCE ASSESSMENT AND SOCIAL AND ECONOMIC SITUATION

STUDY

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POLICY DEPARTMENT B: STRUCTURAL AND COHESION POLICIES

FISHERIES

RESEARCH FOR PECH COMMITTEE - SARDINE FISHERIES: RESOURCE ASSESSMENT AND SOCIAL AND ECONOMIC SITUATION

STUDY

This document was requested by the European Parliament's Committee on Fisheries.

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Abstract

This study describes fisheries, stock status, ICES advice and management measures for the Northern and Southern sardine stocks in EU Atlantic waters. Information on sardine biology and ecology is provided for a better understanding of stock development. Social and economic dimensions are addressed for sardine fisheries in France, Spain and Portugal. The study provides recommendations to improve knowledge on the species and indicates management measures which might be considered for the sustainability of the fisheries.

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LIST OF ABBREVIATIONS

ANFACO	"Associación Nacional de Fabricantes de Conservas de Pescado" - National Association of Manufacturers of canned fish (Spain)
ANICP	"Associação Nacional dos Industriais de Conservas de peixe"- National Association of Manufacturers of canned fish (Portugal)
ANOPCERCO	"Associação Nacional das Organizações de Produtores da pesca do Cerco"- National association of purse seine fishery Producer Organizations (Portugal)
B^{1+}	Biomass of sardine with age 1 and older
CFP	Common Fisheries Policy
CPI	Consumer Price Index
DGRM	"Direção geral dos Recursos Marítimos"-Fisheries Directorate (Portugal)
DEPM	Daily Egg Production Method (survey)
FAO	Food and Agriculture Organisation of the United Nations
F	Fishing mortality
FMSY	Fishing mortality consistent with achieving Maximum Sustainable Yield
HCR	Harvest Control Rule
IEO	Instituto Español de Oceanografia
IPMA	Instituto Português do Mar e da Atmosfera
ICES	Insternational Council for the Exploration of the Sea
LOA	Length Overall
M	Natural mortality
MCRS	Minimum Conservation Reference Size
MLS	Minimum Landing Size
MMS	Minimum Mesh Size
MP	Management Plan
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield

n.a.	Not available
PELGAS	Ifremer Pelagic Sea Surveys in the Bay of Biscay
TAC	Total Allowable Catch
WGACEGG	Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX
WGHANSA	Working Group on Southern Horse Mackerel, Anchovy and Sardine

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EXECUTIVE SUMMARY

Background

Small pelagic species like sardine fluctuate as a function of recruitment success which, in turn, depends mainly on environmental variability. High fishing levels may lead to low stocks levels and contribute to impair recruitment.

Two stocks are considered in EU Atlantic waters: Northern stock (ICES Subareas VII and VIIIa,b,d) fished mainly by France and Spain, and Southern stock (ICES Subarea VIIIc and Division IXa) fished by Spain and Portugal. Sardine is important for the fisheries sector and fish canning industries in those countries.

Sardine landings from the Northern stock have increased over time and in 2014 were 45 000 tonnes. Landings in Subarea VIII increased sharply in recent years due to high abundance of sardine in the area and decrease of fishing opportunities for the Southern stock. ICES assessment and advice is not available for the whole stock due to limited data collected in Subarea VII. A trend-based assessment is performed for sub-area VIII based on scientific surveys. The stock shows an increasing trend over the last five years and current harvest rate appears to be sustainable. ICES advised that catches should be no more than 33 065 tonnes in each of the years 2016 and 2017. Technical measures are in place but effort and catches are not regulated. Given the growing interest on the exploitation of this stock it is recommended to develop a Management Plan and collect data on sardine fisheries and abundance from Subarea VII.

Fisheries on the Southern stock show a long term decrease since the 1980s. In recent years, landings dropped sharply due to stock decline and regulatory measures. Landings in 2014 were 27 900 tonnes. The stock is assessed using an analytical model and advice has been based on the precautionary approach. The biomass of the stock decreased 71% over the past 10 years (2007-2015) due to prolonged low recruitment and high fishing mortality in recent years. Large reductions in effort and catches implemented since 2011 contributed to a substantial reduction of fishing mortality. Technical measures are in place. Spain and Portugal agreed on a multiannual management plan and have regulated catches and effort accordingly since 2014. ICES advises that catches in 2016 should be no more than 1 587 tonnes. Since the productivity of the stock might have changed it is recommended to adopt additional technical measures and to revise the MP.

Aim

This study conducted an in-depth analysis of the sardine resource, considering the most recent ICES evaluation in the different fishing Subareas, the results related to fishing mortality and biomass, and ICES recommendations. The study highlights the evolution of the status of the resource along the past years.

Regulatory fishing measures and management plans are identified as well as any other actions adopted by member States so as to value their possible effectiveness in relation with the evolution of the resource status. It also describes the principal fishing fleets involved, the type of vessels, level of catches, seasonal activities, with a description of the crew and other related activities on land, including market and commercial issues, so as to assess the social and economic aspects of this activity.

On the basis of these analyses the European Parliament will be provided with recommendations to assess the sustainability of the resource, considering, among others, the possible establishment of specific guidelines and new measures for that purpose, taking into account the social and economic dimension of the activity.

GENERAL INFORMATION

KEY FINDINGS

- Sardine has a wide distribution in the Northeast Atlantic and Mediterranean Sea
- Two sardine stocks are considered for management in EU Atlantic waters; the two stocks show some mixing
- Sardine grows fast (~23 cm in 4-5 years), starts to reproduce on the first or second year of life, has high fecundity(400 000 eggs per year per female) and a medium longevity (10-12 years)
- The abundance, biomass and distribution of sardine show fluctuations in response to environmental variability and climate change
- Variations in sardine abundance are strongly linked with variations in recruitment
- Recruitment is mainly dependent on environmental conditions although fishing may amplify variations in recruitment

Sardine (*Sardina pilchardus,* Walbaum, 1792) is a pelagic and migratory fish species that belongs to the Clupeiformes order, which includes, among others, the Engraulidae family (e.g. anchovies) and the Clupeidae family (e.g. sardines, sprat and herring).

Species distribution and stock structure

Sardine is distributed in the Northeast Atlantic Ocean and Mediterranean Sea. In the Atlantic, sardine extends along the continental shelf from the Celtic Sea and North Sea to Senegal, with residual populations off the Azores, Madeira, and the Canary Islands (Parrish et al., 1989) (Map1). The range of sardine has expanded and contracted over time in association with environmental conditions, such as temperature and productivity. Between the mid-1970s and the mid-1980s, the southern limit extended from Morocco to Senegal possibly due to increasing productivity, and retreated to the north in the following years (Lluch-Belda et al., 1982). Changes in the northern limit have also been reported, with abundance increasing in the southern North Sea in the early 1990s and more recently in the northern North Sea, possibly associated with increasing temperature (Alheit et al., 2012).

Five biological populations of sardine may be considered based on integrated genetic and phenotypic data: 1) an African population (south of 30°N); 2) a Northeast Atlantic population (north of 30ºN to the North Sea and the Alboran Sea); 3) a Mediterranean population (east of the Almeria-Oran front); 4) one in the Azores and 5) one in Madeira (Kasapidis et al., 2012; Shaw et al. 2012). For fisheries management purposes, two stocks are considered in EU Atlantic waters (see below), three stocks are considered off northwest Africa (FAO, 2013) and eight stocks are considered in Mediterranean (GFCM, 2006). Overall, the largest sardine stocks are located in central Morocco, with landings around 700 000 tonnes and biomass between 1 000 000 and 5 000 000 tonnes (FAO, 2013). Landings from all Mediterranean stocks are ~80 000 tonnes, at the level of landings from EU Atlantic stocks.

Map 1: Geographical distribution of sardine

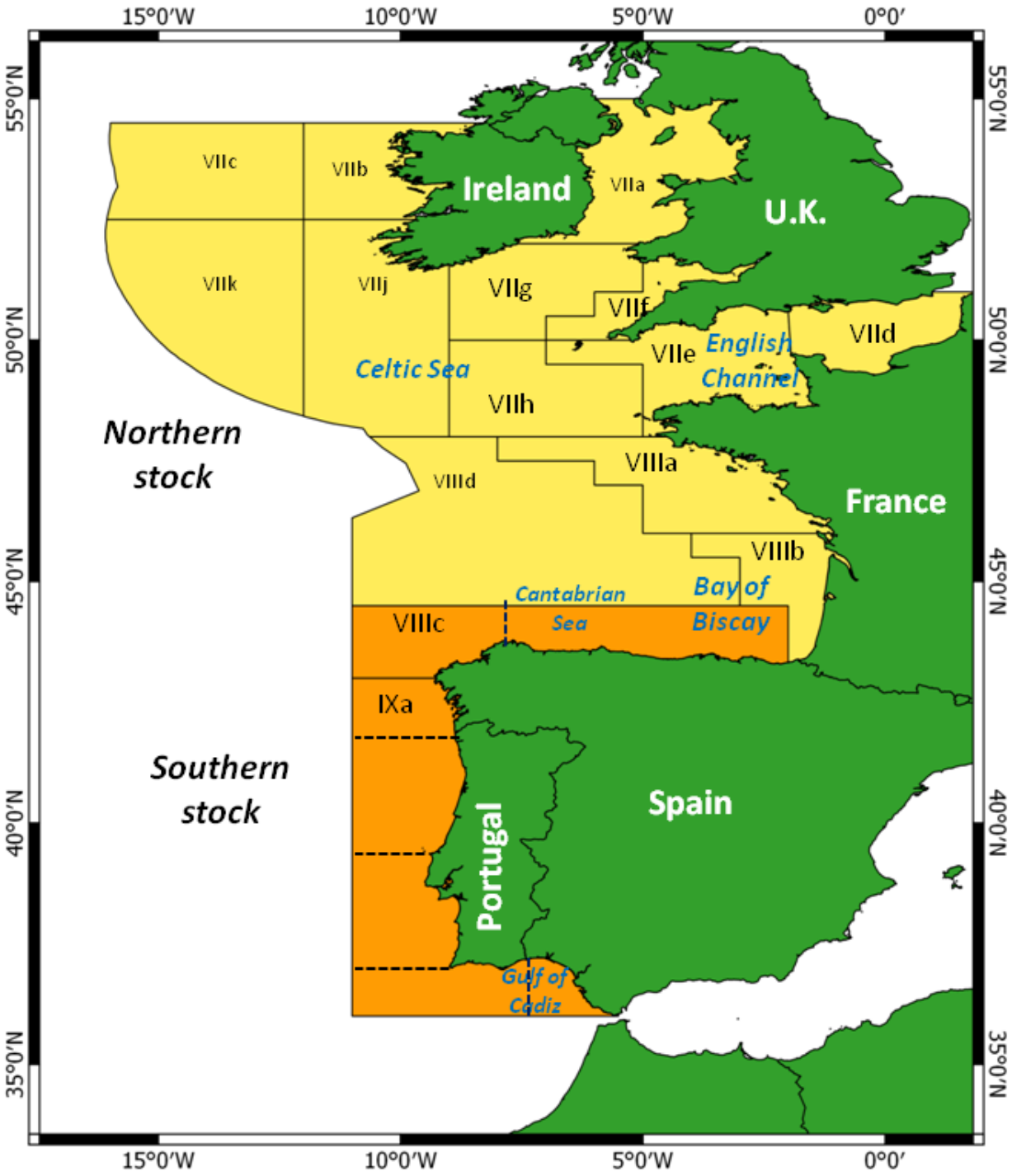
There are studies pointing to the existence of sub-populations and conversely to mixing among regional sardine populations or stocks within NE Atlantic waters (ICES, 2012). There are indications of mixing between the Northern and the Southern stocks. Mixing appears to be higher between the eastern part of Division VIIIc and the southern part of Division VIIIb (Map 2). There are also indications of sub-structure between the Bay of Biscay (Subarea VIII) and the English Channel (Subarea VII). However, levels of mixing are uncertain and are likely to vary between years depending on recruitment strength and environmental conditions.

The difficulty to establish boundaries between stocks or sub-stocks lead ICES to consider two sardine stock units in EU Atlantic waters (ICES, 2012): the Northern stock, distributed between the English Channel, Celtic Sea and the French-Spanish border in Bay of Biscay (ICES Sub-areas VII and VIIIa,b,d) and the Southern stock distributed from the border to Gibraltar Strait in the Gulf of Cadiz (ICES Sub-areas VIIIc and Division IXa) (Map 2).

Biology and ecology of sardine

Sardine attains 14 years of age and 27 cm total length, growing to 90% of their maximum length during the first year. Within EU Atlantic waters, size is usually lower than 23 cm and age below 10 years. Growth and maturity are variable between regions (Silva et al. 2006, 2008). Sardine is an indeterminate and batch spawner, i.e.fecundity is not fixed before the beginning of the spawning period, and eggs are released in batches over a period that can last months (Zwolinski et al., 2001; Somarakis et al., 2006). Each female produces around 400 000 eggs per year (Nunes et al. 2011).

Map 2: Delimitation of the Northern and Southern sardine stocks



Source: adapted from ICES areas map, http://ices.dk/marine-data/maps/Pages/default.aspx.
Note: The main ICES Subareas and Subdivisions where the stocks distribute are marked with a larger lettering. Dashed lines inside Subdivisions VIIIc and IXa show smaller divisions used to report data: VIIIc-East, VIIIc-West, IXa-North, IXa-Central North, IXa-Central South, IXa- South Algarve, IXa- South Cadiz.

The species is also characterised by early maturation and no sexual dimorphism. The length at which most sardines attain sexual maturation increases from south to north in EU Atlantic waters (Silva et al., 2006). Most individuals are mature by age 1 and all fish reach sexual maturity by age 2. During the spawning season, pelagic eggs are produced and, after few days of embryonic development (~3 days at 15ºC; Miranda et al., 1990), result in larval stages (Russell, 1976). Spawning is temperature-dependent (mainly at 12 to 18ºC) and extends throughout most of the continental shelf (Larrañeta, 1960; Ettahiri et al., 2003; Coombs et al., 2006; Bernal et al., 2007). The duration of the spawning season increases from north (1-2 months) to south (6 months) in the northeastern Atlantic while peak spawning activity shifts from late-spring in north to winter in the south (Ettahiri et al., 2003; Coombs et al. 2006; Stratoudakis et al., 2007). Other than temperature, food availability, body size and energy reserves of spawning females are major factors affecting the reproductive dynamics of sardine (Zwolinski et al., 2001; Riveiro et al., 2004; Ganias et al., 2007; Ganias, 2009).

Sardine distribution is restricted to coastal shelf waters, mainly at depth above 150 m, forming dense schools during daytime. In the Southern stock area, main spawning areas are western Portuguese coast, Cantabrian Sea and Gulf of Cadiz (Stratoudakis et al., 2007; Ramos et al., 2009). Juveniles are distributed preferentially in shallower waters, in the vicinity of estuaries and Rias off the northwestern Iberian Peninsula and Gulf of Cadiz (Rodríguez et al., 2014). In the Northern stock area, main spawning areas are in Brittany and southern Bay of Biscay (Massé et al., *in press*).

Sardine feeds on zooplankton (mainly copepods; Bode et al., 2004; Costalago et al., 2012; Jemaa et al., 2015), and may also have alternative preys such as phytoplankton and fish eggs. Above a size threshold (around 4 cm), sardine can change from filter feeding to particulate feeding depending on the relative abundance of these prey groups (Varela et al. 1988; Bode et al., 2003; Garrido et al., 2007; Costalago and Palomera, 2014). This strategy can be useful during periods of low food availability, even though sardine has demonstrated to have a less flexible diet than other pelagic fishes, such as anchovy (Chouvelon et al., 2014; 2015, Costalago and Palomera 2014). This confers a competitive disadvantage to the sardine and leads to a segregation of both species in terms of organisms preyed and feeding areas.

Sardine can be considered a "forage species" because is a small sized organism that serves as food for many marine predators, including mammals (Thompson et al., 1996; Silva, 2001; Weise and Harvey 2008; Santos et al., 2013), seabirds (Crawford and Dyer 1995; Jahncke et al. 2004; Furness and Edwards 2007; Daunt et al. 2008) and larger fish species (Walter and Austin 2003; Magnussen 2011). Forage fish are important for energy transfer through the pelagic food web, and some species have demonstrated to exert a "wasp-waist" control, especially in upwelling ecosystems: they exert both (top down) control of zooplankton and (bottom up) control of top predators (Rice, 1995; Cury et al., 2000). Sardine has been found to be important in the diet of common dolphins (*Delphinus delphis*) in Galicia (NW Spain) Portugal (Silva, 2001) and the Atlantic French coast (Meynier, 2004), but recent studies (Santos et al., 2014) indicate that cetacean predation on sardine represents only 2–8% of the total natural mortality rate, with little influence on sardine population dynamics.

As many other pelagic species, sardine, due to a high dependency of lower trophic levels (Costalago and Palomera 2014), can be highly vulnerable to changes in environmental conditions and plankton community. Sardine abundance, biomass and distribution show important fluctuations in different ecosystems all around the world in response to environmental variability and climate change (Carrera and Porteiro, 2003; Alheit et al. 2014). Shifts in global atmospheric and sea temperatures coincide with productivity cycles,

but the mechanistic link may be caused by an associated process operating at regional level (Lluch-Belda et al., 1992). The relationship between population characteristics and environmental variables is therefore complex, depending on the temporal scale and varying across regions, due to the different recruitment responses in the different areas studied (Guisande et al., 2001; Santos et al., 2012; Leitao et al., 2014).

Changes in sardine biomass are tightly coupled to the magnitude of recruitment. In turn, recruitment is mainly dependent on environmental conditions, such as temperature and productivity (Santos et al. 2001, 2005; Guisande et al., 2004; Santos et al., 2012). Fishing may amplify recruitment fluctuations and in extreme situations lead to recruitment overfishing.

1. SOCIAL AND ECONOMIC DIMENSIONS OF FISHERIES

KEY FINDINGS

- **Northern sardine stock:**
- Fished mainly by France, Spain and the UK; data on Subarea VII fisheries is sparse
- Total landings were 45 000 tonnes in 2014; landings have doubled since 1990
- In Subarea VIII, sardine is fished by 150 vessels from France and Spain that target sardine around 4000 days per year
- In 2014, landings from Subarea VIII were 39 000 tonnes, 45% by France and 55% by Spain; in recent years, the Spanish fleet has increased effort in area VIIIb due to the decrease of fishing opportunities for the Southern stock
- **Southern sardine stock:**
- Fished by purse seine fleets of Spain and Portugal
- In 2014, the fleet targeting sardine had 546 vessels, ca. 5700 fishers, and operated for 9 000 days
- In 2014, landings were 27 900 tonnes (43% by Spain and 57% by Portugal) corresponding to a value of 47 MEUR in first sale value (33% by Spain and 67% by Portugal)
- Landings show a decreasing trend since 1981; a sharp decrease of 65%, (80 400 tonnes to 27 900 tonnes) took place between 2011 and 2014 due to the decline of the stock and catch regulations
- In Portugal, 20 canning factories employed ca. 3500 workers (85% women), and produced 13 000 t (54 MEUR) of canned sardine in 2014, 85% exported
- In Galicia (Spain), there are 65 fish canning factories with more than 12 000 employees; the annual production of canned sardine is estimated to be higher than 22 000 tonnes.

Table 1: Overview of sardine fisheries from the Northern and Southern stocks in 2014, in France, Spain and Portugal

	France	Spain	Portugal
Landings, tonnes	**18 900**	**11 900**	**16 000**
Landings, MEUR	**14** (1)	**15**	**32**
Number of vessels	**49**(2)	**364**	**182**
Number of fishing days(3)	**4 000**	**5 500**	**11 000**
Vessel LOA(m) / Power (kW)	**18/n.a.**	**17/138**	**18-24/215**
Number of fishers	**200**(4)	**3700** (5)	**2000**

Source: Various, see text

Notes:

(1) Value assuming provisional price of 0.75 €/Kg
(2) 29 purse seiners and 20 pelagic trawlers
(3) Corresponding to the number of days with landing
(4) Employed in purse seiners, assuming provisional estimate of 7 fishers per vessel
(5) Assuming provisional estimate of 10 fishers per vessel

1.1. Northern stock (Sardine in ICES Sub-areas VII and VIIIa,b,d)

The **Northern stock of sardine is fished mainly by France, Spain, UK and The Netherlands**. Landings are reported occasionally by other countries, such as Ireland, Germany and Denmark, but in recent years have been generally low. The importance of sardine fisheries is variable between countries. Sardine landings by country in areas VII and VIII reported by ICES (2015) are presented in Annex I.

Landings from the whole stock area show an increasing trend in the past 15 years (Figure 1); landings in 2014, 45 000 tonnes, are almost the double those in 1990, 24 000 tonnes. Up to the mid 2000s, the majority of landings were from Subarea VII and mainly from France but this situation was reversed and in the past 4 years this area represents around 18% of the total.

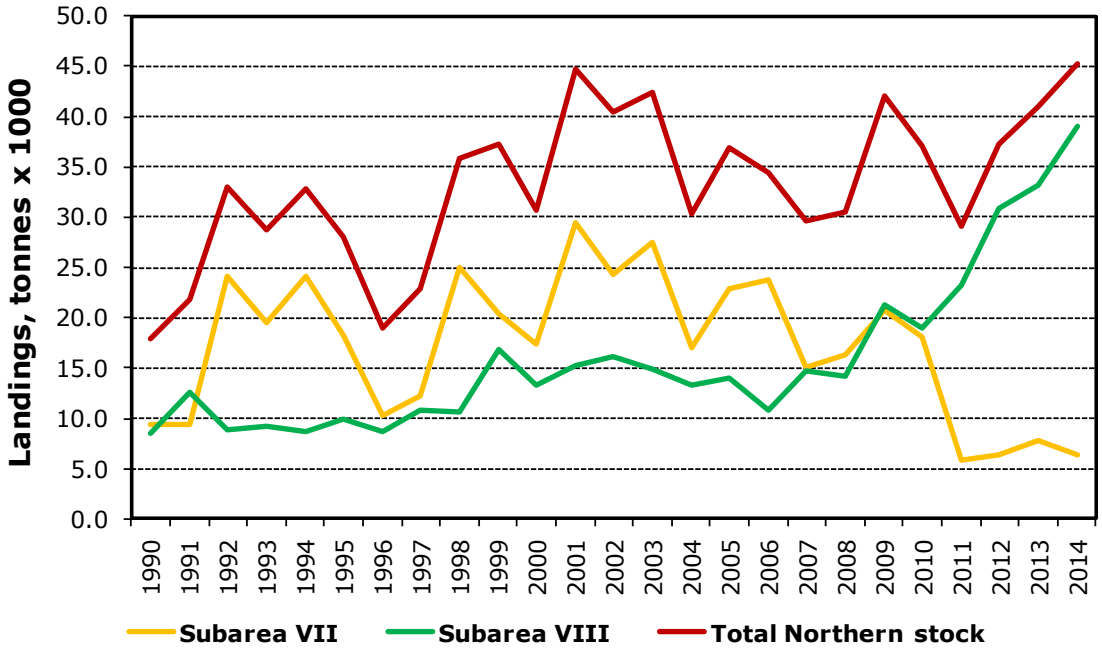
In Subarea VII, most of the landings are concentrated close to or in the English Channel (VIId, e, f) (ICES, 2015). Historically highest landings in this area were made by France and the Netherlands, but the participation of France decreased and that of the UK increased in the last four years (Figure 2). Landings have substantially oscillated over time. In 2014, landings were 6 311 tonnes.

In the UK, there is a small traditional small scale fishery targeting sardine that takes place during summer and autumn around the Cornish Peninsula. Fishing vessels operate with driftnets (12 vessels) and ring-nets (12 vessels) (Parkes, 2010). The fishery engages less than 100 fishers and landings are regular but small, 1 000 to 8 000 tonnes per year (Culley, 1971; Parkes, 2010).

There is little information on the fisheries catching sardine in Subarea VII. Therefore, the remaining of this chapter will focus on fisheries in Subarea VIII.

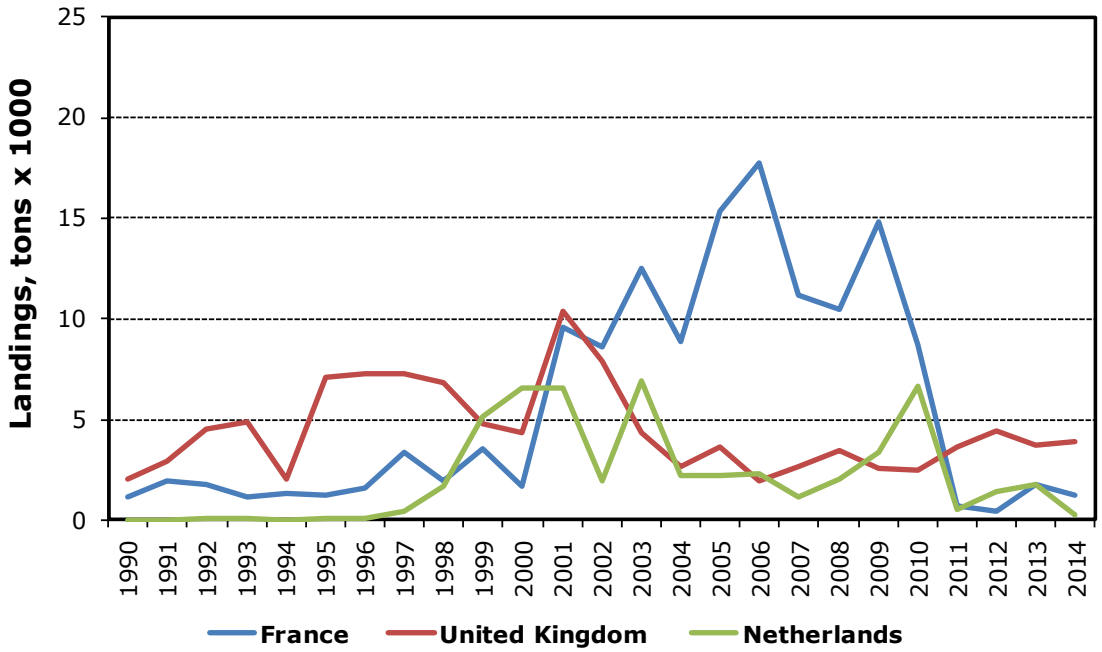
In Subarea VIII sardine is fished mainly by France and Spain (Figure 3). Fisheries in this area are important for both countries, economically and socially. Sardine is used for human consumption, fresh and canned.

Figure 1: Northern stock: total sardine landings by ICES Subarea from 1990 to 2014



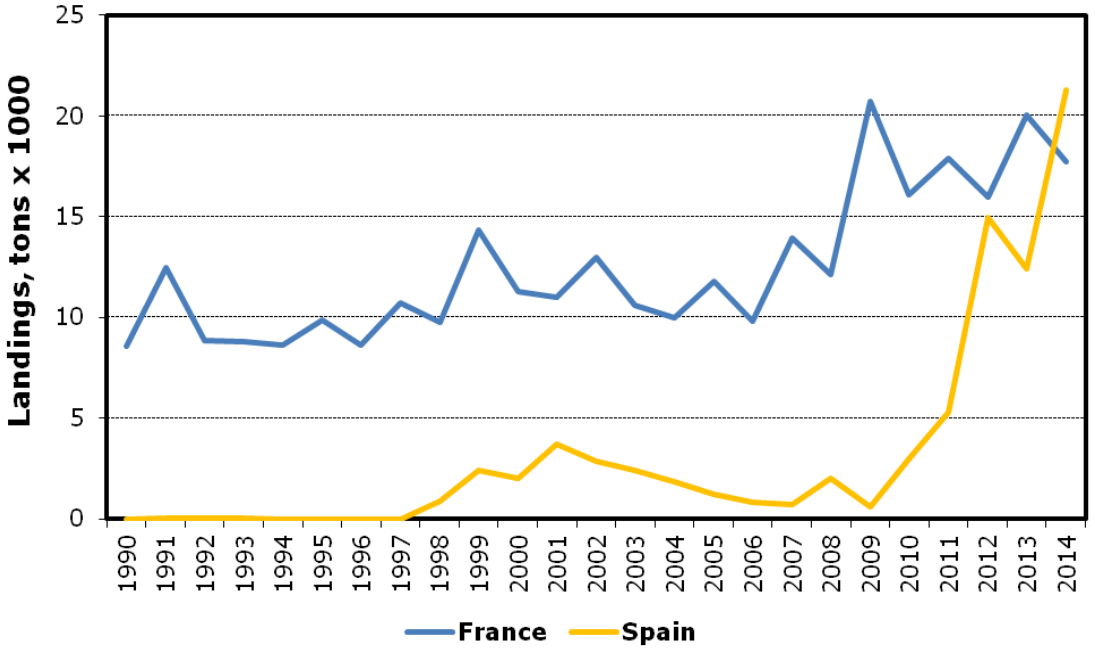
Source: ICES, 2015

Figure 2: Northern stock: sardine landings by country in ICES Subarea VII from 1990 to 2014



Source: ICES, 2015

Figure 3: Northern stock: sardine landings by country in ICES Subarea VIII from 1990 to 2014



Source: ICES, 2015.
Note: In Figures 1 to 3, the countries shown in the graph represent more than 83% of annual landings in the area in the past 10 years.

1.1.1. Fishing fleets

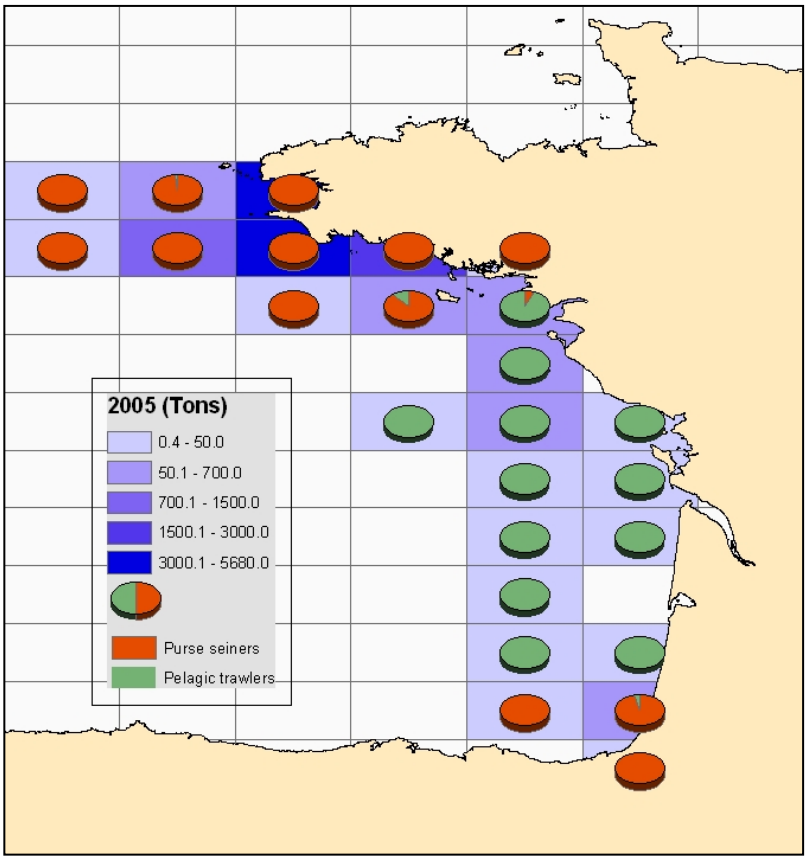
The **French** fishery of sardine is divided into two groups defined by the gears used: purse seine and pelagic trawl operated by pair trawlers. The number of vessels has been relatively stable since 1993, with around 30 purse seiners and 20 trawlers (Table 1.1.1.1). The average length of the two groups of vessels is 18 m.

Purse seiners operate often in coastal areas (<10 nautical miles) (Figure 4); trawlers may operate until 50 nautical miles offshore but are banned inside the three miles coastal zone. Both pair trawlers and purse-seiners operate close to their base harbour when targeting sardine.

Purse seiners target sardine more or less all year round, but with a seasonal peak in the summer. In average, these vessels are responsible for 80 % of the total annual landings of sardine along the French Atlantic coast. They are mainly located in Brittany. Some vessels are located in the southern part of the Bay of Biscay, but they mainly target horse mackerel and mackerel and catch very low quantities of sardine.

In addition, around 100 **Spanish** purse seine vessels registered in the Basque Country, Cantabria, Asturias and Galicia are licensed to fish sardine in sub-area VIIIb (Bureau Veritas, 2010). These vessels fish sardine mainly in spring and autumn.

Figure 4: Northern stock: Spatial distribution of French sardine catches by purse seiners and pelagic trawlers in Subarea VIII

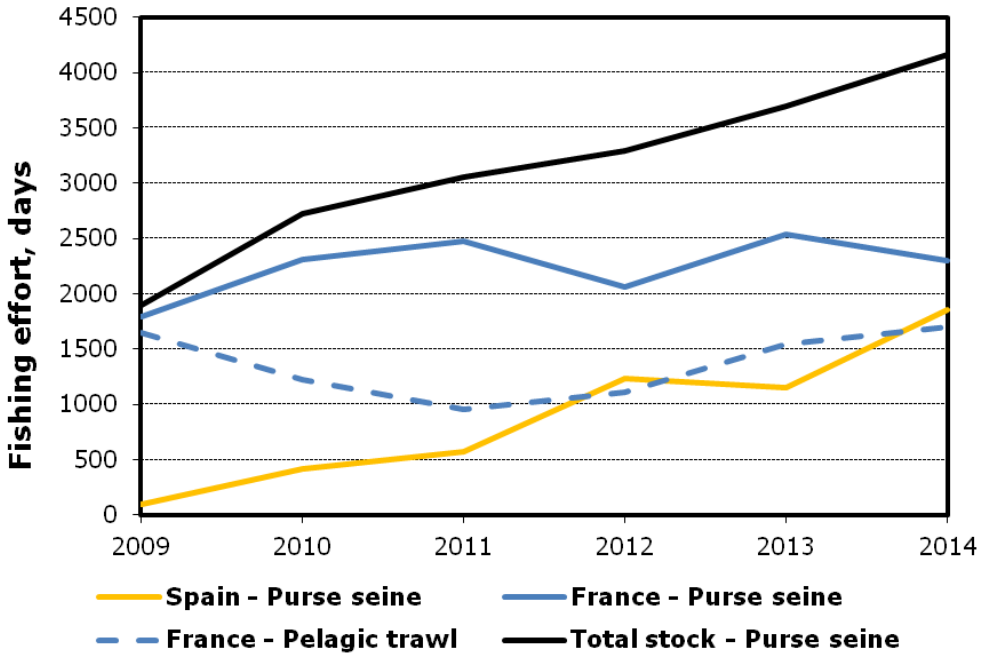


Source: ICES, 2015.

1.1.2. Fishing effort

Effort targeting sardine in Subarea VIII has doubled from 2 000 days in 2009 to 4 000 days in 2014 due to the increase of the activity of the Spanish purse seine fleet in the area (Figure 5). According to information available to authors, in recent years, French purse seine vessels regulate their effort to keep a minimum price between 0.5 and 1 €/kg.

Figure 5: Northern stock: Number of fishing days by country and fishery in Subarea VIII



Source: French log-book data.
Note: Purse seine effort includes only the number of days that vessels landed, i.e. does not include trips with no catch or landing. Pelagic trawl effort refers to pair or single trawlers with annual sardine catch > 50 tonnes.

1.1.3. Landings

Sardine is one of the most important species in French fisheries in terms of quantity landed. It is the most important species for the French purse seine fishery, representing around 95 % of the landings. In winter, purse seiners occasionally catch sea bream, mullet or mackerel. Pelagic trawlers are more opportunistic. Some pelagic trawlers have contracts and deliver their sardine catch directly to canning factories.

French landings consistently increased from 1983 to 2008, with values ranging from 4367 tonnes in 1983 to 21 104 tonnes in 2008 (Figure 3). Since 2009, they display a decreasing trend which stopped in 2013 with 20 066 tonnes landed, close to the historical series maximum. About 90% of French catches are taken by purse-seiners while the remaining 10% is reported by pelagic trawlers (mainly pair trawlers). The highest catches are taken in summer. Almost all the catches are taken in southwest Brittany.

Spanish landings averaged around 4000 tonnes in the late 1990s early 2000s, decreased until 2010 to below 1 000 tonnes (Figure 3). Since 2011, landings raised sharply, reaching 16 237 tonnes in 2014. The recent increase is due to fishing restrictions implemented for Southern sardine stock.

1.1.4. Employment

According to direct employment information available to authors, each purse seiner operating in French waters employs 7 people thus a provisional number of fishermen on board purse seiners is around 200.

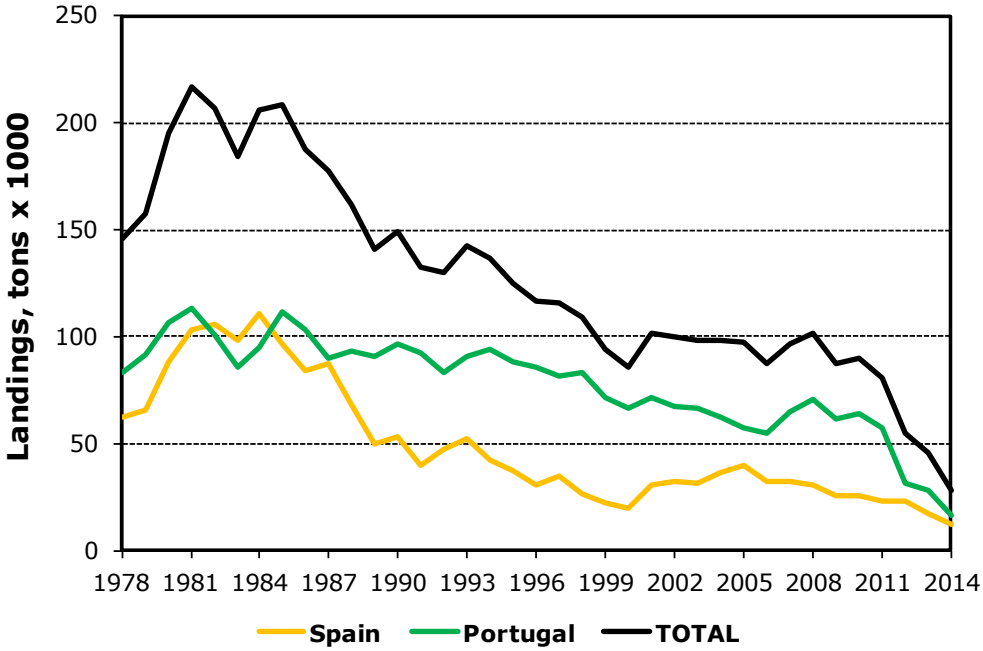
1.2. Southern stock (Sardine in ICES Subarea VIIIc and Division IXa)

The southern sardine stock is fished by **Spain** and **Portugal**. Sardine is used for human consumption, fresh and canned. Total sardine landings by country and area are presented in Annex II.

For both countries the bulk of sardine landings (97% in weight and 98% in value) are made by purse seiners. The remaining is taken as by-catch in the bottom trawl fishery and in local small-scale fisheries. Discards are considered to be negligible. A small number of purse seine vessels from each country may fish within territorial waters of the other country.

Landings from the whole stock show a continuous decrease since 1981 from 217 000 tonnes to 28 000 tonnes in 2014 (Figure 6). Strict regulations implemented from 2011 onwards led to drastic decreases of landings of 32% from 2011 to 2012 and 39% from 2013 to 2014.

Figure 6: Stock: total landings and by country between 1978 and 2014



Source: ICES, 2015.
Note: In Spain, catch regulations started in 1985. In Portugal, catches were regulated from 2000 to 2004 and again since 2010.

1.2.1. Fishing fleets

In Spain, 364 purse seiners were fishing in 2014 (Table 2). Around 77% of the purse seine fleet operates in the Cantabrian and northwest waters (here named North) and the remaining 23% operate in the Gulf of Cadiz (here named Cadiz). The total number of vessels has decreased in recent years. In the North 92% of the fleet targets sardine, while 100% of the purse seiners in Cadiz catch sardine at some time of the year.

Vessels of the North Spanish fleet are larger and have more engine power than vessels in the South fleet. In the North vessels LOA ranges between 9.6 to 29.7 m (average of 24.6 m) and engine power from 33.8 to 809.4 kW (average of 24.6 kW). Sardine, horse mackerel, mackerel and anchovy are the main species in the catch (Castro et al., 2011) (Figure 7).

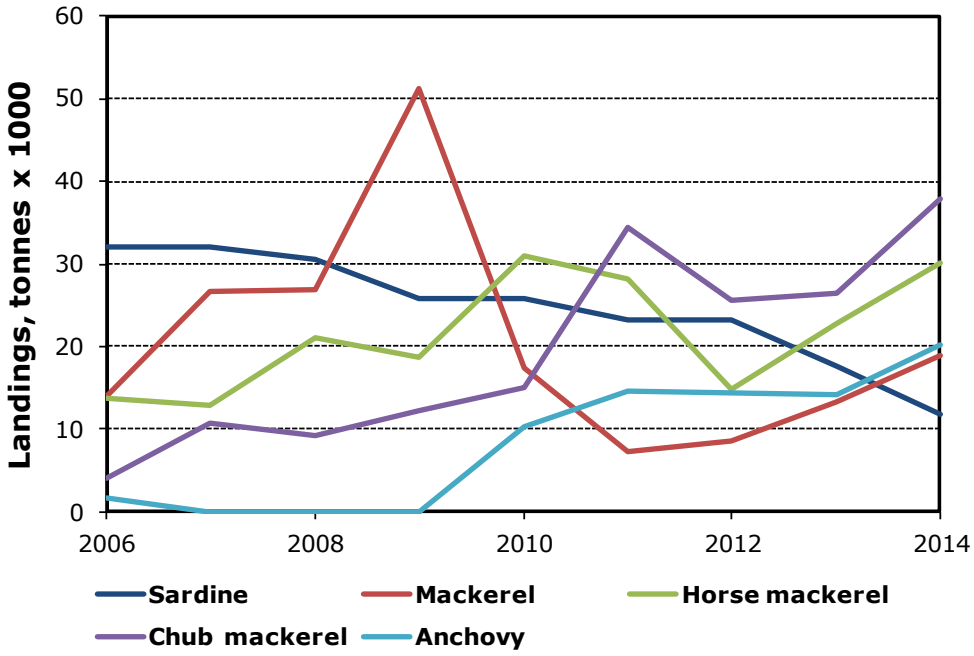
In the South of Spain, the traditional fishery in the Gulf of Cadiz targeting small pelagic species is developed by purse seiners with an average LOA of 16.8 m (range from 10.8 m to 24.5 m) and a power range from 20.6 to 306.5 kW (average 137.9 kW). This fleet is mainly directed towards anchovy although during the last years sardine has exceeded their landings (Castro et al., 2011).

Table 2: Southern stock: number of purse seine vessels by country from 2009 to 2014

Year	Spain North	Spain Cadiz	Spain Total	Portugal	Total Stock
2009	306	103	409	125	534
2010	304	96	400	121	521
2011	296	92	388	147	535
2012	287	86	373	176	549
2013	281	85	366	176	542
2014	280	84	364	182	546

Source: Portugal: INE, 2009-2014; Spain: Castro et al 2011.

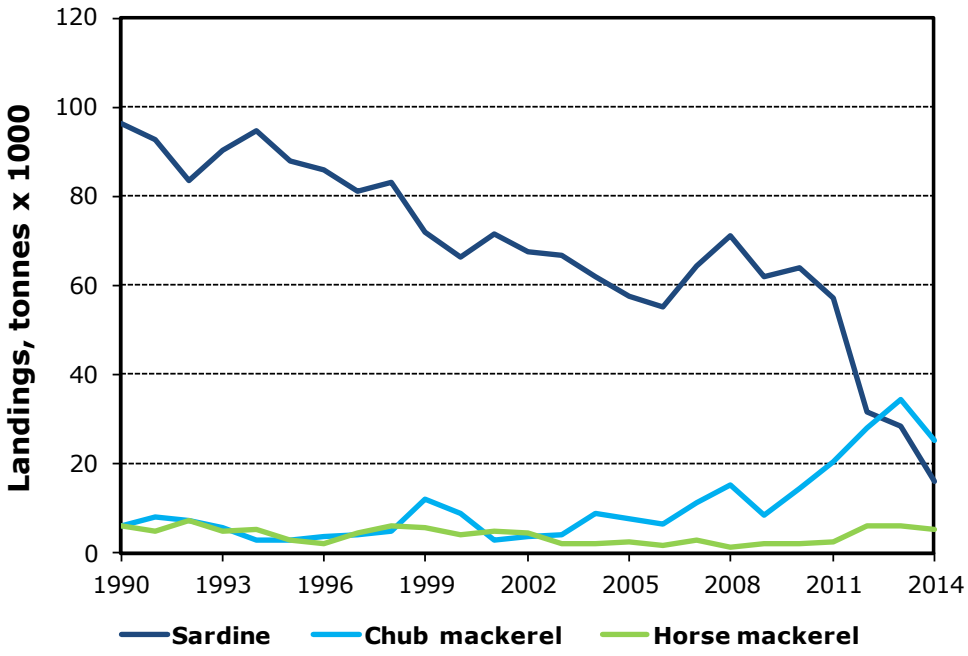
Figure 7: Southern stock: landings of sardine, chub mackerel and horse mackerel in the Spanish purse seine fishery in 2006-2014. For anchovy, landings of Division VIII are also included



In **Portugal**, the purse seine fleet had 182 licensed vessels in 2014 in fleet segment 4K4[1].There are additionally 50-70 polyvalent (i.e. multi-gear) local and coastal[2] vessels (segments 4K1 and 4K2) with license for purse seining, which catch sardine occasionally. The purse seine fleet decreased 30% from 1990 to 2011 and increased since 2011, due to the re-classification of polyvalent vessels which fished mainly sardine, in the purse seine segment (Table 2). Because these new entries were generally small vessels, the average GT and engine power reported for the fleet decreased. The fleet targets sardine but also catches other small and medium pelagic species, such as chub mackerel and horse mackerel. Chub mackerel landings have increased in recent years due to limitations to fish sardine (Figure 8).

Portuguese purse seine vessels range from <10 m to 40 m LOA (the majority is between 18 and 24 m), with an average GT of 43 tonnes and engine power of 215 kW. The bigger vessels ("cercadoras" or "traineiras") use a small auxiliary vessel to aid with the operation of the net ("chalandra" or "chata") Smaller purse seiners (<15-16 m LOA, named "tucas" ou "rapas") are concentrated in a few ports, usually operate in shallower waters with smaller nets and smaller mesh size (16 mm) than "traineiras". Around 60% of the purse seine vessels have their homeport in the North, 30% in the South and 10% in the Southwest (INE, 1990-2014).

Figure 8: Southern stock: Landings in weight of sardine, chub mackerel and horse mackerel in the Portuguese purse seine fishery in 1990- 2014



Source: ICES, 2015.

In both Spain and Portugal, sardine is also caught by the small scale fisheries fleets. These fisheries have negligible importance in terms of landings weight/value but are important in social and cultural terms; they are established in coastal communities for many generations and became part of the individual and collective identity of community members.

[1] Fleet segment 4K4, Code MAPG IV (seine, small pelagics), COMMISSION REGULATION (EC) No 2091/98 of 30 September 1998 and COMMISSION REGULATION (EC) No 26/2004 of 30 December 2003.

[2] Local fishing vessels are < 9 m LOA and operate closer to homeport and to the coastline than coastal fishing vessels (>9 m).

"Xeito" is an artisanal driftnet fishery that catches adult sardine (97.5% of the total catches) in Galicia (Division IXa North). There are around 430 small fishing boats (<6 m) involved in this fishery (Table 3), most of them with a crew of 2 men. The fishery is controlled by Regional Regulations[3] laying down technical measures and effort limitation. Each boat lands on average of 79.3 kg of sardine per trip (Xunta de Galicia, 2014) and annual landings are around 200-300 tonnes. Discards are negligible. Maximum activity is concentrated in the summer (June-September).

"Sardinheiras" is a very small (~6 vessels) driftnet fishery similar to Galician "xeito" operated by vessels of LOA < 9 m (Martins et al. 2003) during summer in beaches near to Lisbon (Table 3). Landings of sardine are around 15 tonnes per year. Sardine is also caught in the summer beach seine fishery which targets horse mackerel in the northern coast and south of Lisbon. The fishery involves ca. 50 vessels with an average LOA of 7.8 m, of 3 tonnes, and engine power of 34.7 kW (Table 3). Sardine landings are around 100 tonnes per year. The beach seine operates in shore areas that are important nursery areas for several species, including sardine (Jorge et al. 2002; Cabral et al. 2003). It is currently monitored within the framework of a Portuguese Commission joining managers, stakeholders and scientists[4].

Table 3: Southern stock: number of vessels in small scale fisheries catching sardine in 2009-2013

Year	Spain "Xeito"	Portugal "Sardinheiras"	Portugal Beach seine
2009	444	5	57
2010	446	1	57
2011	443	5	58
2012	435	6	53
2013	428	6	53

Source: Portugal: DGRM database. Spain: Xunta de Galicia, 2014.

1.2.2. Fishing effort

For the **Spanish** purse seine fleet, it is possible to separate fishing trips targeting sardine from those targeting other species (Table 4). The percentage of trips targeting sardine decreased from 45% in 2009 to 23 % in 2014 (Table 4B). The fishery in the Gulf of Cadiz is more directed to sardine than the fishery in northern waters.

The **Portuguese** purse seine fishery targets mainly sardine but in recent years targeting chub mackerel and horse mackerels increased due to restrictions to fish sardine.

The total number of purse seine trips targeting sardine per year in the whole stock area decreased from ca. 30 000 in 2009-2011 to ca. 20 000 in 2014 (Table 4A). Between 40 and 50% of the trips are carried out by the Portuguese fleet. The major decrease, 53%, was

[3] Diario Oficial de Galicia, No 31 of 15/02/2011.
[4] Portaria n.º 4/2013 from january 7, Diário da República, 1.ª série — N.º 4.

seen in the north of Spain followed by the Gulf of Cadiz (38%) and Portugal (12%).The mean number of trips per vessel decreased as well, from 148 in 2011 to 105 in 2014.

In **Portugal**, effort restrictions intensified in 2012 contributed to reduce fishing effort but scarcity of sardine started to be felt by the fleet may have played a role as well. The reduction of distribution area of sardine in the Iberian Peninsula, as a result of the decline in stock biomass, has been most evident in Spain than in Portugal in recent decades (since the bulk of population is located in Portugal).This has meant that for years there has been a decrease in purse seine effort directed to sardine against purse seiner effort dedicated to other species.

Table 4: Southern stock: number of fishing days per year for purse seine fleets

(A) targeting sardine

Year	Spain North	Spain Cadiz	Spain Total	Portugal	Total Stock
2009	11 624	5 888	17 512	12 225	29 737
2010	11 444	4 748	16 192	12 739	28 931
2011	11 491	5 245	16 736	13 291	30 027
2012	9 285	4 449	13 734	10 617	24 351
2013	7 451	4 248	11 699	11 988	23 687
2014	5 384	3 635	9 019	10 798	19 817

(B) not targeting sardine

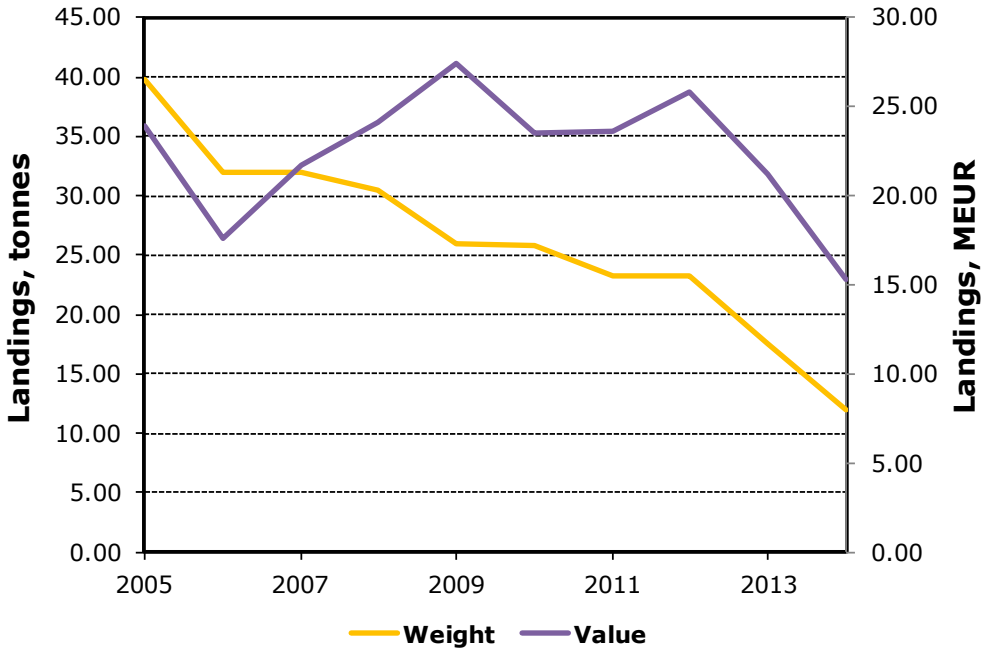
Year	Spain North	Spain Cadiz	Spain Total
2009	17 244	4 034	21 278
2010	18 247	4 261	22 508
2011	23 033	5 285	28 318
2012	18 060	5 294	23 354
2013	19 294	6 916	26 210
2014	22 406	6 913	29 319

Source: Portugal: DGRM database. Spain:IEO database.
Note: The number of fishing days does not account for trips that didn't have landings; one fishing day is assumed to be equivalent to one day with landings.

1.2.3. Landings

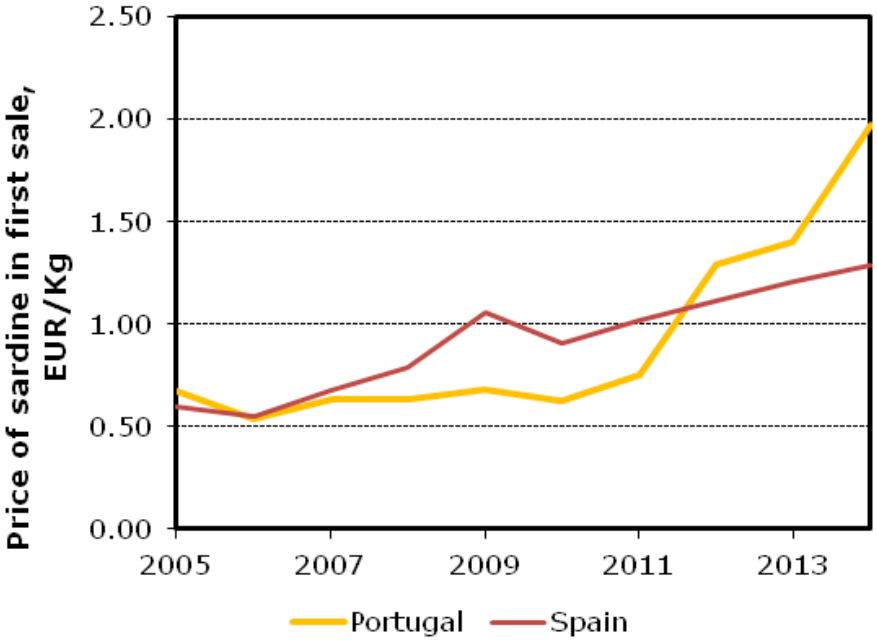
Landings of sardine in the **Spanish** fishery have dropped dramatically from the values around 100 000 tonnes in the 1980's, to 12,000 tonnes in 2014 (Figure 9). Landings in tonnes had a more pronounced decrease than landings in value due to the improvement in price per Kg at first sale (Figure 10); from 2005 to 2014, the price increased from 0.6 €/Kg to 1.3 €/Kg. In 2014, landings worth 15.3 MEUR.

Figure 9: Southern stock: Spanish sardine landings in weight and value adjusted by the consumer price index (CPI) to 2014 prices



Source: European Market Observatory for fisheries and aquaculture (EUMOFA) http://www.eumofa.eu/home.

Figure 10: Southern stock: Average price of sardine at first sale in Spain and Portugal, adjusted by the consumer price index (CPI) to 2014 prices

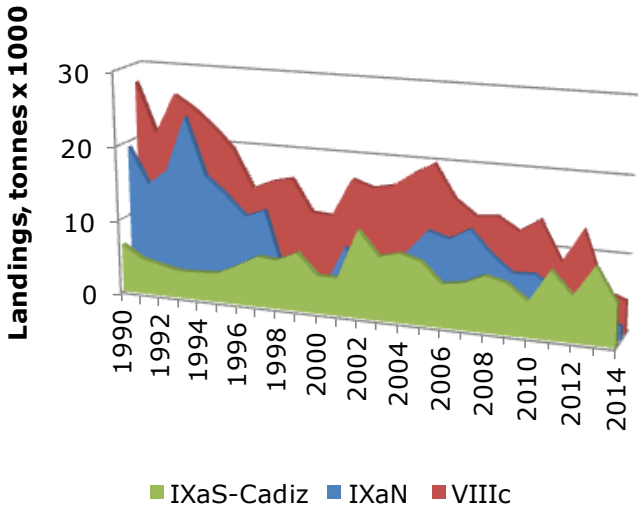


Source: European Market Observatory for fisheries and aquaculture (EUMOFA) http://www.eumofa.eu/home, INE 1990-2015.

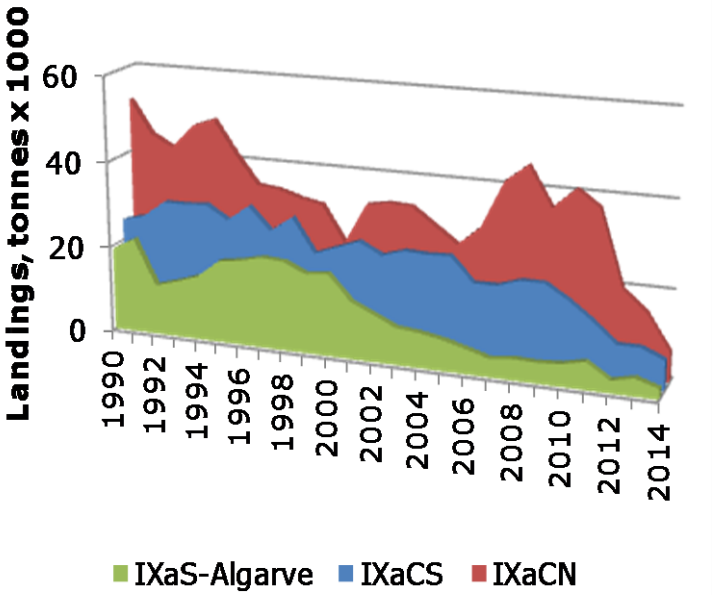
Historically, the bulk of the catches were taken in Galicia (Divisions IXa-North and VIIIc-West), but since 1985, as the stock has been declining, the relative importance of this area has decreased, due to shrinkage in the distribution area (Figure 11A). Nowadays half of catches were recorded in the Gulf of Cadiz, and 35% in Division VIIIc (Cantabrian Sea) and only around 15% in Galicia.

Figure 11: Southern stock: Spanish and Portuguese landings by ICES Subdivision

(A) Spanish landings by ICES Sub-division



(B) Portuguese landings by ICES Subdivision

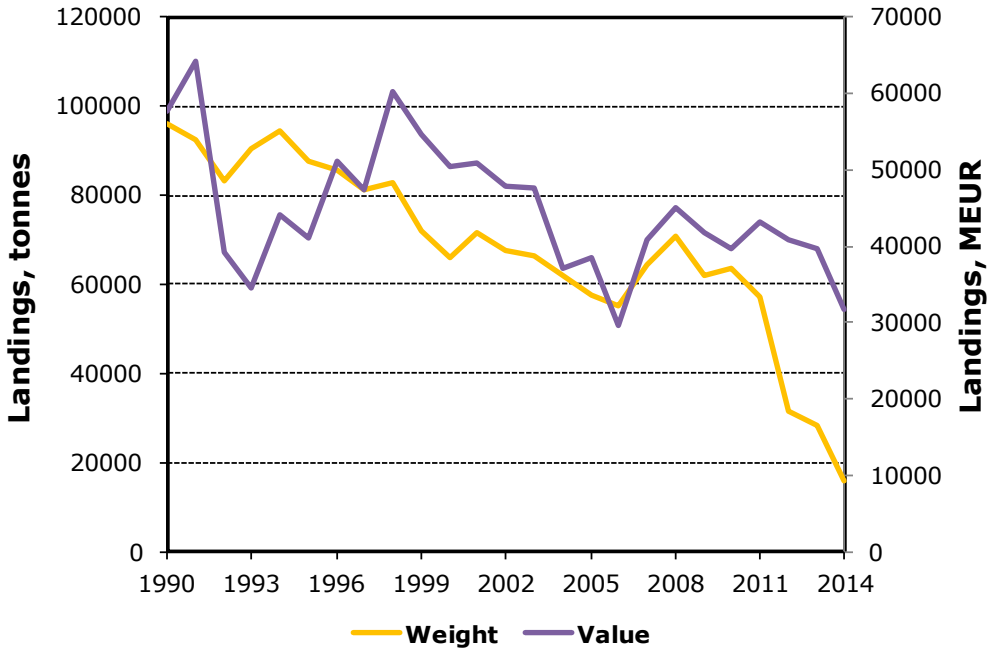


Source: ICES, 2015.

In **Portugal**, sardine is the second most important species both in weight and in value of landings (INE, 2015). Landings have also decreased since the 1980s, although not as much as in Spain. The major decrease (72%) took place from 2011 onwards due to catch regulations and low resource abundance (Figure 12). The value of landings at first sale, also shows a long term declining trend but in recent years, has not changed as much as the volume due to a large increase in the price per kg (Figures 10 and 12). Landings decreased from 96 000 tonnes in 1990, worth the equivalent to 57.7 MEUR to 16 000 tonnes in 2014 worth 31.MEUR. Over the same period, the average price of sardine per Kg at first sale increased from 0,6 €/Kg to 2 €/.

Sardine landings represent 88% in weight and 98% of the fishery landings in the North while in the south these percentages drop to 43% and 51% (Figure 11B). The fishery operates all year round although 60% of the landings take place in the second semester.

Figure 12: Southern stock: Portuguese landings in weight and value adjusted by the CPI to 2014 prices



Source: INE 1990-2015.

1.2.4. Employment

In **Spain** each purse seine vessel employs on average 10 fishers (MAGRAMA 2014a,b), thus in 2014, around 3 700 fishers were employed in the whole purse seine fishery. The number of fishers registered as working on the purse seine fleet decreased 27% since 2004.

In **Portugal**, the purse seine fishery employs 15 to 20 crew member depending on the size of the vessel. The number of registered Portuguese fishers in the purse seine fleet has decreased over the past 15 years, from 3691 fishers registered in 1990 to 2058 fishers in 2014, a decrease of almost 45%.

Table 5: Overview of sardine canning industry in Spain and Portugal

	Spain	Portugal
Canned sardine, tonnes	**>22 041**	**13 300** (2)
Canned sardine, MEUR	**n.a.**	**54.5** (2)
Exports canned sardine, tonnes	**6 271**(1)	**12 000**
Exports canned sardine, MEUR	**27.7**(1)	**58.9**
Countries for exports	**Italy, France, Portugal, UK, Germany**	**France, Italy, UK, Angola, USA, Canada, Japan, Israel**
Imports canned sardine, tonnes	**15 358**(1)	**9 700**
Imports canned sardine, MEUR	**46.1**(1)	**15**
Number people employed in canning industry	**12 000**	**3500**
% women employed in the canning industry	**>95**	**90-95**

(1) Values for Galicia, accumulated for 2012-2014; Galicia produces 80% of Spanish canned fish.
(2) Data for 2013 .

1.2.5. Canning industry

An overview of data for the Spanish and Portuguese canning industry is presented in Table 5. The authors note that, due to difficulties in obtaining data on this sector, the overview should be considered provisional, and offer a broad perception of the sector.

Data about the sardine canning industry is not available for **Spain** at the national level. We present relevant information about Galicia, which is the most important region in Spain in what concerns the fish canning industry, representing about 80% of the total Spanish production (*pers. comm*. Aymerich, 2015[5]). In 2014, there were 65 canning enterprises processing fishes and crustaceans, generating more than 12 000 direct jobs in the region (ANFACO, 2014). The production of the Galician canning industry reached 293 886 tonnes in 2013 with an economic value of 1 290 MEUR having almost duplicated since 2000. In volume, tuna represented 63% of the species processed, sardine represented 7.5% and mackerel 4.6% (ANFACO, 2014). A provisional estimate of total production of canned sardine in Galicia is around 22 041 tonnes.

The canning industry in Galicia (**Spain**) exported more than 6 000 tonnes of sardine products from 2012 to 2014, generating 27.7 MEUR in this 3 year-period. Regarding imports, the Galician canning industry imported more than 15 000 tonnes of sardine with a cumulative value of 46.1 MEUR for the same period. The main importing countries were Italy, France, Portugal, UK and Germany (Alimarket 2015). Internal (Galician) consumption of canned sardine between January 2012 and June 2014 amounted at almost 30 000 tonnes in volume and 233 MEUR (MAGRAMA 2015).

The **Portuguese** fish canning industry is a traditional industry and one of the most important food production exporting industries in Portugal (Dias, 1992; Mendes and

[5] ANFACO.

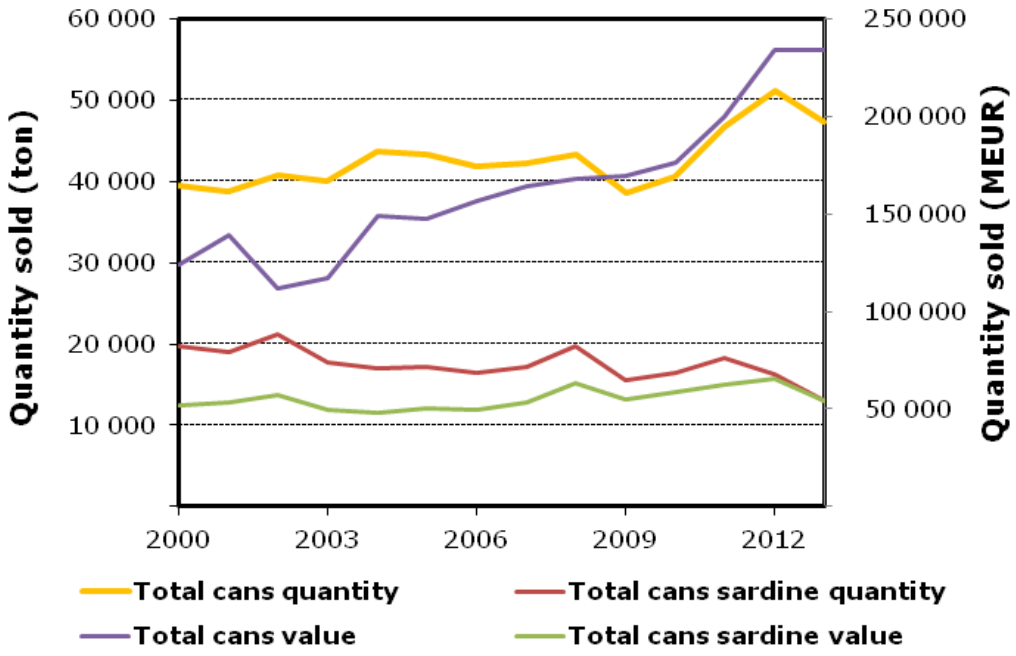
Borges, 2006). Over the years, usually between 40 to 50% of the annual landings of sardine go to the canning sector (*pers. comm*. Castro e Melo[6], 2010), which needs 30 000-35 000 tonnes of sardine per year for its operation (*pers. comm*. Castro e Melo, 2015). The industry tends to buy its raw material mostly from the Portuguese purse seine fleet. However, they also buy from abroad when there is little sardine in the Portuguese coast.

On average, over the last 15 years, the production of canned sardine was 17 000 tonnes per year, accounting for over 40% of the total production of the canning industry. In 2013, this value has decreased to 13 300 tonnes, 27% of the total production. For the same year the industry sold 54.5 MEUR of sardine canned products (Figure 13).

Currently there are twenty fish canning factories transforming mainly sardine, tuna and horse mackerel. For some factories, sardine accounts for over 50% of production (*pers. comm.* Castro e Melo, 2015). Recently, the industry has "modernized" and is producing more gourmet products and working with new species, decreasing its dependency on sardine.

The canning industry employs around 3500 people. All fish canning factories employ a minimum of 50 people, and in the peak of production a single factory can employ up to 700 people. It is estimated that another 1500 have indirect jobs related to the canning industry (can productions, sauce production, transportations, lithography, typography) (*pers. comm*. Castro e Melo, 2015).

Figure 13: Southern stock: Time series of quantity and value of canned total fish and sardine sold in Portugal



Source: INE 2000-2015.

[6] ANICP.

1.2.6. Role of women

It is difficult to have concrete number for female employment related to the sardine fishery but it is clear that both in Portugal and Spain the social dimension of the sardine fishery spans further than direct employment in fishing vessels, the industry contributes indirectly to jobs as well.

In **Spain**, data on the number of women employed in the sardine related industry is not available, mainly because fish companies usually harvest, process and commercialize different seafood products (including sardine) at the same time. Nevertheless, women are directly involved in all sorts of employment, from activities in the sea (e.g., shell fishing on foot) to the management and administration of medium to large companies. 8900 women were directly working on the fisheries [7] in 2013 (MAGRAMA 2015). The number has been declining since 2003, when there were 11 200 affiliated women. The canning industry, including sardine, employs 11 377 women. The total number of employed women in all sea related sectors reached almost 44 000, about 38% of the total number of jobs of the Spanish fisheries sector.

In **Portugal**, the canning industry is labour intensive, being an important employer of women in coastal communities highly dependent on fisheries, with little alternative employment opportunities (Pita et al., 2010). All together, it is estimated that 90 to 95% of the 3500 jobs in the canning industry are carried out by women (*pers. comm.* Castro e Melo, 2015).

1.2.7. Markets and trade

Exports of fresh or refrigerated sardine from **Spain** (Figure 14) show an increasing trend between 2000 and 2014 from 6 178 tonnes to 11791 tonnes. Usually, more than 75% of exported fresh or refrigerated sardine goes to Portugal. A small portion of exports has France, Croatia, Italy and the UK as final destinations. Imports are mainly from Italy and Portugal, and also increased between 2000 and 2014, from around 7 800 tonnes to 18 713 tonnes. The value of exports and imports of fresh or refrigerated sardine in Spain follows the above trends in the same period: exports increased from around 6 MEUR to almost 19 MEUR and imports increased from 6 MEUR to 20 MEUR, almost matching its trade balance.

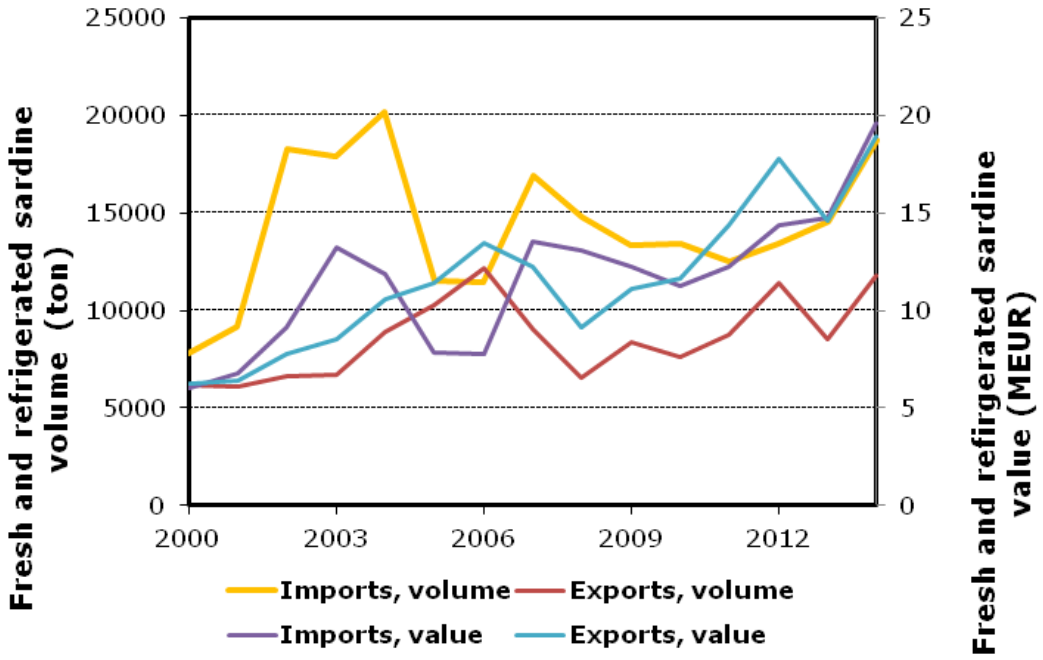
The volume of frozen sardine imports and exports by Spain have been comparatively higher than that of fresh or refrigerated sardine (Figure 15). Nevertheless, the value of fresh or refrigerated sardine is generally higher. The peak of frozen sardine imports was reached in 2011 with 42 778 tonnes, followed by a steep decline to around 17 000 tonnes in 2014. Spain imports frozen sardine mainly from Morocco, Netherlands, Croatia and Italy. Exports rose almost exponentially between 2007 and 2011 to 55 000 tonnes and then declined abruptly to around 10 000 tonnes in 2014. Portugal is the principal destination of exported frozen sardine.

In **Portugal**, traditionally, most of the canned sardine is exported, and the canning industry is the only industry of the fishery transformation sector with a positive trade balance. The production by the canning industry is exported both to European Union markets (France, Italy, UK) and further afield, such as Angola, USA, Canada, Japan, Israel. It is estimated that 80 to 85% of all Portuguese canned sardine is exported (*pers. comm.* Castro e Melo, 2015). Exports of canned sardine have been increasing over the last few years, namely up to 2013. This is a clear reflection of the MSC certification but also of an effort by the industry to find new markets, such as Poland (*pers. comm.* Castro e Melo,

[7] Special Regime for Sea Workers.

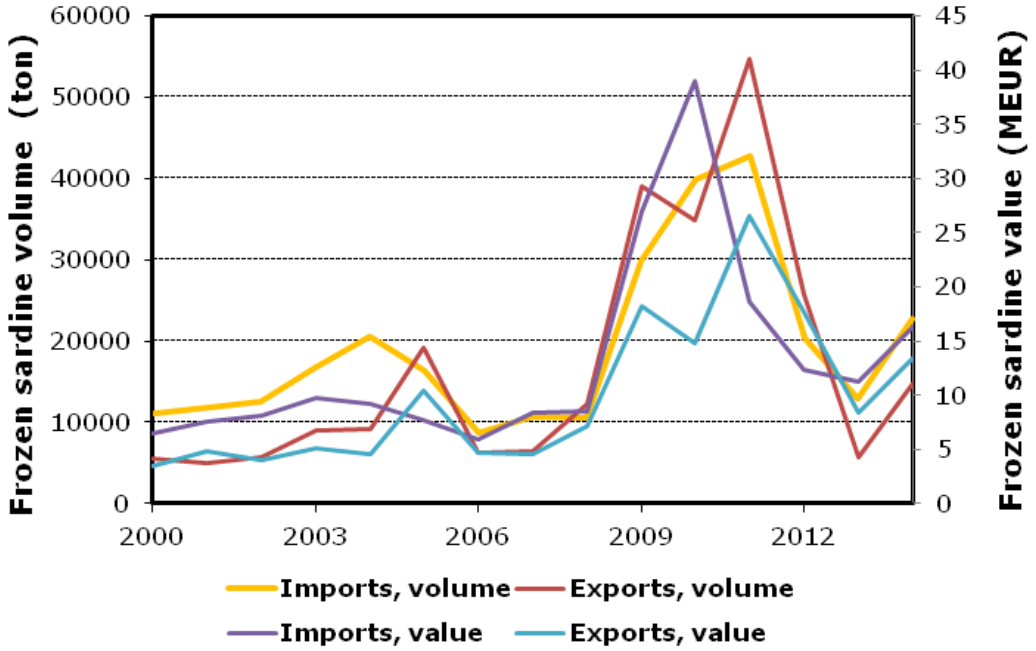
2015). Export by the canning industry increased 17% from 2012 to 2013, around 17 800 thousand tonnes of canned sardine were exported, accounting for 84.5 MEUR in sales (Figure 16). In 2014, just over 12 000 tonnes were exported, generating 58.9 MEUR. This decrease from 2013 to 2014 was mainly due to the decrease in the stock and not a market problem (*pers. comm.* Castro e Melo, 2015).

Figure 14: Southern stock: Time series of imports and exports, in weight (tonnes) and value (MEUR), of fresh and refrigerated sardine to/from Spain



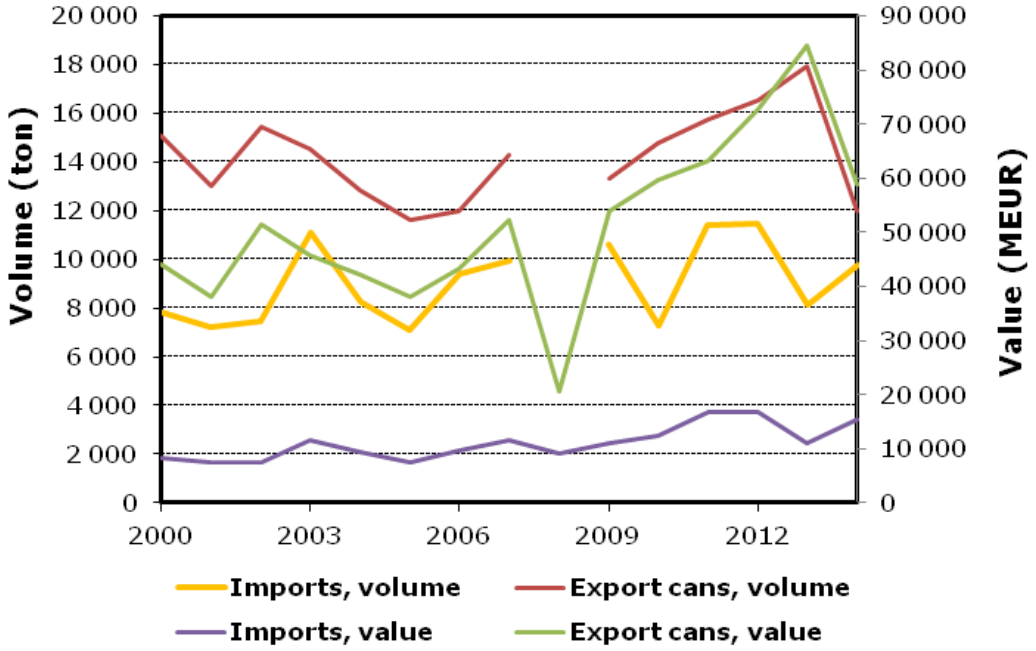
Source: Datacomex, Ministerio de Economia y Competitividad.

Figure 15: Southern stock: Time series of imports and exports, in quantity (tonnes) and value (MEUR), of frozen sardine to/from Spain



Source: Datacomex, Ministerio de Economia y Competitividad.

Figure 16: Southern stock: Time series of imports and exports, in quantity (tonnes) and value (MEUR), of sardine to/from Portugal



Source: INE 2000-2015.

2. STATUS OF THE SARDINE STOCKS

KEY FINDINGS

- **Northern stock:**
- There is no assessment of the whole stock due to insufficient data for Subarea VII; a trend-based assessment is performed for sardine in Subarea VIII (Bay of Biscay)
- Sardine in Subarea VIII shows an increasing trend over the last five years and the current level of exploitation is likely to be sustainable
- ICES advised that catches should be no more than 33 065 tonnes in each of the years 2016 and 2017
- **Southern stock:**
- The stock is assessed using a statistical catch-at-age model using fisheries and survey data covering the whole stock area
- Biomass decreased 71% over the past ten years, due to prolonged low recruitment, and is currently around the lowest historical level; reproductive capacity might be at risk
- Fishing mortality has been high in some recent years and in 2014 was still above a sustainable level; the implementation of strict catch limits has contributed to a decrease of 65% in fishing mortality from 2011 to 2014
- ICES advised that catches in 2016 should not be more than 1 587 tonnes.

2.1. Northern stock (Sardine in ICES Sub-areas VII and VIIIa,b,d)

2.1.1. Data and methods used in the evaluation of the stock

There is no assessment for the whole stock due to insufficient data on catch size composition and biological parameters and lack of surveys for Sub-area VII (Celtic Sea and English Channel). In consequence, there are no short-term predictions or reference points for management.

A trend-based assessment is performed for sub-area VIII (Bay of Biscay) based on a combined standardized index of abundance from two annual surveys: abundance estimates from PELGAS acoustic survey and egg abundance from the BIOMAN DEPM survey. Both surveys are carried out within the framework of the Data Collection Regulation[8] and analysed by ICES WGACEGG (e.g. ICES, 2014). The advice is based on a comparison of the two latest index values with the three preceding values, multiplied by the recent advised catch.

Landings data are considered to be accurate for all countries since 1989 within the whole stock area (Annex I). Discards were measured only in 2012 and were low based on the French Observers at sea program in the Bay of Biscay. For Subarea VIII, catches-at-length and -at-age are known since 1984 for Spain and since 2002 for France. Biological sampling

[8] Council Regulation (EC) No 199/2008 of 25 February 2008, concerning the establishment of a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy.

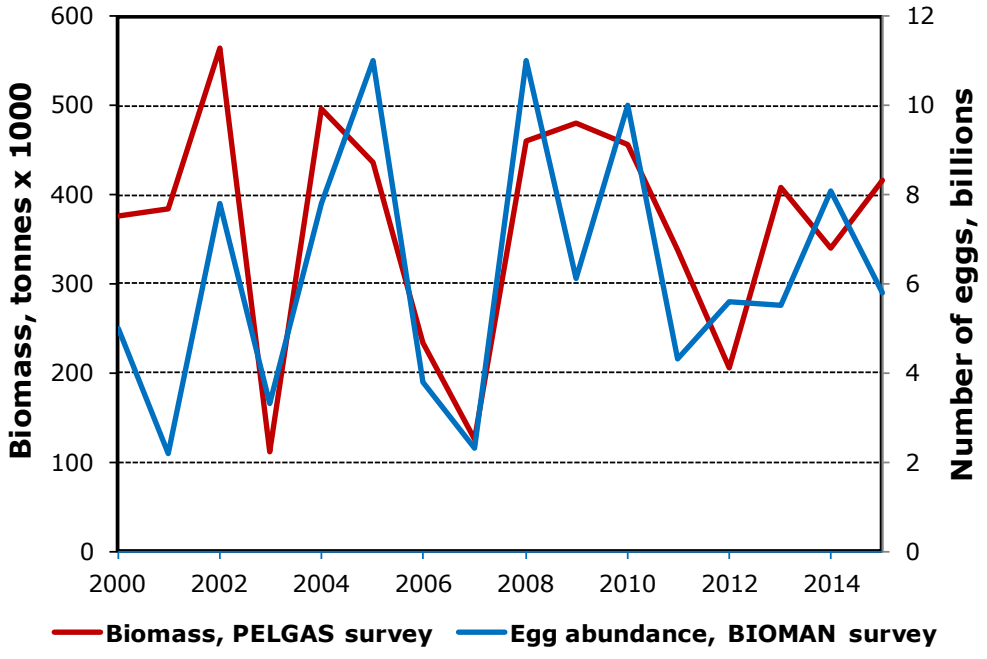
of the catches has been generally sufficient. Complete age composition and mean weight at age on half year basis, are reported each year (e.g. ICES, 2015).

The PELGAS and BIOMAN surveys are carried out annually in spring on the spawning stock since 1999. PELGAS provides spawning biomass and abundance at age estimates for the population in the area. The survey based monitoring system provides population estimates by the middle of the year, when a small part of the annual catches have been already taken.

2.1.2. Historical development of the stock

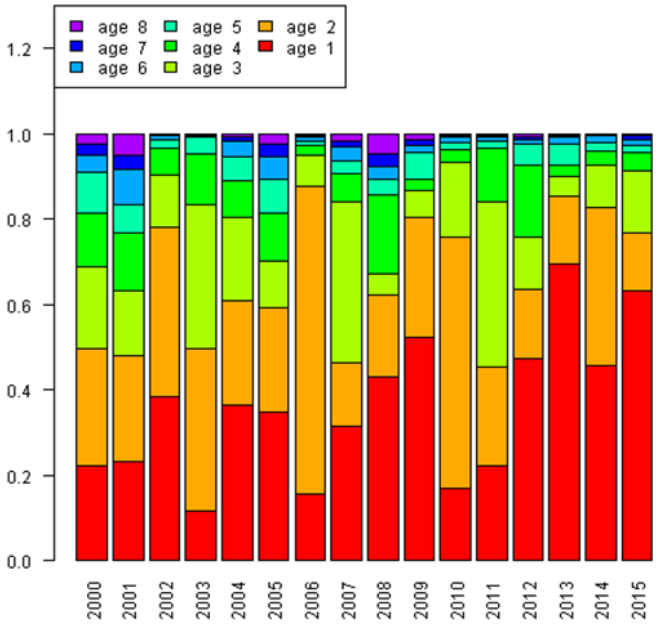
The indices of stock abundance for sub-area VIII (Bay of Biscay) show near cyclic patterns with episodes of lower biomass followed by a period of higher biomass (Figure 17). The composition of catches-at-age from the PELGAS survey shows substantial variations from one year to another (Figure 18). Both survey and commercial catch data indicate there have been frequent episodes of good recruitment in recent years (2011, 2012, 2013) which have lead overall to slightly increasing proportion of young individuals (1 and 2 years old) over the times series. In parallel, weight-at-age has been decreasing (Figure 19). There is no explanation for this decrease. It is assumed there are intra and interspecies competition for food in the oligotrophic waters of the Bay of Biscay which can lead to some density dependant effects.

Figure 17: Northern stock: Sardine abundance indices in Subarea VIIIa,b (Bay of Biscay) from 2002 to 2014



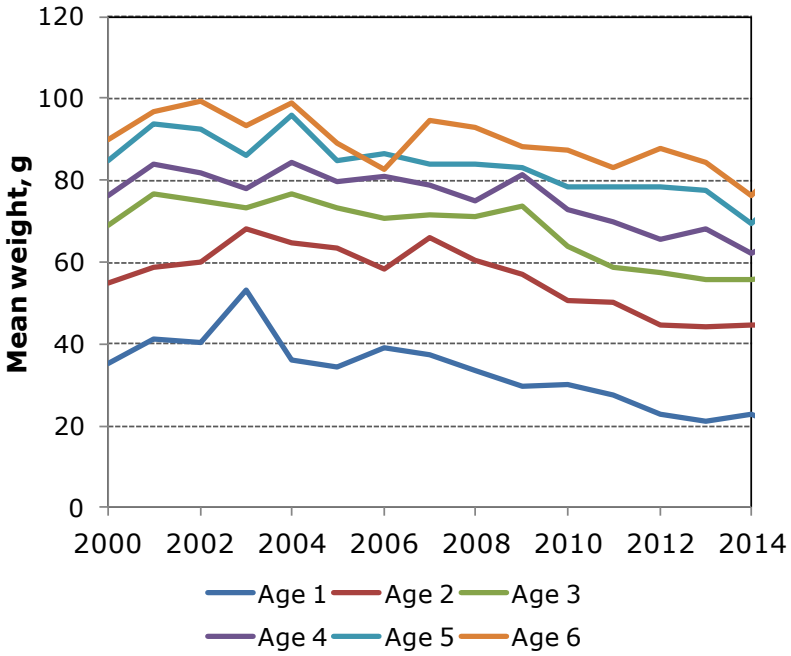
Source: ICES, 2015.

Figure 18: Northern stock: Age structure of sardine in Subarea VIIIa,b (Bay of Biscay)



Source: ICES, 2015.

Figure 19: Northern stock: Sardine mean weight-at-age in Subarea VIIIa,b (Bay of Biscay) from 2002 to 2014



Source: ICES, 2015.

2.1.3. Recent stock status

In the Bay of Biscay (Subarea VIII), sardine egg abundance in 2015 was 6.03E+12 eggs, near to the average of the historical series (Figure 17). In the French shelf, sardine eggs were encountered in the entire platform. The biomass estimated in 2015 was 416 524 tonnes, close to the historical series average, as observed for the egg abundance index

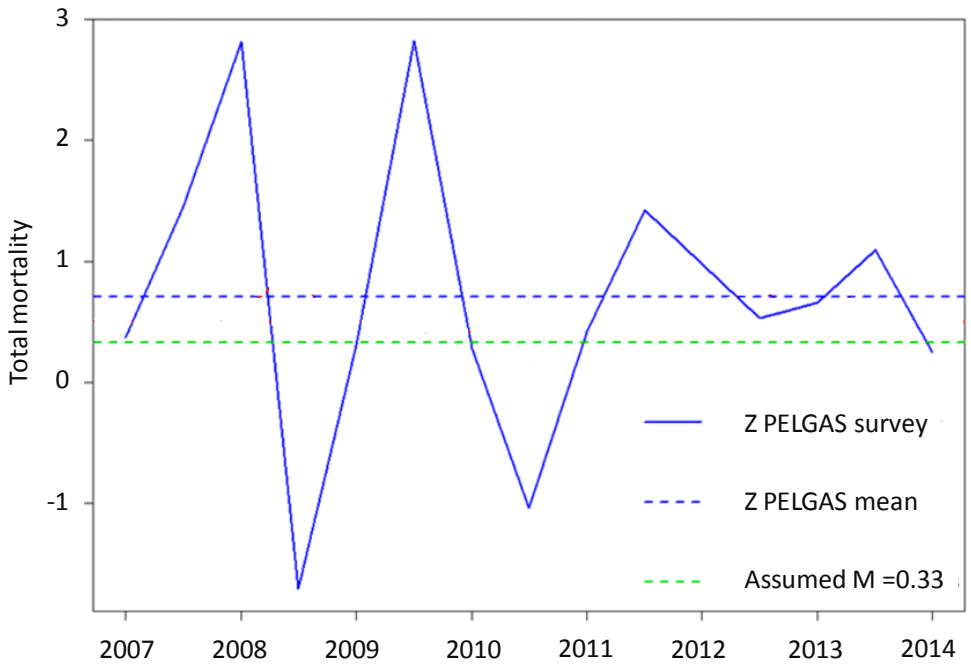
(Figure 17). Sardine was distributed all along the French coast of the Bay of Biscay. A small increase of the biomass has been observed in comparison to 2014. Recruitment in 2015 estimated in the acoustic survey was 7 million individuals, the second highest value in the historical series. Catch-at-age data corroborate a good recruitment in 2014. Young individuals (age 1, ~14 cm) were also distributed along the coast.

Provisional estimates of total mortality (Z) for ages 3-6 in the period 2002–2013 were 0.71 (standard deviation=1.31 per year) based on acoustic survey data (Figure 20). Assuming natural mortality of 0.33 per year, fishing mortality is calculated to be around 0.38 per year, that is, close to natural mortality (ICES, 2015b).

In summary, the stock size indicator shows an increasing trend over the last five years (ICES, 2015b). There have been several good recruitments in recent years, and the 2015 recruitment is indicated to be the highest of the historical series. Current harvest rate is close to the long-term mean and is likely to be close to FMSY; therefore the fishery appears to be sustainable. On the basis of the precautionary approach, ICES advised that catches should be no more than 33 065 tonnes in each of the years 2016 and 2017.

The status of the stock, as detailed above only refers to Subarea VIII (Bay of Biscay) and might not represent the situation of the Celtic Sea and English Channel.

Figure 20: Northern stock: Total mortality estimates from PELGAS and commercial fleets cohort tracking



Source: ICES, 2015.

2.2. Southern stock (Sardine in ICES Sub-areas VIIIc and Division IXa)

2.2.1. Data and methods used in the evaluation of the stock

The sardine stock is assessed using a statistical catch-at-age model (Stock Synthesis 3; Methot and Wetzel, 2012). The assessment assumes a single area (the whole stock area), a single fishery, a yearly season and genders combined. Input data for stock assessment include catch, age composition of the catch, total abundance and age composition from an

annual acoustic survey and spawning stock biomass from a triennial DEPM survey (ICES, 2012).

Catch-at-age data since 1978 (catch numbers-at-age, mean weights-at-age in the catch, mean length-at-age) are derived from the raised national figures routinely provided by both Spain and Portugal. These data are obtained either by market sampling or by onboard observers within the framework of the Data Collection Regulation[5].

The surveys used in the sardine assessment are the Spanish and Portuguese DEPM surveys carried out triennially since 1999 and the spring acoustic surveys carried out annually since 1996. Data from each of the national surveys is pooled into a single index of abundance providing a full coverage of the stock area. Portuguese and Spanish surveys are undertaken within the framework of Data Collection Regulation[5] and are coordinated within WGACEGG (ICES, 2014).

Outputs of the model are the historical series of estimates of B1+, recruitment and fishing mortality, by year, since 1978 and corresponding estimates of uncertainty (standard deviations).

The main uncertainties in the assessment relate to fishery selection patterns along the historical series and divergent signals in the stock trends between the DEPM and the acoustic surveys until 2008. The DEPM survey is carried out every three years. When a new DEPM point enters the assessment it has a large influence on the assessment if it is substantially different from the acoustic estimate. As the influence of the last DEPM data point weakens, over the following two years, the assessment becomes increasingly affected by the acoustic survey. The divergent survey signals contributed to an overestimation of the stock biomass and underestimation of fishing mortality during 2010-2013 and lead to the recommendation of catches likely above sustainable levels. The consistency in trends between the DEPM and acoustic surveys increased in recent years improving the agreement between current assessment and historical results. The extent of mixing with the Northern stock is uncertain although it seems to affect mainly the areas adjacent to the stock boundary in the Bay of Biscay corner.

2.2.2. Historical development of the stock

From 1978 to 2015 the biomass of sardine fluctuated between a minimum of 123 000 tonnes (2014) and a maximum of 962 000 tonnes (1993) showing an average value of 471 000 tonnes (Figure 21A).

Changes in biomass are tightly coupled to the timing and magnitude of recruitment: periods of high biomass develop shortly after (1-2) years of high recruitment and periods of decreasing and low biomass develop shortly after years of low recruitment. For example, high biomass in 1993-1995 followed the 1991 and 1992 recruitment peaks whereas the decrease of the stock in the late 1990s followed a prolonged period of low recruitment (7 years) (Figure 21A,B).

High recruitments are critical for the recovery of the biomass. The time series of sardine recruitment has been characterised by the appearance of high recruitment in one or two consecutive years separated by several years of low recruitment (every 4 years, on average; Santos et al., 2012) (Figure 21 B). There are two important aspects about the historical development of sardine recruitment: it shows a downward trend, both low recruitments and high recruitments have decreased in magnitude, and the appearance of strong recruitments became more widely spaced. There have been nine consecutive years of low recruitment up to 2014. The causes of low recruitment are unknown, although it is likely that environmental conditions have played an important role (see General Information).

F oscillated between 0.19 per year and 0.68 per year showing an average value (0.36 per year) slightly higher than natural mortality (0.33 per year) (Figure 21 C). Fishing mortality has been well below the level that might jeopardize stock renewal (0.51 per year; see below) throughout most of the (known) fishery history. However it was above that level from 2011 to 2013 and may have contributed to the decrease of the stock.

The biomass of the stock decreased 71% over the past 10 years (2007-2015) due to prolonged low recruitment. High fishing mortality in recent years may have contributed to delay stock recovery. The stock consists mostly of young individuals and therefore is likely to have relatively low reproductive potential since younger/smaller sardines contribute proportionally less than older/larger sardines to annual fecundity egg production (Nunes et al. 2011). Concomitant with the decrease in biomass, the distribution and spawning areas decreased substantially (Massé et al., *in press*).

2.2.3. Recent stock status

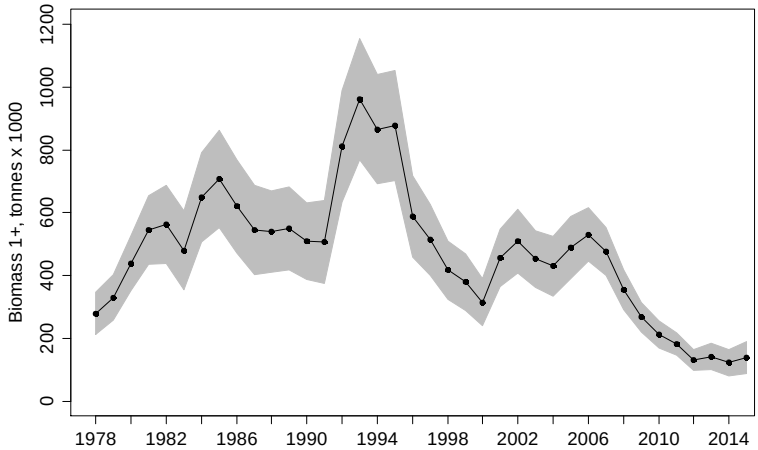
In the beginning of 2015, the sardine biomass, 139 000 tonnes, was around the lowest historical level. The stock is considered to be at risk of reduced reproductive capacity (ICES, 2015b). Fishing mortality decreased 60% from 2011 to 2014 due to the strong reduction of catches (65%). It was estimated to be 0.27 per year in 2014 i.e. around 80% of natural mortality, a level which conforms to the general considerations for choosing F based on M (Deriso, 1982). However, it is still above the harvest rate considered to be sustainable by the MP (0.22 per year, ICES, 2013a,b).

It is noted that, at present, the development of the stock and the fishery are mainly dependent on the strength of the incoming recruitment. A high survivorship of recruits until older ages is also important to improve the reproductive potential of the stock and therefore future recruitment. In fact, if recruitment continues to be at a low level, biomass will grow 14% until 2017 with a closure of the fishery, according to the short term forecast of the stock (ICES, 2015b). However, a scenario considering catches in 2016 similar to those in 2014 (30 000 tonnes) will not allow virtually any recovery of the biomass up to 2017 (<2% increase).

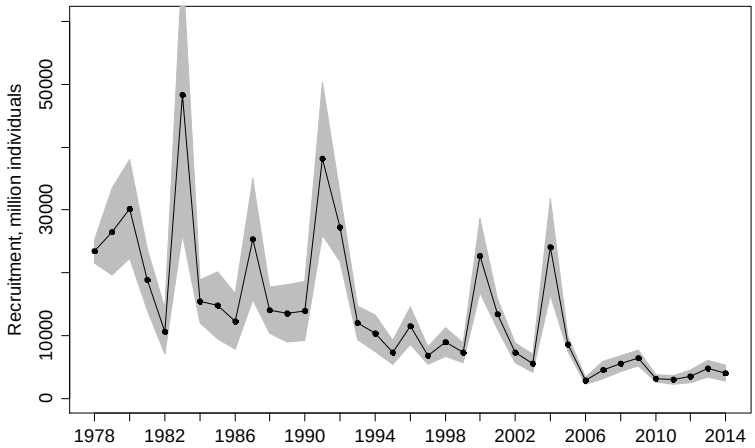
On the basis of the sardine MP (see below) ICES advised that catches in 2016 should not be more than 1 587 tonnes.

Figure 21: Southern stock: Summary plots of the latest stock assessment. Historical series of biomass (B1+), recruitmentand fishing mortality. Shaded areas show 95% confidence intervals

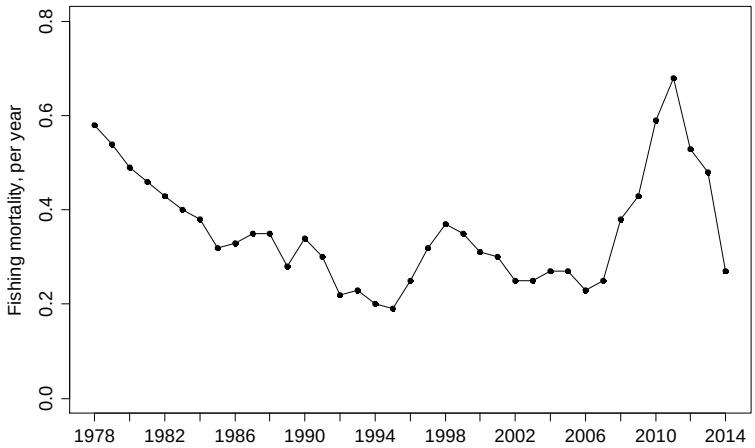
(A) Biomass



(B) Recruitment



(C) Fishing mortality



Source: ICES, 2015.

3. MANAGEMENT OF SARDINE FISHERIES

KEY FINDINGS

- None of the stocks is managed by EU TAC
- Management measures in effect for the Northern stock include technical measures and limits to purse seine licensing in French waters; the fishery in Subarea VIIIc appears to be regulated by the market
- Management measures in effect for the Southern stock include technical measures, limits to fishing effort and catches
- A Management Plan, consisting of catch based HCR, was implemented by Spain and Portugal since 2014
- Possible measures which might be considered to improve sardine management are briefly discussed: for the Northern stock, the development of a MP; for the Southern stock the revision of some technical measures and the revision of the MP.

3.1. Northern stock (Sardine in ICES Sub-areas VII and VIIIa,b,d)

3.1.1. Historical overview of management

There are currently no management measures implemented for this stock in the Bay of Biscay, English Channel and Celtic sea apart from the Minimum Landing Size of 11 cm. Entries of new vessels into the fisheries are also limited by national regulations: licensing scheme for seiners and licensing scheme for anchovy fishery.

Since 2013, ICES is requested to give advice for the Northern sardine stock, on a biannual basis. ICES advice has not lead to any implementation of management measures so far, possibly because of the good shape of the stock and the low fishing pressure.

3.1.2. Management measures in effect

There is currently no EU TAC for this stock. The fisheries appear to be regulated by market price. Some fisheries (e.g. French fleets in the Bay of Biscay) have set their own local management plans in order to sustain a desired market price which implies targeting fish of certain sizes and limits to the total amount of catch. The main driver of this fishery is considered to be the market. Many fishers could catch more sardine than they actually do since the fish is available, but this would lower the price.

3.1.3. Possible management measures

Until recently, the absence of a TAC was not seen as a problem for the management of the fisheries in this area as the demand for sardine was considered to be low for the whole stock unit. However the increasing fishing activity in the Bay of Biscay, possibly in response to the decline of fishing activity for the Southern stock (due to the limitations imposed on catches) is considered by some fishermen as a cause for concern. In addition, the decreasing size of the fish in the Bay of Biscay and its subsequent unsuitability for the canning industry, leads to low market prices. Both issues have raised the interest of fishermen in setting at least a TAC in a near future as a possible management measure. In that context, the development of a HCR to inform on the TAC level in a participatory process with stakeholders, managers and scientists could be valuable.

As referred in sub-chapter 2.1.1, most information for the Northern stock refers to Subarea VIII (Bay of Biscay), despite evidence that fisheries outside the Bay of Biscay operate differently and that the fish itself might not belong to the same population. This currently impairs any assessment and a solid basis for management measures. Therefore the implementation of any management measures outside the Bay of Biscay will require setting a vigorous data collection program for sardine in the Celtic Sea and English Channel.

3.2. Southern stock (Sardine in ICES Sub-areas VIIIc and Division IXa)

3.2.1. Historical overview of management

Annex III provides an overview of measures and regulations implemented over time to manage the Southern sardine stock.

The earliest Portuguese regulation for the management of sardine dates from the beginning of the 20th century[9]. It regulated gear specifications, access rights to coastal areas, fishing periods and effort of the different fishing methods (at the time sardine was fished mainly in the south coast using traps[10] specifically developed to catch sardine).

In 1987, the European regulation for the conservation of fishing resources[11] was transposed to national legislation to set the overall legal framework of fishing activity and specific measures for each fishery in both Spain and Portugal (Annex III).

In 1997, following the evaluation that the stock was outside safe biological limits and advice to reduce fishing mortality, additional measures were adopted to limit effort on sardine and protection of spawning stock in both Galicia (NW Spain) and Portugal. Regulations were more restrictive in the northern area to reflect the perception of a sharper sardine decrease in that area. Given continuing signs of low stock level, regulations were reviewed and extended and for example, in Portugal annual catch limits were established from 2000 to 2004. Following strong recruitments in 2000 and 2004 the stock showed a notable recovery and, in Portugal, annual catches and fishing days were not limited from 2005 to 2009.

In 2010, the stock started to decrease again after five years lacking strong recruitments. Catch and effort limitations were re-introduced in Portugal in 2010 and have, since then, been enforced. A Commission for the Sardine Fishery was set up by the Ministry, coordinated by DGRM and involving representatives of IPMA, DOCAPESCA, ANOPCERCO and ANICP. One of the tasks of the Sardine Commission was to develop a MP for the sardine fishery. The MSC certification process was a strong motivation to develop a MP for the Portuguese sardine fishery. Catch limits for the Portuguese fishery have been set on the basis of ICES advice for the stock (2010, 2011) or the MP (2012 – 2014) assuming a share of around 70% of total stock catches.

In Spain, concern for the sardine fishery goes back to the eighteenth century when the first records of regulation of fishing gears appear (Cornide of Saavedra 1774, Sañez Reguart 1791). At the beginning of the 20Th century some fishing laws were published to regulate areas, timetables and fishing methods (Rodríguez Santamaría 1923) and from the second

[9] "Regulamento geral da pesca da sardinha nas costas de Portugal, Decreto de 14 de Maio de 1903, Ministério dos Negócios da Marinha e Ultramar, Imprensa Nacional, 49 p."
[10] « Armações à Valenciana ».
[11] COUNCIL REGULATION (EEC) No 3094/86.

half of the century, in the 60s and especially in the area of Galicia, time closures were established to protect the resource and stabilize the market price (Annex III).

Since 1985 (throughout yearly regulations) daily catch limits per boat were established (10 000 tonnes from 1985 to 2007, and since 2007, 7 000 tonnes for Cantabrian area and 3 000 for the Gulf of Cadiz) and additional measures were taken to regulate effort in a weekly and annual basis for both areas.

In addition to national implementation measures, regional governments (in particular the Xunta de Galicia), have established their own laws for the conservation of sardine in its jurisdictional waters over this period.

3.2.2. Management measures in effect

There is no EU TAC. Management measures in effect are summarized in Annex III.

Since 2014, Portugal and Spain have implemented a multiannual MP to manage the fishery. This management plan consists in a rule where the annual catch limit is set at a fixed level (86 000 tonnes), but reduced if the biomass (B1+) is below a trigger point of 368 400 tonnes. The fishery is stopped if B1+ drops below 135 000 tonnes. The catch for a given year is set by the formula 0.36 × (B1+ (year-1) – lower trigger level).

This plan was evaluated by ICES (at the request of the European Commission, ICES, 2013) and was considered to be provisionally precautionary because it was not possible to identify precautionary reference points, namely a limit biomass, against which to evaluate risks (ICES 2013a,b).

3.2.3. Possible management measures

The sardine MP implemented by Spain and Portugal provides the basis to set a annual catch limit for the Southern sardine stock. It does not provide a basis to set national quotas. The authors consider the MP should be revised, if required, taking into account the recent development of the stock. Moreover, biological and socioeconomic criteria need to be explored to split the annual catch limit for the whole stock into national quotas.

Additional technical measures aiming to reduce fishing mortality of juveniles and/or spawners might be considered for sardine. Technical measures for the protection of juveniles usually have a double aim: decrease fishing mortality on fishes that have not yet reached the age of sexual maturity (prevent growth overfishing) and to reduce discarding of under-sized or commercially less valuable individuals. Some of the measures which might be considered for protection of juveniles are: (i) improve selectivity, (ii) increase MLS and (iii) establish closed areas/periods. The latter might be considered for the protection of spawners as well.

Below, we discuss briefly some *pros* and *cons* of each measure. However, we consider the proposal of concrete measures should result from dialogue between managers, stakeholders and scientists. Concrete measures should be scientifically evaluated in terms of short and long term biological and socioeconomic impacts.

a) Improve selectivity

Purse seining is a non-selective gear regarding fish size, as the mesh size is chosen to be so small that there should be no risk of mass meshing of fish, even by the smallest size groups of the target species (Cochrane, 2002). Some selectivity in purse-seining can only be achieved through the utilization of fixed rigid grids, or panels. For example, Gonçalves et

al. (2008) observed a significant reduction of by-catch of undersized fish (demersal and pelagic) in experiments with small purse seiners using a panel of diamond-shaped mesh netting of 70 mm in the posterior part of the net.

Data from onboard observer programs and information from fishermen indicate the risk of mass meshing and catch of undersized fish is restricted to localized nursery areas and periods. Those areas and periods are well known to fishermen and the catch of small individuals is generally avoided with the aid of sonar equipment. When, by accident, the catch consists of undersized individuals, it is slipped, i.e. released after partially drying-up the net but without the fish being drawn aboard. Slipping of undersized sardine might be high in years that juveniles are abundant (Stratoudakis and Marçalo, 2002). Mortality of the escapees is highly variable. According to information from captivity experiments, mortality increases with increasing time in the net, crowding density, temperature and lower fish condition (Marçalo et al., 2009). The establishment of practical rules to decrease mortality of slipped fish, such as the so-called "7/8"[12] could be investigated. Such rules would contribute to the progressive elimination of slipping mortality, a core objective of the new CFP[13].

b) Minimum Landing Size (MLS)

MLS regulations are often considered a necessary backup to MMS regulations (Suuronen and Sardà, 2007). The current MLS for sardine in EU Atlantic waters is 11 cm[14]. Data from DEPM surveys covering Atlantic waters of the Iberian Peninsula suggest the length at first maturity of female sardine is larger than 11 cm (ICES, 2011). Moreover, maturation length increases towards the northern Atlantic waters (Silva et al., 2006).

Although the studies above point to the need to review the current MLS, we think available information is insufficient to propose a MCRS[15] appropriate for the whole EU Atlantic waters. Given there is mixing between the southern and northern stocks and some fisheries exploit both stocks, it seems unreasonable to set different MCRS for each stock. Further studies should be carried out, namely to incorporate more recent surveys data and to collate data from the southern and northern sardine stocks, in order to propose a concrete MCRS.

c) Closed areas/periods

Several types of fishery exclusion zones (temporary and permanent) have been implemented in Europe with the objective of, in the case of overfished stocks, decreasing fishing mortality on fishes that have not yet reached the age of sexual maturity or on fish which are actively spawning and reducing by-catch of undersized fish (Pickering, 2003). Although benefits of such zones have not been fully evaluated, gains in recruitment or increases in abundance have been below expectation in a number of cases.

Simulation studies indicate that greater benefits (in terms of stock abundance and yield in the long term) are obtained even for very mobile fish like sardine, if the exclusion zone is both a spawning and a nursery area, or in case those areas are separate, by protecting the

[12] In Norway, the so-called "7/8" rule has been applied to determine a point-of-no-return for high survivability in mackerel caught by purse-seining. The name of the rule refers to the proportion of the length of the net that is hauled on-board by the time a decision on slipping is made.

[13] Regulation (EU) No1380/2013.

[14] Council Regulation (EC) No 850/98.

[15] REGULATION (EU) No 1380/2013 of 11 December 2013: 'minimum conservation reference size' means the size of a living marine aquatic species taking into account maturity, as established by Union law, below which restrictions or incentives apply that aim to avoid capture through fishing activity.

size classes that are the main target of the fishery (Apostolaki et al. 2002). Benefits are only to be expected if fishing effort is not redistributed outside the exclusion zone/period.

Sardine spawning and nursery areas and seasons are well known (see general information). However, the long spawning and recruitment seasons complicate the identification of closed periods to protect spawning activity or juvenile fish. In the case of spawners, the lack of confined spawning areas is an additional complication while the poor link between spawning and recruitment success casts doubts on the efficacy of protecting spawning activity. Nevertheless, given the low stock abundance, protecting spawning activity, in conjunction with other management measures such as effort and catch limitations, may assist the recovery of the stock. Moreover, fishery closures to avoid catching spawning fish seem to be easily accepted by fishermen and in fact, closures during spawning time are already implemented in Portugal and the Gulf of Cadiz. Therefore, it might be considered to extend such closures to the whole stock area taking into account biological differences between areas and socioeconomic impacts. Contrary to spawning areas, nursery areas are relatively confined, and periods of closure could be considered for the protection of juveniles. Closed areas-periods to protect juveniles may raise regional issues due to the local nature of nursery areas and the local operation of the purse seine fleet, because only some ports and fishing communities would be affected.

4. CONCLUSIONS AND RECOMMENDATIONS

Sardine is the target of important fisheries in France, Spain and Portugal with significant social and economic importance to the fishing and canning industries.

The Northern stock of sardine (ICES Sub-areas VII and VIIIa,b,d) is fished mainly by France and Spain. ICES assessment and advice is available for Subarea VIII only, due to limited data on northern part of the area (Subarea VII). In Subarea VIIIb, the sardine has increased over the last five years and the current harvest rate appears to be sustainable. ICES advised that catches should be no more than 33 065 tonnes in each of the years 2016 and 2017. Sardine catches on the Bay of Biscay, mainly by Spain, have increased notably in recent years due to the abundance of sardine in the area and the decrease of fishing opportunities for the Southern stock. Technical measures are in place to manage the stock but effort and catches are not regulated.

In contrast, the Southern stock of sardine shows a downward trend since 2006 due to poor recruitments and high fishing mortality in recent years. Large reductions in effort and catches implemented since 2011 contributed to a substantial reduction of fishing mortality. Despite that, recruitment continued to be low. Biomass in 2015, 139 000 tonnes, was at the lowest historical level. Spain and Portugal implemented a Management Plan for sardine. On the basis of this management plan ICES advised catches of no more than 1 587 tonnes in 2016.

In both Spain and Portugal, artisanal gears were developed specifically to exploit sardine and they therefore depend exclusively of its availability. This is the case of "xeito" in Galicia and "sardinheiras" in Portugal. These fisheries have high social and cultural relevance for local communities despite low economic importance.

Management measures are currently implemented to protect juveniles and spawners in the Southern stock but due to the current status of the stock, additional measures may be needed to enhance reproductive potential and hopefully recruitment.

Sardine landings are well documented for most sardine fisheries. The distribution and biology of sardine within European Atlantic waters is generally well known. Relationships between sardine and environmental conditions are poorly understood, in particular the reasons behind the decline in recruitment over time for the southern stock. Similarly, it is still unclear how sardine populations might be affected by food availability, cannibalism and predation. The degree of connectivity between the Northern and Southern sardine stocks is uncertain; there is evidence of differences in biology and dynamics at the sub-stock level, within both the Northern and the Southern stocks. Lacking or incomplete socioeconomic data makes it difficult to evaluate the real importance of sardine fisheries and to correctly assess the socioeconomic impact of the decline of the Southern stock or of any management measures.

Given the above conclusions, the authors group recommends to:

- Implement and evaluate additional technical measures to protect the southern stock (MLS, selectivity closed areas/periods for juvenile protection)
- Review the harvest rule of the Management Plan for Southern stock taking into account the dynamics of the stock in recent years
- The catch limit obtained from the application of the harvest control rule of the MP needs to be divided between Spain and Portugal at the beginning of the year. The current lack of agreement on how to divide it among both countries needs to be resolved.
- Develop a Management Plan for the Northern stock and promote the collection of data from the English Channel and Celtic Sea (ICES Subarea VII)

- Carry out multidisciplinary studies to evaluate how the environment and the current situation of the stock can be affecting recruitment success and model how the population will respond in the future to different scenarios (climate, exploitation, predation, etc.)
- Carry out integrated studies to improve knowledge on the connectivity among sardine stocks
- Promote reporting of social and economic data for the fisheries
- Improve fishing practices to decrease slipping

REFERENCES

- Alimarket (2015) Conservas de pescado: El atún da un respiro. Conservas de Pescado, 20 Febrero 2015.
- ANFACO (2014) *El sector conservero de pescados y mariscos de Galicia: evolución de su impacto socioeconómico, internacionalización e innovación*, Vigo, 93 p.
- Alheit J, Pohlmann T, Casini M, Greve MW, Hinrichs R, MathisM, O'Driscoll K, Vorberg R, Wagner C (2012) *Climate variability drives anchovies and sardines into North Sea and Baltic Sea*. Prog. Oceanogr., 96:128–139
- Alheit J, Licandro P, Coombs S, García A, Giráldez A, Garcia Santamaría MT, Slotte A, Tsikliras AC (2014) *Atlantic Multidecadal Oscillation (AMO) modulates dynamics of small pelagic fishes and ecosystem regime shifts in the eastern North and Central Atlantic.* Journal of Marine Systems, 133:88-102.
- Apostolaki P, Milner-Gulland EJ, McAllister MK, Kirkwood GP (2002) *Modeling the effects of establishing a marine reserve for mobile fish species*. Can J Fish Aquat Sci. 59:405–415.
- Bernal M, Stratoudakis Y, Coombs S, Angelico M, Lago de Lanzós A, Porteiro C, Sagarminaga Y, Santos M, Uriarte A, Cunha E, Valdés L, Borchers D (2007) *Sardine spawning off the European Atlantic coast: characterization of spatio-temporal variability in spawning habitat.* Progress in Oceanography, 74:210-227
- Bode A, Alvarez-Ossorio MT, Carrera P, Lorenzo J (2004) *Reconstruction of trophic pathways between plankton and the North Iberian sardine (Sardina pilchardus) using stable isotopes.* Scientia Marina, 68(1), 165-178.
- Bode A, Carrera P, Lens S (2003) *The pelagic food web in the upwelling ecosystem of Galicia (NW Spain) during spring: natural abundance of stable carbon and nitrogen isotopes.* ICES Journal of Marine Science, 60 (1): 11-22.
- Bureau Veritas (2010) Southern Brittany's Purse Seine Sardine Fishery- Public certification report against the principles & criteria of the MSC for sustainable fishing, 139 p.
- Cabral H, Duque J, Costa MJ (2003). *Discards of the beach seine fishery in the central coast of Portugal.* Fisheries Research 63: 63-71.
- Cardona L, Martínez-Iñigo L, Mateo R, González-Solís J (2015) *The role of sardine as prey for pelagic predators in the western Mediterranean Sea assessed using stable isotopes and fatty acids.* Marine Ecology Progress Series, 531: 1-14.
- Carrera P, Porteiro C (2003) *Stock dynamic of the Iberian sardine (Sardina pilchardus, W.) and its implication on the fishery off Galicia (NW Spain).* Scientia Marina: 67(S1), 245-258.
- Castro J, Marín M, Costas G, Abad E, Punzón A, Pereiro J., Vázquez A (2011) *Atlas de las flotas de pesca españolas de aguas europeas atlánticas.* ISBN 978-84-95877-06-2.
- Cochrane KL (ed.) *A fishery manager.s guidebook*. Management measures and their application. FAO Fisheries Technical Paper. No. 424. Rome, FAO. 2002. 231p.
- Coombs SH, Smyth TJ, Conway DVP, Halliday NC, Bernal M, Stratoudakis Y, Alvarez P (2006*) Spawning season and temperature relationships for sardine (Sardina pilchardus) in the eastern North Atlantic*. Journal of the Marine Biological Association of the United Kingdom, 86(05): 1245-1252.

- Costalago D, Navarro J, Álvarez-Calleja I, Palomera I (2012*) Ontogenetic and seasonal changes in the feeding habits and trophic levels of two small pelagic fish species.* Marine Ecology Progress Series, 460: 169-181.
- Costalago D, Palomera I (2014) *Feeding of European pilchard (Sardina pilchardus) in the north-western Mediterranean: from late larvae to adults*. Scientia Marina, 78(1): 41-54.
- Cornide de Saavedra, J (1774) Memoria sobre la pesca de la sardina en las costas de Galicia.
- Crawford RJ, Dyer BM (1995). *Responses by four seabird species to a fluctuating availability of Cape anchovy Engraulis capensis off South Africa*. Ibis, 137(3): 329-339.
- Cury P, Bakun , Crawford RJ, Jarre A, Quiñones RA, Shannon LJ, Verheye HM (2000) *Small pelagics in upwelling systems: patterns of interaction and structural changes in "wasp-waist" ecosystems*. ICES Journal of Marine Science: Journal du Conseil, 57(3), 603-618.
- Chouvelon T, Chappuis A, Bustamante P, Lefebvre S, Mornet F, Guillou G, Violamer L, Dupuy, C. (2014). *Trophic ecology of European sardine Sardina pilchardus and European anchovy Engraulis encrasicolus in the Bay of Biscay (north-east Atlantic) inferred from δ 13 C and δ 15 N values of fish and identified mesozooplanktonic organisms*. Journal of Sea Research, 85, 277-291.
- Culley M (1971). *The Pilchard Biology and Exploitation.* Pergamon Press, Oxford, 241 p.
- Daunt F, Wanless S, Greenstreet SP, Jensen H, Hamer KC, Harris MP (2008*) The impact of the sandeel fishery closure on seabird food consumption, distribution, and productivity in the north-western North Sea*. Canadian Journal of Fisheries and Aquatic Sciences, 65(3): 362-381.
- Deriso RB (1982) *Relationship of Fishing Mortality to Natural Mortality and Growth at the Level of Maximum Sustainable Yield*. Canadian Journal of Fisheries and Aquatic Sciences, 39(7):1054-1058.
- Dias F (199*2) Analise estrutural da indústria: um ensaio na Indústria Portguesa de Conserva de Peixe.* Tese Mestrado. ISCTE.
- Ettahiri O, Berraho A, Vidy G, Ramdani M (2003) *Observation on the spawning of Sardina and Sardinella off the south Moroccan Atlantic coast (21–26 N).* Fisheries Research, 60(2): 207-222.
- FAO. 2013. *Report of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa*. Dakar, Senegal 21–25 May 2012. FAO Fisheries and Aquaculture Report/FAO No. 1036. Rome. 245 pp.
- Furness RW, Edwards AE, Oro D (2007) *Influence of management practices and of scavenging seabirds on availability of fisheries discards to benthic scavengers.* Marine Ecology-Progress Series, 350: 235-244.
- Ganias K (2009) Linking *sardine spawning dynamics to environmental variability.* Estuarine, Coastal and Shelf Science, 84(3), 402-408.
- Ganias K, Somarakis S, Koutsikopoulos C, Machias A (2007) *Factors affecting the spawning period of sardine in two highly oligotrophic Seas.* Marine Biology, 151(4): 1559-1569.
- Garrido S, Marçalo A, Zwolinski J, Van der Lingen CD (2007) *Laboratory investigations on the effect of prey size and concentration on the feeding behaviour of Sardina pilchardus.* Marine Ecology Progress Series, 330: 189-199.
- GFCM, 2006. *Report of the eighth session of the sub-committee on stock assessment (SCSA)*. GFCM:SAC9/2006/Inf.8. ftp://ftp.fao.org /DOCUMENT/gfcm/sac9/inf8e.pdf.

- Guisande C, Cabanas JM, Vergara AR, Riveiro I (2001*) Effect of climate on recruitment success of Atlantic Iberian sardine Sardina pilchardus.* Marine Ecology Progress Series, 223: 287-297.
- Gonçalves J, Bentes L, Monteiro P, Coelho R, Corado M, Erzini K (2008) *Reducing discards in a demersal purse-seine fishery*. Aquat. Living Resour., 21: 135-144.
- ICES (2011). *Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG)*. ICES CM 2011/SSGESST:20, 157 p.
- ICES.(2012) *Report of the Benchmark Workshop on Pelagic Stocks (WKPELA 2012)*, 13–17 February 2012, Copenhagen, Denmark. ICES CM 2012/ACOM:47. 572 pp.
- ICES. (2013a). *Report of the Workshop to Evaluate the Management Plan for Iberian Sardine (WKSardineMP)*, 4–7 June 2013, Lisbon, Portugal. ICES CM 2013/ACOM:62.
- ICES. (2013b). *Management plan evaluation for sardine in Divisions VIIIc and IXa*. In Report of the ICES Advisory Committee, 2013. ICES Advice, 2013. Book 7, Section 7.3.5.1.
- ICES (2014) *First Interim Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VII, VIII and IX (WGACEGG)*. ICES CM 2014/SSGESST:21, 547 p.
- ICES (2015a) *Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA)*, Lisbon, Portugal, 24–29 June 2015, ICES CM 2015/ACOM:16
- ICES (2015b) *Advice basis.* In Report of the ICES Advisory Committee, 2015. ICES Advice 2015, Book 1, Section 1.2.
- INE (1990 - 2015) *Estatísticas da Pesca.* Instituto Nacional de Estatística, I.P. Lisboa.
- Jahncke J, Checkley DM, Hunt GL (2004) *Trends in carbon flux to seabirds in the Peruvian upwelling system: effects of wind and fisheries on population regulation*. Fisheries Oceanography, 13 (3): 208-223.
- Jemaa S, Dussene M, Cuvilier P, Bacha M, Khalaf G, Amara R (2015) *Comparaison du régime alimentaire de l'anchois (Engraulis encrasicolus) et de la sardine (Sardina pilchardus) en Atlantique et en Méditerranée.* Lebanese Science Journal, 16: 7-22.
- Jorge I, Siborro S, Sobral MP (2002) *Contribuição para o conhecimento da pescaria da xávega da zona centro. Relatórios Científicos e Técnicos,* IPIMAR 85.
- Kasapidis P, Silva A, Zampicinini G, Magoulas A (2012) *Evidence for microsatellite hitchhiking selection in European sardine (Sardina pilchardus) and implications in inferring stock structure*. Scientia Marina, 76, 123-132.
- Larrañeta MG (1960) *Synopsis of biological data on Sardina pilchardus of the Mediterranean and adjacent seas.* Fisheries Division, Biology Branch, Food and Agriculture Organization of the United Nations.
- Leitão F, Alms V, Erzini K (2014) *A multi-model approach to evaluate the role of environmental variability and fishing pressure in sardine fisheries*. Journal of Marine Systems, 139, 128-138.
- Lockwood SJ, Pawson MG, Eaton DR (1983) *The effects of crowding on mackerel (Scomber scombrus L.) — Physical condition and mortality.* Fisheries Research Vol.2, Issue 2, September 1983: 129–147.
- Lluch-Belda D, Lluch-Cota DB, Hernández-Vázquez, Salinas-Zavala CA (1992) *Sardine population expansion in eastern boundary systems of the Pacific Ocean as related to sea surface temperature*. South African Journal of Marine Science, 12(1): 147-155.
- Magnussen E (2011) *Food and feeding habits of cod (Gadus morhua) on the Faroe Bank.* ICES Journal of Marine Science, 68(9):1909-1917.

- MAGRAMA (2014)a. *Ministerio de Agricultura, Alimentación y Medio Ambiente (MAGRAMA). Estadísticas pesqueras: Estadísticas de la Flota pesquera*. Available online at: http://www.magrama.gob.es/es/estadistica/temas/estadisticas-pesqueras/2014_01_buques_eslora_tcm7-194379.pdf (accessed on 13 October 2015)
- MAGRAMA (2014)b. *Ministerio de Agricultura, Alimentación y Medio Ambiente (MAGRAMA). Estadísticas pesqueras: Encuesta económica de pesca marítima*. Available online at: http://www.magrama.gob.es/es/estadistica/temas/estadisticas-pesqueras/01099_ENCUESTA_ECON%C3%93MICA_DE_PESCA_MAR%C3%8DTIMA_tcm7-352153.pdf (accessed on 13 October 2015)
- MAGRAMA (2015) *Ministerio de Agricultura, Alimentación y Medio Ambiente (MAGRAMA). Anuario de Estadística 2013 (Datos 2012 y 2013).* Available online at: http://www.magrama.gob.es/es/estadistica/temas/publicaciones/anuario-de-estadistica/2013/default.aspx?parte=1&capitulo=05 (accessed on 9 October 2015).
- Marçalo A, Marques TA, Araujo J, Pousao-Ferreira P, Erzini K, et al. (2010) *Fishing simulation experiments for predicting the effects of purse-seine capture on sardine (Sardina pilchardus).* ICES J Mar Sci 67: 334–344. doi:10.1093/icesjms/fsp244.
- Marçalo A (2009) *Sardine (Sardina pilchardus) delayed mortality associated with purse-seine slipping: contributing stressors and responses.* Tese de doutoramento. Faculdade de Ciências e Tecnologia. Universidade do Algarve. 189pp.
- Martins R, Carneiro M, Margarido MC, Rebordão FR, Frias C (2003) *Relatório de acompanhamento da pesca com arte Sardinheira.* INIAP / IPIMAR, 21 pp.
- Massé J, Uriarte A, Angelico MM, Carrera O. (*in press*). *Pelagic surveys series for sardine and anchovy in ICES areas VIII and IX (WGACEGG)-Towards an ecosystem approach*. ICES Cooperative Research Report.
- Mendes HV, Borges MF (2006) *A sardinha no século XX: capturas e esforço de pesca.* Relat. Cient. Téc. IPIMAR, Série digital nº 32, 20pp.
- Methot RD, Wetzel CR (2012). *Stock synthesis: a biological and statistical framework for fish stock assessment and fishery management*. Fish. Res. 142: 86–99.
- Meynier L (2004) Food and feeding ecology of the common dolphin, *Delphinus delphis*, in the Bay of Biscay: Intraspecific dietary variation and food transfer modelling. Master thesis, University of Aberdeen, Aberdeen, United Kingdom. 63 pp.
- Miranda A, Cal RM, Iglesias J (1990) *Effect of temperature on the development of eggs and larvae of sardine Sardina pilchardus Walbaum in captivity*. Journal of Experimental Marine Biology and Ecology 140 (1): 69-77.
- Nunes C, Silva A, Marques V, Ganias K. 2011. *Integrating fish size, condition, and population demography in the estimation of sardine annual fecundity*. Ciencias Marinas, 37, 564 – 584.
- Parkes G, Pilling G, Wakeford R, Trumble B (2010) *Cornish Sardine MSC Assessment Public Certification Report*, MRAG Americas, Inc., St. Petersburg, 131 pp.
- Parrish RH, Serra R, Grant WS (1989). *The monotypic sardines, Sardina and Sardinops: their taxonomy, distribution, stock structure, and zoogeography*. Can. J. Fish. Aquat. Sci., 46, 2019-2036.
- Pérez N, Porteiro C, Alvarez F (1985) *Contribución al conocimiento de la biología de la sardina de Galicia.* Boletín del Instituto Español de Oceanografía, 2(3): 27-37.
- Pickering H (Ed.) (2003) *The Value of Exclusion Zones as a Fisheries Management Tool: A strategic evaluation and the development of an analytical framework for Europe.* CEMARE Report, University of Portsmouth, UK.

- Pita C, Dickey H, Pierce GJ, Mente E, Theodossiou I (2010) *Willingness for mobility amongst European fishermen*. Journal of Rural Studies 26: 308-319.
- Ramos S, Ré P, Bordalo AA (2009) *New insights into the early life ecology of Sardina pilchardus (Walbaum, 1792) in the northern Iberian Atlantic*. Scientia Marina 73 (3): 449-49.
- Rice J (1995) *Food web theory, marine food webs and what climate changes may do to northern marine fish populations*. In: Beamish RJ (Ed), *Climate Change and Northern Fish Populations.* Canadian Special Publication Fisheries & Aquatic Science, 121:561-568.
- Riveiro I, Guisande C, Maneiro I, Vergara AR (2004) *Parental effects in the European sardine Sardina pilchardus.* Marine Ecology Progress Series, 274, 225-234.
- Rodríguez S, Marques V, Angélico MM, Silva A (2014) *Identifying essential juvenile habitat for sardine (Sardina pilchardus (Walbaum, 1972)) along the Portuguese coast and Gulf of Cádiz*. Poster presented at the Johan Hjort Symposium on Recruitment Dynamics and Stock Variability 7-9 November 2014 Bergen (Norway).
- Rodríguez Santamaría B (1923) Diccionario de artes de pesca de España y sus posesiones (1923).
- Russell FS (1976) *The eggs and planktonic stages of British marine fishes.* Academic Press, New York.
- Santos MB, German I, Correia D, Read FL, Martinez-Cedeira J, Caldas M, López A, Velasco F, Pierce GJ (2013). *Long-term variation in common dolphin diet in relation to prey abundance*. Marine Ecology Progress Series 481, 249-268.
- Santos MB, González-Quirós R, Riveiro I, Cabanas JM, Porteiro C, Pierce GJ (2012). *Cycles, trends, and residual variation in the Iberian sardine (Sardina pilchardus) recruitment series and their relationship with the environment*. ICES Journal of Marine Science: Journal du Conseil, 69(5): 739-750.
- Santos MB, Saavedra C, Pierce GJ (2014). *Quantifying the predation on sardine and hake by cetaceans in the Atlantic waters of the Iberian Peninsula*.Deep Sea Research II: Topical Studies in Oceanography 106, 232-244.
- Sañez Reguart A (1791) Diccionario histórico de los artes de pesca nacional.
- Shaw P, McKeown N, Van der Kooij J (2012) *Analysis of genetic population structuring of Sardine (Sardina pilchardus) in Eastern Atlantic waters using nuclear microsatellite DNA markers*. Working Document for WKPELA, 13–17/02/2012 Copenhagen.
- Silva A, Santos MB, Caneco B, Pestana G, Porteiro C, Carrera P, Stratoudakis Y (2006) *Temporal and geographic variability of sardine maturity at length in the north-eastern Atlantic and the western Mediterranean*. ICES Journal of Marine Science: 63(4): 663-676.
- Silva MA (2001) *Diet of common dolphins, Delphinus delphis, off the Portuguese continental coast.* Journal of the Marine Biological Association of the U.K. 87: 231-241.
- Somarakis S, Ganias K, Siapatis A, Koutsikopoulos C, Machias A, Papaconstantinou C (2006) *Spawning habitat and daily egg production of sardine (Sardina pilchardus) in the eastern Mediterranean*. Fisheries Oceanography, 15(4): 281-292.
- STECF (2014*) Scientific, Technical and Economic Committee for Fisheries (STECF) – The Economic Performance Report on the EU Fish Processing (STECF-14-21).* 2014. Publications Office of the European Union, Luxembourg, EUR 27029 EN, JRC 93340, 355 pp.

- Stratoudakis Y, Coombs S, Lago de Lanzós A, Halliday N, Costas G, Caneco B, Franco C, Conway D, Santos MB, Silva A, Bernal M (2007). *Sardine (Sardina pilchardus) spawning seasonality in European waters of the northeast Atlantic*. Marine Biology, 152(1): 201-212.
- Stratoudakis Y, Marçalo A (2002) *Sardine slipping during purse-seining off northern Portugal.* ICES J. Mar. Sci. 59: 1256–1262.
- Suuronen P, Sardá F (2007) *The role of technical measures in European fisheries management and how to make them work better.* – ICES Journal of Marine Science, 64: 751–756.
- Thompson PM, McConnell BJ, Tollit DJ, MacKay A, Hunter C, Racey PA (1996) *Comparative distribution, movements and diet of harbour and grey seals from the Moray Firth, N.E. Scotland*. Journal of Applied Ecology, 33:1572–1584.
- Varela M, Larrañaga A, Costas E, Rodriguez B (1988) *Contenido estomacal de la sardina (Sardina pilchardus Walbaum) durante la campaña Saracus 871 en las plataformas Cantábrica y de Galicia en febrero de 1971.* Boletín Instituto Español de Oceanografía, 5: 17-28.
- Walter JF, Austin HM (2003) *Diet composition of large striped bass (Morone saxatilis) in Chesapeake Bay.* Fishery Bulletin, 101:414–423
- Weise MJ, Harvey JT (2008) *Temporal variability in ocean climate and California sea lion diet and biomass consumption: implications for fisheries management.* Marine Ecology Progress Series, 373: 157-172.
- Xunta de Galicia (2014) *Informe sobre el arte del xeito: caso particular de actividad profesional pesquera artesanal con redes de deriva en aguas interiores de competencia de la comunidad autónoma de Galicia. Temporada 2013* Xunta de Galicia, Consellería do Medio Rural e do Mar, Dirección Xeral de Desenvolvemento Pesqueiro. (unpublished manuscript)
- Zwolinski J, Stratoudakis Y, Sares E (2001) *Intra-annual variation in the batch fecundity of sardine off Portugal.* Journal of Fish Biology, 58(6): 1633-1645.

ANNEX I: NORTHERN SARDINE STOCK: HISTORICAL LANDINGS (TONNES) FOR COMBINED FISHERIES

Year	Subarea VII									Divisions VIIIa,b,d									ALL STOCK								
	France	United Kingdom	Netherlands	Ireland	Germany	Denmark	Lithuania	Spain	TOTAL VII	France	Spain	Netherlands	Ireland	United Kingdom	Denmark	Germany	Lithuania	TOTAL VIIIa,b,d	France	United Kingdom	Netherlands	Ireland	Germany	Denmark	Lithuania	Spain	Total catch
1989	1.2	1.7	0.0	0.0	0.0	4.7	0.0	0.0	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.4	16.4	1.2	1.7	0.0	0.0	0.0	4.7	16.4	0.0	23.9
1990	1.1	2.1	0.0	0.0	0.1	6.1	0.0	0.0	9.4	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.5	9.7	2.1	0.0	0.0	0.1	6.1	0.0	0.0	18.0
1991	2.0	3.0	0.0	0.0	0.0	4.5	0.0	0.0	9.4	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	14.4	3.0	0.0	0.0	0.0	4.5	0.0	0.0	21.9
1992	1.8	4.5	0.0	0.0	0.0	17.8	0.0	0.0	24.2	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.9	10.6	4.5	0.0	0.0	0.0	17.8	0.0	0.0	33.0
1993	1.1	4.9	0.1	0.0	0.0	13.4	0.0	0.0	19.6	8.8	0.0	0.0	0.0	0.0	0.3	0.0	0.0	9.2	9.9	4.9	0.1	0.0	0.0	13.7	0.0	0.0	28.7
1994	1.3	2.1	0.0	0.0	0.0	20.8	0.0	0.0	24.2	8.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.6	9.9	2.1	0.0	0.0	0.0	20.8	0.0	0.0	32.8
1995	1.3	7.1	0.1	0.0	0.1	9.6	0.0	0.0	18.2	9.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.9	11.2	7.1	0.1	0.0	0.1	9.6	0.0	0.0	28.1
1996	1.6	7.3	0.0	0.0	0.0	1.4	0.0	0.0	10.3	8.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.6	10.2	7.3	0.0	0.0	0.0	1.4	0.0	0.0	18.9
1997	3.3	7.3	0.4	0.0	0.0	1.1	0.0	0.0	12.2	10.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.7	14.1	7.3	0.4	0.0	0.0	1.1	0.0	0.0	22.9
1998	2.0	6.9	1.6	0.2	0.1	14.3	0.0	0.0	25.1	9.8	0.9	0.0	0.0	0.0	0.0	0.1	0.0	10.7	11.8	6.9	1.6	0.2	0.2	14.3	0.0	0.9	35.8
1999	3.5	4.8	5.2	3.2	0.1	3.5	0.0	0.0	20.3	14.4	2.4	0.0	0.0	0.0	0.1	0.0	0.0	16.9	17.9	4.8	5.2	3.2	0.2	3.6	0.0	2.4	37.2
2000	1.7	4.4	6.6	2.6	0.4	1.7	0.0	0.0	17.3	11.3	2.0	0.0	0.0	0.0	0.0	0.0	0.0	13.4	13.0	4.4	6.6	2.6	0.5	1.7	0.0	2.0	30.7
2001	9.6	10.4	6.6	2.4	0.5	0.0	0.0	0.0	29.5	11.0	3.7	0.3	0.0	0.0	0.0	0.1	0.0	15.2	20.6	10.4	6.9	2.4	0.6	0.0	0.0	3.7	44.7
2002	8.6	7.9	1.9	5.7	0.2	0.0	0.0	0.0	24.4	13.0	2.9	0.0	0.0	0.3	0.0	0.0	0.0	16.2	21.6	8.1	1.9	5.7	0.2	0.0	0.0	2.9	40.5
2003	12.5	4.4	6.9	3.8	0.0	0.0	0.0	0.0	27.6	10.6	2.4	0.1	1.7	0.1	0.0	0.0	0.0	14.9	23.2	4.4	7.0	5.5	0.0	0.0	0.0	2.4	42.5
2004	8.9	2.7	2.2	2.4	0.1	0.7	0.0	0.0	17.0	10.0	1.9	0.0	1.4	0.0	0.0	0.0	0.0	13.2	18.9	2.7	2.2	3.8	0.1	0.7	0.0	1.9	30.3
2005	15.4	3.6	2.2	1.4	0.3	0.0	0.0	0.0	22.9	11.8	1.2	0.0	1.0	0.0	0.0	0.1	0.0	14.0	27.2	3.6	2.2	2.4	0.3	0.0	0.0	1.2	37.0
2006	17.7	1.9	2.3	1.3	0.5	0.0	0.0	0.0	23.7	9.8	0.8	0.0	0.0	0.0	0.0	0.1	0.0	10.8	27.5	1.9	2.3	1.3	0.6	0.0	0.0	0.8	34.5
2007	11.2	2.7	1.1	0.0	0.0	0.0	0.0	0.0	15.0	14.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	14.7	25.2	2.7	1.1	0.0	0.0	0.1	0.0	0.7	29.7
2008	10.5	3.5	2.1	0.2	0.0	0.1	0.0	0.0	16.4	12.1	2.0	0.0	0.0	0.0	0.0	0.0	0.0	14.1	22.6	3.5	2.1	0.2	0.0	0.1	0.0	2.0	30.5
2009	14.8	2.5	3.4	0.0	0.0	0.0	0.0	0.0	20.8	20.7	0.6	0.0	0.0	0.0	0.0	0.0	0.0	21.3	35.5	2.5	3.4	0.0	0.0	0.0	0.0	0.6	42.1
2010	8.7	2.5	6.6	0.0	0.1	0.0	0.0	0.0	18.0	16.1	2.9	0.0	0.0	0.0	0.0	0.0	0.0	19.0	24.8	2.5	6.6	0.0	0.1	0.0	0.0	2.9	37.1
2011	0.7	3.6	0.5	1.0	0.0	0.0	0.0	0.0	5.8	17.9	5.3	0.0	0.0	0.0	0.0	0.0	0.0	23.2	18.6	3.6	0.5	1.0	0.0	0.0	0.0	5.3	29.0
2012	0.4	4.4	1.4	0.0	0.0	0.0	0.0	0.0	6.3	16.0	14.9	0.0	0.0	0.0	0.0	0.0	0.0	30.9	16.4	4.4	1.4	0.0	0.0	0.0	0.0	14.9	37.2
2013	1.8	3.7	1.8	0.2	0.2	0.0	0.0	0.0	7.8	20.1	12.4	0.4	0.0	0.3	0.0	0.0	0.0	33.2	21.8	4.0	2.2	0.2	0.2	0.0	0.0	12.4	41.0
2014	1.2	3.9	0.2	0.0	0.0	1.0	0.0	0.0	6.3	17.7	21.3	0.0	0.0	0.0	0.0	0.0	0.0	39.0	18.9	3.9	0.2	0.0	0.0	1.0	0.0	21.3	45.3

ANNEX II: SOUTHERN SARDINE STOCK: HISTORICAL LANDINGS (TONNES) FOR COMBINED FISHERIES

Year	VIIIc	IXa						ALL STOCK		
		IXa North	IXa Central-North	IXa Central-South	IXa South-Algarve	IXa South-Cadiz	TOTAL IXa	Spain	Portugal	TOTAL
	Spain	Spain	Portugal	Portugal	Portugal	Spain				
1978	43.5	12.9	34.2	26.0	23.3	5.6	102.1	62.1	83.6	145.6
1979	18.3	43.9	39.7	27.5	24.1	3.8	139.0	65.9	91.3	157.2
1980	35.8	49.6	59.3	29.4	17.6	3.1	159.0	88.5	106.3	194.8
1981	35.6	65.3	61.2	37.1	15.0	2.4	181.0	103.3	113.3	216.5
1982	31.8	71.9	45.9	38.1	16.9	2.4	175.2	106.1	100.9	206.9
1983	32.4	62.8	33.2	31.2	21.6	2.7	151.5	97.9	85.9	183.8
1984	28.0	79.6	42.8	35.0	17.3	3.3	178.0	110.9	95.1	206.0
1985	25.9	66.5	61.8	31.5	18.4	4.3	182.5	96.7	111.7	208.4
1986	39.2	38.0	57.4	31.7	14.4	6.8	148.2	83.9	103.5	187.4
1987	36.4	42.2	44.8	27.8	17.6	8.9	141.3	87.5	90.2	177.7
1988	40.9	24.0	52.8	27.4	13.4	3.0	120.6	67.9	93.6	161.5
1989	29.9	16.2	52.6	26.8	11.7	3.8	111.1	49.9	91.1	141.0
1990	27.5	19.3	52.2	24.7	19.2	6.5	121.9	53.3	96.2	149.4
1991	20.7	14.4	44.4	26.2	22.1	4.8	111.9	40.0	92.6	132.6
1992	26.2	16.6	41.7	30.0	11.7	4.2	104.1	46.9	83.3	130.2
1993	24.5	23.9	47.3	30.0	13.2	3.7	118.0	52.1	90.4	142.5
1994	22.2	16.2	49.1	30.4	14.9	3.8	114.4	42.1	94.5	136.6
1995	19.5	13.9	41.4	27.3	19.1	4.0	105.7	37.5	87.8	125.3
1996	14.4	11.3	34.8	31.1	19.9	5.3	102.3	31.0	85.8	116.7
1997	15.6	12.3	34.2	25.9	21.1	6.8	100.2	34.7	81.2	115.8
1998	16.2	3.3	32.6	29.6	20.7	6.6	92.7	26.0	82.9	108.9
1999	11.9	2.6	31.6	21.7	18.5	7.8	82.2	22.3	71.8	94.1
2000	11.7	2.9	23.3	23.7	19.1	5.1	74.1	19.6	66.1	85.8
2001	16.8	8.4	32.7	25.6	13.4	5.1	85.2	30.3	71.7	102.0
2002	15.9	4.6	33.6	23.0	11.0	11.7	83.8	32.1	67.5	99.7
2003	16.4	6.4	33.3	24.6	8.6	8.5	81.4	31.3	66.5	97.8
2004	18.3	8.6	29.5	24.4	8.1	9.2	79.7	36.1	62.0	98.0
2005	19.8	11.7	25.7	24.6	7.2	8.4	77.5	39.9	57.5	97.3
2006	15.4	10.9	30.2	19.1	5.8	5.8	71.6	32.0	55.0	87.0
2007	13.4	12.4	41.1	19.1	4.3	6.2	83.1	32.0	64.5	96.5
2008	13.6	9.4	45.2	20.9	4.9	7.4	87.8	30.5	71.0	101.5
2009	12.0	7.2	36.2	20.8	4.8	6.7	75.8	25.9	61.8	87.7
2010	13.8	7.4	40.9	17.6	5.2	4.7	75.8	25.8	63.7	89.6
2011	8.5	5.6	37.2	13.7	6.4	9.0	71.9	23.2	57.2	80.4
2012	13.1	4.2	19.6	9.0	2.9	6.0	41.8	23.3	31.6	54.9
2013	5.3	2.1	15.1	9.1	4.1	10.2	40.5	17.6	28.3	45.8
2014	4.3	1.9	6.9	6.7	2.4	5.6	23.6	11.9	16.0	27.9

ANNEX III: OVERVIEW OF MANAGEMENT MEASURES FOR THE SOUTHERN SARDINE STOCK REGULATED BY THE EU, SPAIN AND PORTUGAL

Fishery Species	Measure	National European level	Specification	Regulations	Date of implementation
All species	Mesh size	European	Different specifications according to catch compositions	Council Regulation (EC) No 850/98 amended 1999, 2000, 2001, 2004	1998 Transposed to PT and ES regulation
Sardine	Minimum catch size	European	11cm, 10% undersized allowed	Council Regulation (EC) No 850/98 amended 1999, 2000, 2001, 2004	1998
Sardine	Time closure	National (ES)	I mplementation of a closure of the fishery during the spawning season	BOE 42/1960, BOE 33/1961, BOE76/2001	1960
All species	Minimum catch size	National (ES)	11 cm for sardine	Real decreto 560/1995, BOE 84/1995	1995
Sardine/Anchovy	Effort limitations	National (ES)	VIIIc,IXa: minimum vessel tonnage 20GRT, maximum engine power 450hp, max length purse seine 450m, max height purse seine 80m, minimum mesh size 14mm, max number of fishing days/week: 5, fishing prohibited in bays and estuaries Gulf of Cadiz: Maximum net length 450 m. Maximum net high 80 m.		1997

Sardine	Catch limitation	National (ES)	Max 10000 kg/day/boat fish > 15 cm	Orden Ministerial del 14 de Mayo de 1985, Orden del 21 de abril de 1986, Orden del 10 de Junio de 1987, Orden del 22 de febrero de 1988, Orden del 5 de abril de 1989, Orden del 28 de mayo de 1990, Orden del 31 de Julio de 1991, Orden del 12 de junio de 1992, orden del 29 de enero de 1993, orden del 12 de mayo de 1994, orden del 8 de marzo de 1995, orden del 22 de marzo de 1996, orden del 2 de abril de 1997, orden del 9 de marzo de 1998, orden del 7 de abril de 1999, orden del 22 de febrero de 2000, orden del 25 de enero de 2001, orden APA/142/2002 del 25 de enero de 2002, Orden APA/1733/2003 del 24 de junio de 2003, Orden APA/2118/2004 del 24 de Junio de 2004	1985 - 2004
Purse seine/all	Overall legal framework applied to the fishery and species	National (ES)	Defines the gear, target species, minimum landing sizes, limits to net and mesh size, area and depth of operation, use of attraction lights. live baits	Orden APA/676/2004	2004
Sardine	Catch limitation	National (ES)	Max 7000 kg/day/boat fish > 15 cm, max 2000 kg/day/boat fish between 11 and 15 cm.	Orden APA/2108/2007	2007
Sardine	Catch and effort limitation	National (ES)	Purse seiner management Plan in IXa South Cadiz: 3000kg/vessel day(<10% of small sardine (<9cm)). Maximum effort 200 days/year and 5 days/week	Orden APA/3288/2007	2007
Sardine/anchovy	Area closure	National (ES)	IXaS Cádiz: fishing closures implemented annually between November-February		2008
Sardine	Catch and effort limitations	National (ES)	Adopts the sardine Management Plan. .	Orden AAA/1512/2014 Orden AAA/1835/2014 Orden AAA/1/2015	2014-2015

Purse seine/all	Overall legal framework applied to the fishery and species	National (PT)	Gear: 3 types of gear allowed: american type purse seine, south american "lampara" and mediterranean "lampara". Target species: Sardina pilchardus, Scomber colias, Scomber scombrus, Boops boops, Engraulis encrasicholus, Trachurus spp., Scomberomorus spp., Sarda sarda Balistes spp., Belone belone, Mugil spp., Liza spp., Chelon spp., Pomatomus saltatrix. Minimum Mesh size: 16 mm. Minimum Landing Size: 11 cm. Limits to net size: variable with vessel LOA, maximum length 800 m, maximum height 150 m. Attraction lights: at most two attraction lights in areas over 2 miles distance of the coastline. Area and depth of operation: within ¼ miles distance to the coastline, as well as, in depths below 20 m within 1 mile distance to the coastline.	Decreto-regulamentar No. 43/87 de 17 Julho, transposes Council Regulation No. 3094/86 of 7 October 1986 providing for certain fishery resources conservation technical measures. Ammended by Decreto-Regulamentar No 7 /2000 de 7 Maio and Decreto-Regulamentar No 15/2007 de 28 Março. Portaria No. 1102-G/2000 de 22 Novembro- Regulation of the Purse Seine Fishery, condenses all matters related to fishing with purse seine from the previous regulations. Ammended by Portaria No. 346/2002,de 2 de Abril and Portaria No. 397/2007 de 4 de Abril.	1987
Purse seine/Sardine	Effort limitation Time/area closure	National (PT)	Limits the number of fishing days per year (lower in the north) and per week (5 days), seasonal fishing closures winter/spring in the northern coast. 10% by-catch allowed in other fisheries.	Portaria n.o 281-B/97 de 30 de Abril	1997
Purse seine/Sardine	Effort and catch limitations	National (PT)	Reduces the number of fishing days per year and equal along the coast, sets annual catch limits, split by POs in some years, sets quota for non-associated vessels. 10% by-catch allowed in other fisheries.	Portaria nº 236/2000 de 28 de Abril, Portaria No. 543-B/2001 de 30 Maio, Portaria No. 123-A/2002 de 8 Fevereio, Portaria No. 184/2003 de 21 Fevereiro, Portaria n.o 1423-A/2003 de 31 Dezembro	2000 - 2004
Purse seine/Sardine	Catch limitations	National (PT)	Maximum catch: 55 000 tonnes in 2010 and 2011 Maximum fishing days per year (180 days) and per week (5 days) Crates a consultative Commission of stakeholders for the sardine fishery coordinated by the Fisheries Management Authority.	Portaria n.º 251/2010 de 4 Maio, Portaria n.º 294/2011, de 14 de Novembro.	2010 - 2011

Purse seine/Sardine	Catch and effort limitations	National (PT)	Adopts the sardine Management Plan. Catch limits set for successive periods along the year. Annual limits 36 000 tonnes in 2012, 2013, 13 500 tonnes sin 2014. Portuguese landings assumed to be 70% of total stock landings. 45 day fishing ban in winter/spring alternating between regions.	Despacho n.º 1520/2012, de 18 de janeiro, Despacho n.º 7509/2012, de 29 de maio, Despacho n.º 15351-A/2012, de 30 de novembro, Despacho n.º 12213/2013 de 25 de setembro, Despacho n.º 7112-A/2013 31 de maio, Despacho n.º 15261/2013 22 de novembro, Despacho n.º 8503/2014 1 de julho, Despacho n.º 8856/2014 9 de julho	2012 - 2014
Purse seine/Sardine	Time closure Effort and catch limitations	National (PT)	59 days fishing ban in winter/spring A single trip per day. Maximum catch per vessel per day depending on vessel LOA. Maximum 6 tonnes/day for LOA> 16 m. Catch limits set by period: total in year 13 500 tonnes. Catches split by PO. Portuguese landings assumed to be 68% of total stock landings. Specific limits for sardine in commercial category T4 (36-67 individuals/Kg)	Despacho n.º 15793-B/2014 31 de dezembro, Despacho n.º 2179-A/2015 de 2 Março, Despacho n.º 5119-H/2015 15 de maio.	2015
Sardine	Catch limitation small individuals	National (PT)	No catch of sardine T4	Despacho n.º 10062-B/2015 de 4 de setembro	Since 4 September 2015

Note: Compilation carried out by the authors; shaded cells indicate management regulations currently in place.

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