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OCEANOGRAFÍA

INVESTIGATIONS ON ANCHOVY (*Engraulis encrasicolus* Linnaeus, 1758) BY THE IEO (Instituto Español de Oceanografía) IN THE NORTHERN AND CENTRAL EASTHERN ATLANTIC

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INTRODUCTION

Due to the social-economical value of the species, the Instituto Español de Oceanografía (IEO) has carried out investigations on anchovy in the North and Central-East Atlantic since several years ago. Anchovy distributed in the Bay of Biscay have been studied from various IEO laboratories located in the north of Spain; anchovy off the Gulf of Cádiz and northern Morocco from the Centro Oceanográfico de Cádiz:

In the case of the Bay of Biscay anchovy three different research institutions are involved in its study (surveys, biological and fishery data and assessment): IFREMER (France) and AZTI and IEO (Spain). This Report includes, by geographical area, a summary of the data series obtained and the studies carried out along the historical time series (statistical and biological). In addition, some comments about the fisheries (fleet, fishing gear, target species, fishing activity) and the state of knowledge of the resources (fishery independent information, assessment and management) are presented. A relation of references is also included.

BAY OF BISCAY

Species: European anchovy (*Engraulis encrsicolus*, L.)

Area: Bay of Biscay (Includes ICES Subarea VIII, mainly the ICES Divisions VIIIa,b,c).

Data series:
Catches: 1940 – 2008
Catch at age data: 1987-2008
Catch per unit of effort (*): 1987-2008. There is standardized effort available since 1987.
Fishery independent information: DEPM surveys: 1987-2008; Recruitment surveys: 2003-2006-2008. Acoustic surveys: 1986-2008. Exploratory surveys carried out with commercial vessels: 2000, 2005, 2007.

Fleet: Two fleets operate on anchovy in the Bay of Biscay: Spanish purse seiners and French fleet constituted of purse seiners and pelagic trawlers. The pattern of each fishery has not changed in recent years. In general, most of Spanish landings (85 %) are usually caught in divisions VIIIc and VIIIb in spring. Since the start of the 90's the percentage of catches by country were almost equal (= 50%) (Uriarte *et al*., 1996; ICES, 2008).

The Spanish fleet is composed of about 200 purse seiners that operate at the south-eastern corner of the Bay of Biscay (in Divisions VIIIc and b), mainly in spring, when usually more than 80 % of the Spanish annual catches occurred. This fleet is composed of vessels from different Autonomous Communities of the North of Spain (Galicia, Asturias, Cantabria and Basque Country). The technical characteristics and number of vessels operating for anchovy are shown in table below. The total purse seine fleet is not homogeneous and shows technical differences between the vessels from the different Autonomous Communities: Vessels of the Basque Country and Cantabria are larger (mean length = 29.5 m and 26.6 m respectively), mainly because they sail further, above all during the tuna fishing season, whereas the fleet of Galicia has the smallest vessels (mean length = 16.6 m), since an important part of its activity is concentrated around the Rias. Vessel sizes in the Asturian fleet tend to be somewhere between these two cases (mean length = 22.4 m) (Punzon *et al*., 2007; Villamor *et al*., 2008)

Table I.- Technical characteristics of Spanish purse seine fleet operating for anchovy during the years 2003-2005

		Purse seine		
		2003	**2004**	**2005**
Number		173	195	108
Length	**Mean**	26.4	25.7	27.5
	Range	14-38	10-38	13-38
Horsepower	**Mean**	435.2	408.7	467.1
	Range	85-1100	30-1100	90-1100
GRT	**Mean**	92.7	86	97.9
	Range	14-158	6-201	9-201

Fishing gear: As it was already described above the Spanish fleet directed to anchovy uses only the purse seine as fishing gear.

Catch species composition: If anchovy is abundant the landings of this fleet is almost entirely anchovy. Analyzing the composition of the landings from the fishing trips in spring 2003-2005, the anchovy was always the main species in percentage (Figure 1). In 2005 it made up only 40% of landings, with a noteworthy increase in those of other species, such as *Scomber scombrus*, *Trachurus trachurus* and *Sardina pilchardus*, due to the scarcity of anchovy in that year. (STECF, 2008)

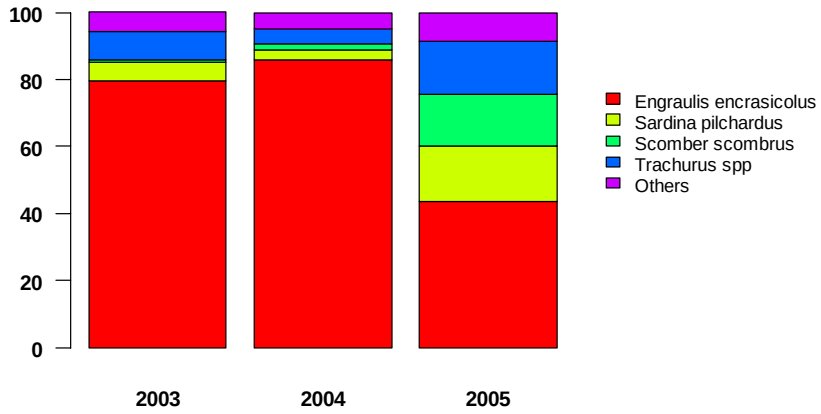


Figure 1. Catch composition of the Spanish purse seiners targeting anchovy by year (2003-2005)

Kind of activity: The fishery is regulated under the European Union fisheries policy (TAC constraint). There are also agreements between the countries involved in the fishery (French and Spain) to accommodate whenever possible the general EU rules to their particular fisheries objectives (e.g. interchange of quotas, etc).

Assessment organization and periodicity: The assessment is carried out under the auspicious of ICES every year (although in some years the assessment was also carried out under STECF from EU). Specialists from the two countries involved in the fishery, France and Spain, attend the assessment Working Group. In addition, other specialists from other countries are also involved. Since anchovy is a short lived species, the assessment is carried out as soon as the results from the spring research surveys (spawning season) is available, usually in June.

Fishing activity information: Routine control of landings from IEO and other fishery research institutions from Basque Country (SIO and at present AZTI) since seventies. Information is obtained from fishermen's associations or from observers/samplers at the main fishing ports. Control of effort (number of vessels) is also provided by the General Secretary for Spanish Fisheries.

Length information: sampling is extensively covered by IEO and AZTI (previously SIO) since seventies. The sampling is produced during the whole year but especially during the main fishing season in spring on monthly basis. In recent years the fishery has been closed or the catches were very limited. The discards are negligible.

Biological information: Biological information (weight, maturity, age,..etc) is also obtained from samples collected in research surveys during acoustic surveys (since late eighties) in

spring and egg surveys since 1987 in spring. At present, recent research surveys of recruitment are also providing biological information in autumn (since 2006).
Mean length at age, mean weight at age in the catch and in the stock, are available since 1987.
As reported in previous years reports (ICES, 2008), anchovies are fully mature as soon as they reach 1 year old, at the following spring after they hatched. No differences in specific fecundity (number of eggs per gram of female body weight) have been found so far according to age).

Fishery independent information:

- DEPM, Daily Egg Production Method, surveys (AZTI): 1987-2008
- Recruitment surveys:
    - JUVENA (AZTI): 2003-2008
    - PELACUS 10_200X (2006-2008)
- Acoustic surveys (IEO): 1986-2008. The timing of the survey (March-April) is not adequate to study anchovy in the Cantabrian Sea, but information on pelagic community is obtained.

Other surveys: Exploratory surveys carried out with commercial vessels to search for anchovy distribution and fishing opportunities (IEO + AZZTI):
"Canal de la Mancha survey (2000)"; "Centinela (2005)"; "Proa (2005)"; "Consort surveys, (2007)" = Commercial vessels that accompanied the surveys of scientific research vessels; "Rake survey (2007)".

Assessment:

Model:

It is a kind of Bayesian production model. In particular it is a two-stage biomass-based state-space model with stochastic recruitment processes and deterministic dynamics (Ibaibarriaga *et al*., 2008). The two-stages refers to the splitting the population in two groups: population of age 1 and population of ages greater than one. It is fitted in a Bayesian context with posterior computations carried out using Markov Chain Monte Carlo techniques. The model uses the historical catch information (since 1987) and the biomass estimates from acoustic (France) and DEPM (Spain) surveys.

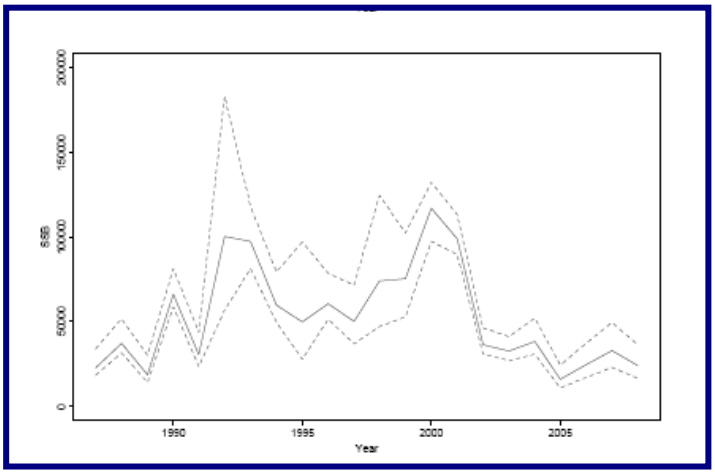


Figure 2. Time series (1987-2008) of estimated SSB for the Bay of Biscay anchovy (with indication of credible intervals)

State of the stock (ICES, 2008):

The stock is classified as being at risk of reduced reproductive capacity. The Spawning Stock Biomass (SSB) is estimated to have a 23% probability of being below Blim (limit reference point = 21,000 tones). Low recruitment since 2002 and almost complete recruitment failure of the 2004 year class are the primary causes of the low stock size.
The recruitment at age 1 in 2008 is lower than in 2006 and 2007 and is the second lowest in the time series.

Management considerations: The current situation of the stock calls for the utmost protection of the juveniles as well as what is left of the spawning population, because the recovery of the anchovy population depends entirely on a good recruitment entering the population this year. That is to say, the preferred aim of managing a resource like anchovy should be to prevent the collapse of the stock–recruit binomial by means of the maintenance of stable spawning biomass above a certain critical level (Precautionary level Bpa = 33,000 t). For this reason, ICES (and in years before also the STECF) recommends that the Bay of Biscay anchovy fishery should remain closed at least until anchovy biomass estimates for 2009 and recruitment for 2008 are available. These new estimates will be based on the results of the research surveys (acoustic and DEPM) of spring 2009, carried out during the anchovy spawning season. As with other stocks of small pelagic species that tend to form in shoals, the catch per unit of effort of the commercial fleets (purse-seiners and pelagic trawlers) is not always a trustworthy index of stock abundance. So assessment models must be calibrated using fishery-independent information. For the efficient management of this resource, an indicator of recruitment strength is also needed to be able to apply adaptive management (Villamor *et al.*, 2007, ICES, 2008; STECF, 2008).

Currently, a series of research surveys is now being developed along these lines for the period of the juvenile phase of anchovy (autumn) to learn its ecology and estimate the abundance of new recruits. It is anticipated that, once the usefulness of this new historical series has been established together with the spring surveys, the Bay of Biscay anchovy can be managed more efficiently, and these episodes of crisis can be avoided as far as possible.

In the past TAC was set independent of the state of the stock in the range of 30,000 to 33,000 tones and had limited impact on the fishery. Recent developments in management have been moving towards and in-year monitoring regime. Since the 2005 the fishery has been very limited or closed.
Harvest control rules are currently under development, in particular for setting a TAC on the basis of the estimated SSB in June. TACs may be set for the whole period July-June, with or without a provision to revise it at the beginning of the year based on results of juvenile's surveys. Supplementary measures (area closures, minimum landing size) may be considered in addition to TACs.

Other comments: The main uncertainty in the assessment is referred to the parameter that comprises the growth and natural mortality in the biomass Bayesian model.
The recruitment depends strongly on environmental factors. The prediction of incoming recruitment based on environmental indices has been attempted (Borja *et al*., 1998; Allain *et al*., 2001), but so far such predictions have not been sufficiently accurate.

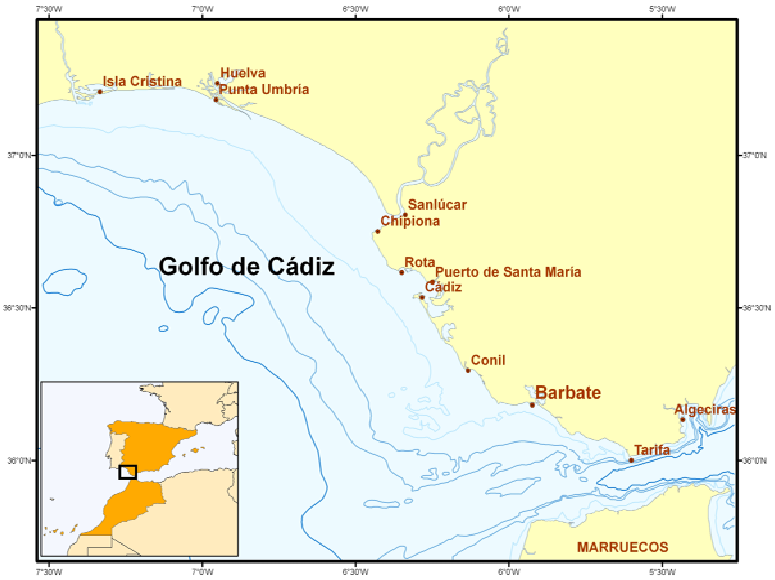
SUMMARY INFORMATION

Year	Catches (kg)	Effort (positive fishing trip)	Length-Weight	Sex-ratio	Spawning period	Length first maturity	Growth	Other studies	Acoustic Surveys/ DEPM	Assessment (ICES advice)	Management
1987	X	X	Q	Q	X	X	X	Fecundity + environmental factors	A, DEPM	Not assessed	Implementation of EC-CFP technical measures
1988	X	X	Q	Q	X	X	X	"	A, DEPM	Not assessed	"
1989	X	X	Q	Q	X	X	X	"	A, DEPM	Increase SSB; TAC	"
1990	X	X	Q	Q	X	X	X	"	A, DEPM	Precautionary TAC	"
1991	X	X	Q	Q	X	X	X	"	A, DEPM	"	"
1992	X	X	Q	Q	X	X	X	"	A, DEPM	No advice	"
1993	X	X	Q	Q	X	X	X	"	A, DEPM	Reduced F on juveniles; closed area	"
1994	X	X	Q	Q	X	X	X	"	A, DEPM	"	"
1995	X	X	Q	Q	X	X	X	"	A, DEPM	"	"
1996	X	X	Q	Q	X	X	X	"	A, DEPM	"	"
1997	X	X	Q	Q	X	X	X	"	A, DEPM	"	"
1998	X	X	Q	Q	X	X	X	"	A, DEPM	"	"
1999	X	X	Q	Q	X	X	X	"	A, DEPM	"	"
2000	X	X	Q	Q	X	X	X	"	A, DEPM, C	Closure of the fishery	"
2001	X	X	Q	Q	X	X	X	"	A, DEPM	Preliminary TAC corresponding to recent exploitation	"
2002	X	X	Q	Q	X	X	X	"	A, DEPM	"	"
2003	X	X	Q	Q	X	X	X	"	A, DEPM, R	"	"
2004	X	X	Q	Q	X	X	X	"	A, DEPM, R	"	
2005	X	X	Q	Q	X	X	X	"	A, DEPM, R,C	Rebuilding SSB	"
2006	X	X	Q	Q	X	X	X	"	A, DEPM, R	Closure of the fishery	"
2007	X	X	Q	Q	X	X	X	"	A, DEPM, R,C	"	"
2008	X	X	Q	Q	X	X	X	"	A, DEPM, R	"	"

Q: Quarterly. A: Acoustic. DEPM: Daily Egg Production Method. R: Recruitment. C: Commercial

Notes: The biological information (age length keys, etc) in on monthly basis during the fishing season (spring). The measure of effort is in relation to the number of vessels, fishing trips and the technical characteristics of each type of vessel.

GULF OF CÁDIZ



Species: European Anchovy (*Engraulis encrasicolus* Linnaeus, 1758)

Area: Gulf of Cádiz (jointly with the Portuguese waters off Algarve both areas configure the ICES Sub-division IXa South within the Division IXa).

Data Series: Landings from Moroccan fishing grounds and Gulf of Cádiz (separated) was almost impossible until 1988. Landings records between 1988 and 1992 are incomplete since they don't include those recorded in the ports of the Huelva province. Since 1993 onwards the data base for landings is complete. Since 1998 onwards daily landings and nominal effort by vessel are available for all the fleets. Technical characteristics of vessels are available from annual official censuses of the operative fleet. Length composition of landings is available since 1988 but with variable sampling intensity. Biological data, including individual ageing, are available since 1988 but with gaps for 1994 and first semester 1995. Data from IEO early summer acoustic surveys are available since 2004, but with gaps in 2005 and 2008, when IEO DEPM (Daily Eggs Production Method) surveys have been carried out.

Fleet: The number of purse-seine vessels from 1999 to 2007 has oscillated between 145 (in 2004) and 104 (in 2000) vessels, and the vessels within this fleet targeting anchovy between 90 (2001) and 135 (2004) vessels. Average technical characteristics of the purse-seine fleet in 2007 are the followed: Length between perpendiculars (12.0-17.8 m), GRT (15.9-46.9 t) and Engine power (138.1-357.4 HP).

Fishing gear: Purse-seine gear with (allowed maximum dimensions) 450 m length X 80 m height and a 14 mm (minimum) mesh size. Anchovy and Sardine fisheries are usually performed by night with an auxiliary boat and light lamps. A detailed description of the fishing gear is given in Millán (1992).

Catch species composition: at least 3 *métiers* have been clearly identified in the recent Gulf of Cádiz purse-seine Spanish fishery but only based on the targeted species (Silva *et al*., 2007): 1) fishing trips targeting anchovy (spring-summer), 2) trips targeting sardine (*Sardina pilchardus*) (late summer-late winter), and 3) trips targeting on a mackerel species mixture (*Scomber scombrus* and *S. japonicus*, although basically dominated by the later species) (summer). For anchovy and sardine, their fishing seasons coincide with their respective spawning seasons (Millán, 1999; Ramos and Millán, 2006; Ruíz *et al*., 2006; Baldó *et al*., 2006). The whole purse-seine fleet/fishery dynamics is actually controlled by both the abundance and market prices of anchovy.

Kind of activity: the fishery is exploited by Spanish local fleets whose activity is regulated by Regional Fishery Administration's fishing plans and National Fishery Administration's regulations which are the result of the implementation of the EU-CFP (Common Fisheries Policy of the European Union).

Assessment organization and periodicity: Gulf of Cádiz anchovy data has been annually provided to the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (WGMHSA, usually held in early September) until 2007. Since 2008 these data are being provided to the recently created ICES Assessment Working Group that is exclusively devoted to the European Anchovy stocks in ICES waters (ICES Working Group on Anchovy, WGANC). Since 2005 the direct assessment either by Acoustic or DEPM surveys on anchovy and sardine stocks in ICES sub-areas VIII and IX is also planned, internationally coordinated, their methods standardised, and their estimates reviewed in the ICES Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES areas VIII and IX (WGACEGG).

Fishing activity information: the monitoring of the purse-seine fishing activity in the Gulf of Cádiz started in 1988. Since then the fishing activity information (landings by species and fishing effort/vessel/day or month) has been gathered by an IEO's information and sampling network with observers/samplers distributed by the main fishing ports in the region.

Length information: under the abovementioned network, observers at the main ports also behave as samplers of the length composition in anchovy landings. At least one sampling per month is available throughout the historical series.

Biological information: monthly samples from commercial landings at Cádiz and Sanlúcar de Barrameda (and in a lesser extent from Barbate) ports has been routinely processed in laboratory since 1988. In the last years, however, biological samples come almost exclusively from Cádiz which are obtained with a fortnightly periodicity. Variables considered are: total length, fresh weight, sex, maturity stage and otolith. Eviscerated weight, gonad weight and visceral fat content have not been recorded with regularity during the whole historical series. Reproductive characteristics (spawning season, length at first maturity) and condition status of the species during the period 1989–1992 were analysed by Millán (1999). For the same period (1989-1993) Bellido *et al*. (2000) estimated growth parameters from length frequency analysis methods. Ageing from otoliths is difficult, with problems in the interpretation of both the otolith edge and the annual rings which lead to state the need for establishing more standardised ageing criteria for the species in this area (Santamaría, 1998).

Fishery independent information:

Portuguese IPIMAR acoustic surveys: In addition to the previously sardine estimates from the surveys series (*SAR* and *SARNOV* series) onboard R/V *Noruega*, anchovy estimates started to be available since November 1998 for both sardine and anchovy.

Spanish IEO acoustic surveys: Spanish acoustic surveys in the Gulf of Cadiz waters (Subdivision IXa-South) have been sporadically conducted from 1993 to 2003. A consistent yearly series of early summer acoustic surveys (*ECOCÁDIZ* series) estimating the anchovy abundance in the Subdivision IXa South (Algarve and Gulf of Cadiz) started in 2004. Surveys in this new series, for the time being conducted by the R/V *Cornide de Saavedra,* may show as it happened in 2005 and 2008, some gaps in those years coinciding (same dates and surveyed area) with the conduction of the anchovy DEPM survey.

Gulf of Cádiz Anchovy DEPM surveys: anchovy DEPM surveys are being triennially carried out by IEO since 2005 within the *BOCADEVA* surveys series. The second survey in the series was carried out this year.

Assessment: data availability, recent catch trajectories and biological evidences have been the basis for a data exploration of anchovy catch-at-age data in Subdivision IXa South (Algarve and Gulf of Cádiz) independent of the rest of the Division IXa (Atlantic Iberian

façade and Southern Galicia). An *ad hoc* seasonal (by half-year periods) separable model implemented and run on an Excel spreadsheet has been used in the last years for such a data exploration since 1995 onwards. At present the separable model is tuned to half-year catch-at-age data and to the available acoustic estimates of anchovy aggregated biomass from the spring Portuguese surveys series only (including the acoustic estimate one year ahead of the assessment's last year).

The last exploratory assessment, performed this year in the ICES WGANC, as it was implemented, was not recommended by ICES as a basis for predictions or advice since it did not give reasonable results. ICES considered that the available information is inadequate to evaluate the spawning stock or fishing mortality relative to precautionary reference points. At present, there is no sufficient information to estimate reference points for this stock. Accordingly, the state of the stock is unknown under an analytical assessment approach.

However, a qualitative assessment (accepted as valid by ICES) based on available data indicates stable stock status with little change from previous years. There is no evidence of serious problems: catches, catch per unit effort, and survey trends are variable but show no trends; length and age composition data indicate appreciable recent recruitment levels; the ratio of catch in Area IXa south to DEPM spawning biomass during 2005 (4423/14219=0.31) is reasonably low. The most recent direct acoustic estimates indicate that the stock in Sub-division IXa South is still in a relatively stable situation (about 30 thousand tonnes as an average for the 2006-2008 period), a situation that could be reversed if the fishery, as evidenced by the increased effort levels reached in 2007, is still expanding its fishing capacity.

Management: As stated above, it is not possible to determine limit and precautionary reference points for management purposes based on the available information. Hence, harvest control rules cannot be provided, as reference points are not determined. Therefore, ICES advice for anchovy in Division IXa has to be framed in a precautionary manner (*i.e.*, a precautionary TAC) to limit exploitation and, accordingly, the basis for advice is average catches over a reference period (since 1988 onwards, but excluding those years recording peaks in landings). However, such TACs advised by ICES (4.8 thousand tonnes in 2007, 2008, and 2009) have not been restrictive to the fishery (agreed TACs of 8 thousand tonnes since 2002; and 6.5 thousand tonnes landed in 2007).

As this stock experiences high natural mortality and is highly dependent upon recruitment, ICES recommends the consideration of an in-season management or alternative management measures. Such measures should, however, take into account the data limitations on that stock and the need for a reliable index of recruitment strength.

The regulatory measures in force for the Spanish anchovy purse-seine fishing in the Division are summarised as follows: Minimum landing size: 12 cm total length in VIIIc and IXa North, 10 cm in Gulf of Cádiz (IXa South). Minimum vessel tonnage of 20 GRT with temporary exemption. Maximum engine power: 450 HP. Purse-seine maximum length: 450 m. Purse-seine maximum height: 80 m. Minimum mesh size: 14 mm. Fishing time limited to 5 days per week, from Monday to Friday. Cessation of fishing activities from Saturday 00:00 h to Sunday 12:00 h. Fishing prohibition inside bays and estuaries.

In the Gulf of Cádiz (Subdivision IXa South) the Spanish purse-seine fleet was performing a voluntary closure of three months (December to February) until 1997. Since 2004 two complementary sets of management measures affecting directly to the Gulf of Cádiz fishery have been implemented and are still in force: a fishery closure during some months, and a delimitation of a marine protected area (fishing reserve) for protecting recruitment.

SUMMARY INFORMATION

Year	Catches (kg)	Effort (positive fishing trip)	Length-Weight	Sex-ratio	Spawning period	Length first maturity	Growth (*)	Other studies	Acoustic Surveys/ DEPM	Assessment (ICES advice)	Management
1988	X	X	Q	Q	X	X	X			Not assessed	Implementation of EC-CFP technical measures
1989	X	X	Q	Q	X	X	X			Not assessed	"
1990	X	X	Q	Q	X	X	X			Not assessed	"
1991	X	X	Q	Q	X	X	X			Not assessed	"
1992	X	X	Q	Q	X	X	X			Not assessed	"
1993	X	X	Q	Q	X	X	X		X	If required, precaution.TAC	"
1994	X	X	-	-	-	-	-		X	If required, precaution.TAC	"
1995	X	X	-	-	-	-	-		X	If required, precaution.TAC	"
1996	X	X	Q	Q	X	X	X		X	If required, precaution.TAC	"
1997	X	X	Q	Q	X	X	X		X	If required, TAC at pre-95 catch level	"
1998	X	X	Q	Q	X	X	X		X	No advice	"
1999	X	X	Q	Q	X	X	X		X	If required, TAC at pre-95 catch level	"
2000	X	X	Q	Q	X	X	X		X	Fishery less than pre-95 level and develop and implement management plan	"
2001	X	X	Q	Q	X	X	X		X	Average catch excl. 95 and 98	"
2002	X	X	Q	Q	X	X	X		X	Average catch excl. 95 and 98	"
2003	X	X	Q	Q	X	X	X		X	Average catch excl. 95, 98, and 01	"
2004	X	X	Q	Q	X	X	X	Dynamics of maturation	X	Average catch excl. 95, 98, 01, and 02	+ Regional Purse-seine Fishery Plan & MPA
2005	X	X	Q	Q	X	X	X	"	X	Average catch excl. 95, 98, 01, and 02	"
2006	X	X	Q	Q	X	X	X	"	X	Average catch excl. 95, 98, 01, and 02	"
2007	X	X	Q	Q	X	X	X	"	X	Average catch 1988-2005 excl. 95, 98, 01, 02	"
2008	X	X	Q	Q	X	X	X	"		Average catch 1988-2006 excl. 95, 98, 01, 02	"

Q: Quarterly. *: Quarterly Age-Length Keys built from otoliths readings

	No catch data for Punta Umbría, Huelva and Isla Cristina fleets
	No effort data for Punta Umbría, Huelva and Isla Cristina fleets
	No effort data for Punta Umbría fleets

NORTHERN MOROCCO

Species: European Anchovy (*Engraulis encrasicolus* Linnaeus, 1758).

Area: Moroccan waters belonging to the CECAF 34.1.1 area (*i.e*., North-western Morocco: at present purse-seine fishing allowed to the North of 34º18').

Data Series: separation of landings from Moroccan fishing grounds and Gulf of Cádiz in the Spanish official statistics is almost impossible until 1988. Landings and fishing effort data by species/vessel/fishing trip are available from 1988 to 1999, and since April 2007 on. Technical characteristics of vessels are available from annual official censuses of the operative fleet. Length composition of landings is available from the 1988-1999 period and since August 2007 on but with variable sampling intensity. Biological data have been collected with different intensity and temporal coverage through the historical series for the reasons exposed below.

Fleet: The vessels which have usually been benefited from the licences' system belong to a fleet segment of heavy-tonnage purse-seiners based at Barbate (Cádiz, SW Spain), the so called Barbate's "Traíñas". These vessels have traditionally alternated the small pelagics fishery (mainly anchovy) in the North-western Moroccan fishing ground with the fishing in the Spanish waters off the Gulf of Cádiz (Millán, 1992). The general trend throughout the Fishing Agreements shows a decrease of the GRT of the vessels that composed the Barbate's purse seiners fleet (with the exception of 1991) until minimal values in 1993. In the following years, this trend softly increased because of the lower restricted conditions of the 1995 Agreement. So, the total number of Andalusian purse-seiners fishing in the Moroccan fishing ground decreased until a minimum of 22 vessels occurring in 1992. From this year onwards, this number increased, reaching a maximum of 47 vessels fishing before the end of the last Agreement in 1999. The trends of both the total annual and quarterly number of vessels, do not coincide because of the rotating licences' system deployed by the Barbate's fleet. By applying this system, different vessels rotated the licences from one quarter to another. In this way, all the licensed vessels of this fleet were able to fish in Moroccan waters throughout one year. In 2007, the Barbate's fleet has re-incorporated to the Moroccan fishing ground with 19 vessels of the 20 allowed ones in the last Agreement. In 2007 and 2008 the GRT and number of vessels (total and monthly) showed the lowest values of the analysed historical series (García-Isarch *et al*., 2008). Average technical characteristics are: 17 m of length between perpendiculars, 46 t of GRT and 357 HP of engine power.

Fishing gear: Purse-seine gear with (allowed maximum dimensions) 500 m length X 90 m height and a 14 mm (minimum) mesh size. A detailed description of the fishing gear is given by Millán (1992). Use of lamps, although formerly used, is banned by the present Agreement.

Catch species composition: anchovy (*Engraulis encrasicolus*) is the target species for the Spanish purse-seine fleet off North-western Moroccan waters. It accounts for more than 77 percent of the total landings in average, its contribution being higher than 85 percent in most of the years. The lower percentages of anchovy were landed during the period 1992-1995. Sardine (*Sardina pilchardus*) represents the second species in landings, accounting for less than 20 percent of the landings in most of the years. Only in 1993, the contribution of sardine landings (49.8 percent) was higher than the anchovy's, which recorded the lowest value in the series. The rest of the species show a low relative importance in the landings. These species belong, in order of importance, to the *Trachurus* spp. and *Scomber* spp. The horse-mackerel species group represents 3.4 percent in landings as an average in the whole series and only in 1994 and 1996 accounted for more than 12 percent. The average percentage of the mackerel species group in the total landings was lower than 1.4 percent, this relative importance showing a decreasing trend along the analysed historical series (Millán, 1992, García-Isarch *et a*l., 2008).

Kind of activity: Moroccan waters were fishing grounds of free access for the Spanish fisheries until the enforcement of the Law of the Sea. Accordingly, from 1979 onwards, Spanish purse-seine fishing has been managed by fishing agreements between the Kingdom of Morocco and either Spanish or EU Administrations.

Assessment organization and periodicity: since 2005 Northern Morocco anchovy data has been annually provided to the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa. Direct assessment by Acoustic surveys in the Moroccan area and in the sub-region has been also carried out.

Fishing activity information: the monitoring of the Spanish purse-seine fishing activity in the Moroccan grounds covers the duration of the different Agreements from 1988 to 1999 and recently since 2007 on. Available data (landings by species and fishing effort/vessel/fishing trip) are collected by personnel of our information and sampling network at the Barbate port. Fishing trips last between 1 and 3 days depending on the target species' abundance in the fishing ground.

Length information: this information has been collected with different sampling intensity since 1988. So, anchovy size composition of landings was sampled once (1 fishing trip of a single vessel) fortnightly between 1988 and 1995. Then, between 1996 and 1999 only one size sampling was carried out following the same scheme. Under the new Agreement sampling intensity has significantly increased up to one sampling per week.

Biological information: biological information is only available from (one) monthly commercial samples for 1989 and from 1996 to 1998. No biological sampling has been carried out since 2007 to date, although is expected that such sampling be re-initiated in 2009. It should be bearing in mind in relation to the available biological information since 1996 that, according to the Agreement in force, the fishery is closed in February and March and therefore the information on the annual cycle of the species is incomplete. So, the anchovies sampled in April (once the fishery is re-opened) all showed spawning activity, and the spawning season extended until October. These facts lead us to suppose that the spawning season of North-western Moroccan anchovy may be very similar to the spawning season observed for its Gulf of Cádiz counterpart (from March-April to October).

The size at first maturity was estimated at about 11 cm, although it should be taken into account that the smaller anchovies were scarcely represented in the catches despite of the decrease in the mean size in catches observed in the last 3 years of the last Agreement (from 14-15 cm during 1989-1994 to the 13 cm for the period 1995-1999).

Although the otoliths were extracted during the biological sampling their reading was very difficult because of the almost complete opacity of the otolith (by CO_2Ca deposition) and therefore we don't have any data on ageing and individual/population growth patterns.

Fishery independent information (without IEO participation):

Regional Surveys

R/V Dr. Fridtjof Nansen

This Norwegian research vessel surveyed the sub-region during the period 1995 – 2006, carrying out acoustic surveys during the months October – December each year. In addition, in the period 2001 – 2003, the vessel carried out acoustic surveys covering the same area in May–July. The surveys aimed to map the distribution and estimate the abundance of the main small pelagic fish species, sardine (*Sardina pilchardus*), sardinellas (*Sardinella aurita* and *Sardinella maderensis*), horse mackerels (*Trachurus trachurus* and *Trachurus trecae*) and chub mackerel (*Scomber japonicus*). However, the distribution of other pelagic resources

(other carangids, and anchovy) was also mapped and their abundance was estimated. The estimated biomass of *Engraulis encrasicolus* in the sub-region from 2000 to 2004 showed fluctuations from one year to the next. A marked drop could be seen between 2000 and 2001. For 2005 an increase in biomass for this species was detected but in 2006 the estimation indicated a decrease in the biomass in Mauritania.

In addition, other acoustic surveys have been carried out (FAO, 2005, 2006, 2007, 2008 *in press*):

R/V Atlantniro
The anchovy biomass series is available for the period 1994-2004 in the Mauritanian zone and the zone north of Cape Blanc. However, data points are very scattered over that period, and therefore it was impossible to establish any trend in this dataset.

R/V Atlantida
The anchovy biomass series is available for the period 1998-2007 in the Mauritanian and Moroccan zones. However, the scattering of the data points during this period does not allow for any trend to be established. For this reason, these data were not used for the *E. encrasicolus* assessment.

In 2007, anchovy abundance was estimated during the coordinated regional survey between the national R/Vs of the region; Al Amir in Morocco; Al Awam in Mauritania and Itaf Deme in Senegal–The Gambia. The indices were corrected to the R/V Dr. Fridtjof Nansen series of indices by the application of an intercalibration coefficient between the national boats and the Norwegian vessel calculated in 2006.

National surveys

The Mauritanian research vessel, R/V Al Awam carried out two surveys during 2004 and 2005. The results of each survey were used to calculate the fish biomasses in the whole EEZ. In 2006 an acoustic survey was carried out and anchovy was observed south of Cape Timiris. This vessel carried out a joint acoustic survey with two boats from Senegal and Morocco in November 2007. During this survey, anchovy (*Engraulis encrasicolus*) was observed in the northern extremity of the Mauritanian zone. The biomass estimated showed a slight increase on the previous year's biomass. However, the short time series from this vessel does not allow any clear trend for this species to be established and these data were not used in the assessment.

In the autumn of 2005 the Moroccan research vessel R/V Al Amir estimated the anchovy biomass in the zone north of Cape Blanc. This Moroccan research vessel carried out four acoustic surveys in 2006: the first between Cape Cantin and Cape Juby, the second between Cape Juby and Cape Bojador, the third between Cape Blanc and Cape Bojador, and the fourth took place in the northern zone.
This vessel carried out two acoustic surveys in April–May and December 2007. During the April–May survey the anchovy stock was estimated at 39 000 tonnes in the northern zone. In the central zone, the stock was estimated at 147 000 tonnes of which 142 000 tonnes were found between Cape Cantin and Cape Juby. Traces of anchovy were detected in the Cape Bojador to Cape Blanc zone. During the December survey anchovy was recorded between Cape Cantin and Cape Bojador with a large biomass of 178 000 tonnes, thus confirming the increase in June. In the Cape Bojador to Cape Blanc zone, anchovy was detected with an estimated biomass of 28 000 tonnes. In 2007, the biomass estimate between Cape Cantin and Cape Blanc was the highest of this vessel's time series.

In 2007 anchovy was not detected in the Senegalese/Gambian waters during the acoustic survey on board the R/V Itaf Deme.

Estimates of biomass (in tonnes) of *Engraulis encrasicolus* in Northwest Africa in 2007

	Cap Spartel–Sidi Ifni AL AMIR	Sidi Ifni–Cap Blanc AL AMIR	Cap Cantin–Cap Blanc AL AMIR	Cap Safi–St Louis ATLANTIDA	Mauritania AL AWAM
Biomass estimates (tonnes)	65 000	126 000	206 000	36 000	18 900
Survey season	April	May-June	December	July–August	November

Assessment: The Working Group carried out a Jones (LCA) exploratory analysis of the length frequencies using the available data for this species. Subsequently the Thomson and Bell model of catch by recruit was applied using the same data. The Working Group decided not to adopt the results of the model due to the lack of available data and the uncertainty over stock identities (FAO, 2008 *in press*).

Management: since the enforcement of the Law of the Sea, Spanish Fisheries in Moroccan waters have been regulated by different agreements (see Table I). The first two ones (1979, 1983) were bilaterally negotiated between the Spanish Fishery Administration and the Kingdom of Morocco. Since the integration of Spain in the EU, access to the Moroccan fishery resources was conditioned by the Fishing Agreements signed by Morocco and the EU (1988, 1992, 1995 and 2006). These agreements became more restrictive for the Spanish fleet over the years. There even was a closure of the fisheries in Morocco to the European fleet (exclusively composed of Spanish purse seiners) by the end of November 1999, when the 3rd Communitarian Fishing Agreement of 1995 expired. This fishery was not re-opened until April 2007, with the signing of the current Fishing Agreement in 2006.

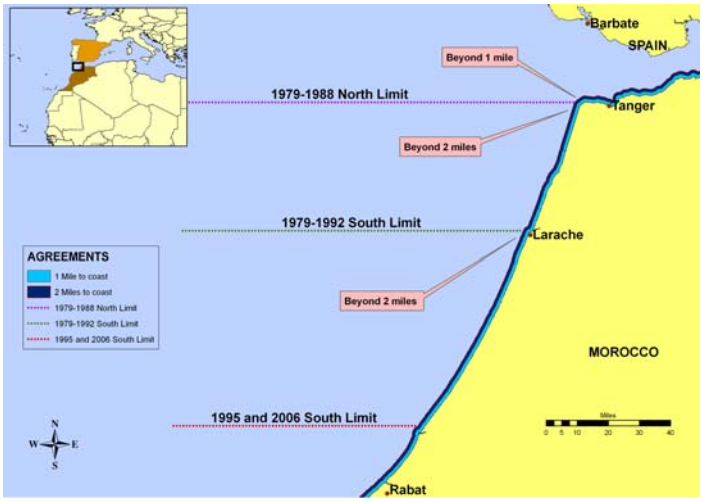


Figure 1.- Map of the fishing zones allowed to the Spanish purse-seine fishery in North Atlantic Moroccan waters by the different Fishing Agreements (from García-Isarch *et al*., 2008)

The Barbate's purse seine fleet was included into the categories called: "Seiners-Northern Cape Noun/North Atlantic/North" of the different agreements. The management measures of this Andalusian purse seine fleet regulated by the agreements mainly consist on an effort control (through GRTs limitations) and technical measures such as the limitation of the fishing areas, close seasons and gear size (see Table I). Figure 1 shows the fishing zones allowed to this fleet by the different agreements.

Table I.- Management measures regulating the purse seine fishery in North Atlantic Moroccan waters by the different Fishing Agreements (from García-Isarch *et al*., 2008)

AGREEMENT	CATEGORY	ZONE	DISTANCE TO COAST	GEAR DIMENSIONS	NUMBER OF VESSELS	CLOSE SEASON	GRT	OBSERVATIONS
1979 (transitory)	Seiners/Northern Cape Noun	Between Tanger and Larache (35º48N'-->35º35'N)					3500	
1983			Beyond 1 mile	500 m x 90 m			3500-->1088	
1988			1 mile (N of 35º48') 2 miles (S of 35º48')	500 m x 90 m			1088	
1992	Seiners/North Atlantic	North of 35º12'N	1 mile (N of 35º12'N) 2 miles (35º12'-->35º48')	500 m x 90 m	36 (10%)	2 months: February and March	1088	
1995	Seiners/North	North of 34º18'N	1 mile (N of 35º48') 2 miles (34º18'-->35º48')	500 m x 90 m	26 (10%)		1300	
2006	Small-Scale Fishing/North: Seine nets	North of 34º18'N	Beyond 2 miles	500 m x 90 m	20			Ban of fishing with lampara nets. Requirement of landings in Morocco.

Whilst waiting for better statistical identification of the species, the Working Group recommends not increasing current effort in the sub-region as a precautionary approach (FAO, 2008 *in press*).

SUMMARY INFORMATION

Year	Catches (kg)	Effort (fishing trip)	Length Composition	Length-Weight	Sex-ratio	Spawning period	Length first maturity	Acoustic Surveys (No IEO)	Assessment (FAO advice)	Management
1988	X	X	Q							Fishery Agreement
1989	X	X	Q	Q	Q					
1990	X	X	Q							
1991	X	X	Q							
1992	X	X	Q							
1993	X	X	Q							
1994	X	X	Q					From 1994 to 2007		
1995	X	X	Q							
1996	X	X	Q	Q	Q	X	X			
1997	X	X	Q	Q	Q	X	X			
1998	X	X	Q	Q	Q	X	X			
1999	X	X	Q							
2006									Schaefer model. Average catch last 3 years	
2007	X	X	Q						LCA Thomson & Bell. Average catch last 3 years	Fishery Agreement
2008	X	X	Q						LCA Thomson & Bell. Not increasing current effort	

Q: Quarterly

REFERENCES

Allain, G., P. Petitgas and P. Lazure. 2001. The influence of mesoscale ocean processes on anchovy (*Engraulis encrasicolus*) recruitment in the Bay of Biscay estimated with a three-dimensional hydrodinamic model. *Fisheries Oceanography*, 10 (2): 151-163.

Baldó, F., E. García-Isarch, M.P. Jiménez, Z. Romero, A. Sánchez-Lamadrid & I.A. Catalán. 2006. Spatial and temporal distribution of the early life stages of three commercial fish species in the north-eastern shelf of the Gulf of Cadiz. *Deep-sea Research II* (53): 1391-1401.

Bellido, J.M., G.J. Pierce, J.L. Romero & M. Millán. 2000. Use of frequency analysis methods to estimate growth of anchovy (*Engraulis encrasicolus* L. 1758) in the Gulf of Cadiz (SW Spain). *Fisheries Research*., 48: 107-115.

Borja, A., A. Uriarte, J. Egaña, L. Motos, & V. Valencia, V. 1998. Relationships between anchovy (*Engraulis encrasicolus*) recruitment and environment in the Bay of Biscay. *Fisheries Oceanography*, 7: 375–380.

FAO. 2006a. Report of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa. *FAO Fisheries Report* Nº 785: 180 pp.

FAO. 2006b. Report of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa. *FAO Fisheries Report* Nº 811: 192 pp.

FAO. 2007. Report of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa. *FAO Fisheries Report* Nº 849: 238 pp.

FAO. 2008. Report of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa. *FAO Fisheries Report (In press)*.

García-Isarch, E., M. Millán, F. Ramos, Santamaría, M.T.G. & C. Burgos. 2008. Recent past and present of the Spanish fishery of Anchovy (*Engraulis encrasicolus*) in Atlantic Moroccan waters. Poster presented to the International Symposium on *Science and the Challenge of Managing Small Pelagic Fisheries on Shared Stocks in Northwest Africa*. 11- 14 March 2008. Casablanca, Morocco.

Ibaibarriaga, L., Fernández, C., Uriarte, A., Roel, B.A. 2008. A two-stage biomass dynamic model for the Bay of Biscay anchovy: A Bayesian approach. *ICES Journal of Marine Science* 65: 191-205.

ICES. 2006a. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES areas VIII and IX (WGACEGG), 24-28 October 2005, Vigo, Spain. *ICES, C.M. 2006/LRC: 0.*: 126 pp.

ICES. 2006b. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG), 27 November-1 December 2006, Lisbon, Portugal. *ICES C.M. 2006/LRC:18*:. 169 pp.

ICES. 2007a. Report of the Working Group on the Assessment of Mackerel, Horse-Mackerel, Sardine and Anchovy (WGMHSA), 4-13 September 2007, ICES Headquarters. *ICES C.M: 2007/ACFM:31*: 712 pp.

ICES. 2007b. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG), 26 - 30 November 2007, Palma de Mallorca, Spain. ICES C.M. 2007/LRC:16: 167 pp.

ICES. 2008. Report of the Working Group on Anchovy (WGANC), 13 - 16 June 2008, ICES Headquarters, Copenhagen. *ICES C. M. 2008/ACOM:04*: 226 pp.

Millán, M. 1992. Descripción de la pesquería de cerco de la región suratlántica española y atlántico-norte marroquí. *Inf. Tec. Inst. Esp. Oceanogr.*, 136: 70 pp.

Millán, M. 1999. Reproductive characteristics and condition status of anchovy *Engraulis encrasicolus* L. from the Bay of Cádiz (SW Spain). *Fisheries Research.*, 41: 73-86.

Punzón, A. C. Hernández, B. Villamor and P. Abaunza. 2007. The Spanish Purse Seine Fishery targeting anchovy in the Bay of Biscay 2003-2005. *Working Document* to STECF-SGBRE-07-01 monitoring fishery for Bay of Biscay anchovy. Bruxelles, 19th-20th February 2007.

Ramos, F. & M. Millán. 2006. Biología y pesca de los principales recursos pelágicos costeros del Golfo de Cádiz. Pp. 100-170. *In*: J. M. Morales, A. J. Mata, A. Rodríguez, C. J. Revilla (Eds.). *Acuicultura, Pesca y Marisqueo en el Golfo de Cádiz*. Junta de Andalucía. Consejería de Agricultura y Pesca. Depósito Legal: SE-6014-05.

Ruíz, J., E. García-Isarch, E. Huertas, L. Prieto, A. Juárez, J.L. Muñoz, A. Sánchez-Lamadrid, S. Rodríguez-Gálvez, J.M. Naranjo & F. Baldó. 2006. Meteorological and oceanographic factors influencing *Engraulis encrasicolus* early life stages and catches in the Gulf of Cadiz. *Deep-sea Research II* (53): 1363-1376.

Santamaría, M.T.G. 1998. Anchovy (*Engraulis encrasicolus*) Otolith Exchange (1997-1998). European Fish Ageing Network (EFAN). Report 4-98, 33 pp (mimeo).

Silva, L., J. Castro, F. Ramos & A. Punzón. 2007. Identification of *métiers* in the Gulf of Cadiz Spanish purse-seine fishery (ICES Subdivision IXa-South). Working document presented to the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. *ICES, C.M. 2007/ACFM:31*.

STECF. 2008. First Report of the Meeting to inform the Comisión on a long-term management plan for the stock of anchovy in the Bay of Biscay, Hamburg, April 2008.

Uriarte, A., P. Prouzet and B. Villamor, 1996. Bay of Biscay and Ibero Atlantic Anchovy populations and their fisheries. *Scientia marina*, 60 (Supl.2): 237-255.

Villamor, B., Abaunza, P., Petitgas, P., Massé, J., Uriarte, A. 2007. Bay of Biscay anchovy: a resource in crisis. *ICES Insight*, nº 44- September 2007, 16-19.

Villamor, B., A. Aranda, A. Punzón, A. Uriarte and J.C. Báez. 2008. The anchovy fishery in the Bay of Biscay: Description and Analysis of the Spanish fleet (2000-2005). *ICES CM 2008/ I:30*