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Scientific, Technical and Economic Committee for Fisheries (STECF)

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2016 Mediterranean assessments part 1 (STECF-16-22)

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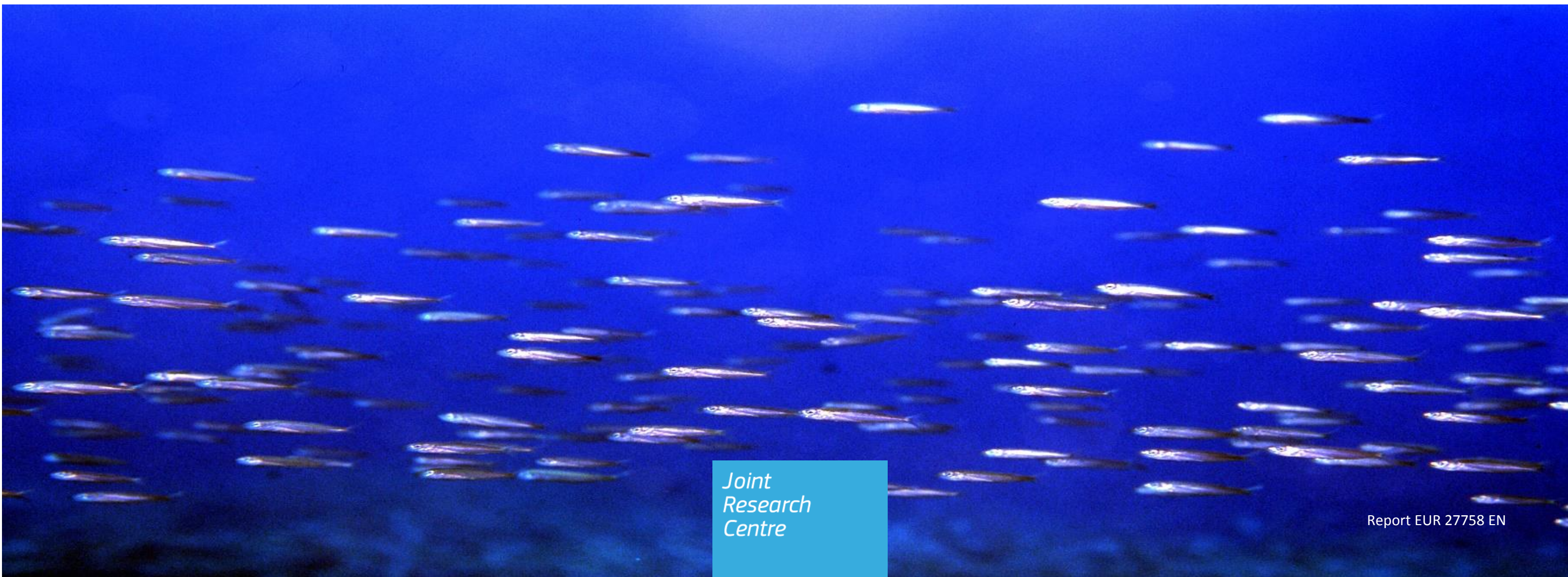
This report was reviewed by the STECF during its 53rd plenary meeting held from 24 to 28 October 2016 in Brussels



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Abstract

Commission Decision of 25 February 2016 setting up a Scientific, Technical and Economic Committee for Fisheries, C(2016) 1084, OJ C 74, 26.2.2016, p. 4–10. The Commission may consult the group on any matter relating to marine and fisheries biology, fishing gear technology, fisheries economics, fisheries governance, ecosystem effects of fisheries, aquaculture or similar disciplines. The Expert Working Group meeting of the Scientific, Technical and Economic Committee for Fisheries EWG 16-13 was held from 26- 30 Sept. 2016 in Barza, Italy to assess the status of demersal and small pelagic stocks in the Mediterranean Sea against the proposed FMSY reference points. The report was reviewed by the STECF plenary in October 2016.

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SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

2016 Mediterranean assessments part 1 (STECF-16-22)

THIS REPORT WAS REVIEWED BY THE STECF DURING ITS 53TH PLENARY MEETING HELD FROM 24 TO 28 October 2016 IN BRUSSELS, BELGIUM

Request to the STECF

STECF is requested to review the report of the STECF Expert Working Group meeting, evaluate the findings and make any appropriate comments and recommendations.

STECF observations

The working group was held in Ispra, Italy, from 26th to 30th September 2016. The meeting was attended by 14 experts in total, including one STECF member and 3 JRC experts.

The objective of the EWG 16-13 was the stock assessment of small-pelagic species. The ToRs were based on the STECF-16-14 (Methodology for the stock assessments in the Mediterranean Sea) report, where the available information was classified into levels and stock assessments methods were proposed to determine stock status (https://stecf.jrc.ec.europa.eu/documents/43805/1446742/2016-07_STECF+16-14+-+Methods+for+MED+stock+assessments_JRC102680.pdf).

STECF acknowledges the EWG16-13 ToRs were ambitious. These were the following:

ToR 1. Data gathering

For the stocks given in Annexes I and II, the STECF-EWG 16-13 is requested to:

1.1. Compile and provide the most updated information on stock identification, age and growth, maturity, feeding, habitat, and natural mortality.

1.2. Compile and provide complete sets of annual data on landings and discards for the longest time series available up to and including 2015. This should be presented by fishing gear as well as by size/age structure (see Annex III for more details).

1.3. Compile and provide complete sets of annual data on fishing effort for the longest time series available up to and including 2015. This should be described in terms of amount of vessels, time (days at sea, soaking time, or other relevant parameter) and fishing power (gear size, boat size, horse power, etc.) by Member State and fishing gear. Data shall be the most detailed possible to support the establishment of a fishing effort or capacity baseline (see Annex III for more details).

1.4. Compile and provide indices of abundances and biomass by year and size/age structure for the longest time series available up to and including 2015 (see Annex III for more details).

ToR 2. Stock assessments (Level 1)

For the stocks given in Annex I-A, or combinations thereof, the STECF-EWG 16-13 is requested to:

2.1. Assess trends in fishing mortality, stock biomass, spawning stock biomass, and recruitment. Different assessment models should be applied as appropriate. Models should be compared using model diagnostics including retrospective analyses when the models can produce one. The selection of the most reliable assessment should be justified. Assumptions and uncertainties should be reported.

2.2. Propose and evaluate candidate MSY value, range of values and safeguard points in terms of fishing mortality and stock biomass. The proposed values shall be related to long-term high yields and low risk of stock/fishery collapse and ensure that the exploitation levels restore and maintain marine biological resources at least at levels which can produce the maximum sustainable yield.

2.3. Provide short and medium[1] term forecasts of spawning stock biomass, stock biomass and catches. The forecasts shall include different management scenarios, *inter alia*: zero catch, the status quo fishing mortality, and target to F_{MSY} or other appropriate proxy by 2018 and 2020 (by means of a proportional reduction of fishing mortality as from 2017). In particular, predict the level of fishing effort exerted by the different fleets which is commensurate with the short- and medium-term forecasts of the proposed scenarios.

[1] Medium term forecast only when an acceptable stock-recruitment relationship is identifiable.

2.4. Make any appropriate comments and recommendations to improve the quality of the assessments. Furthermore, advise on the ideal assessment frequency.

ToR 3. Stock assessments (Levels 2-4)

For the stocks given in Annex I-A, or combinations thereof, the STECF-EWG 16-13 is requested to:

3.1. Assess trends in fishing mortality, stock biomass, spawning stock biomass, and recruitment. Based on the precautionary approach, determine proxies MSY reference points on the exploitation level and the status of the stocks. Different assessment models should be applied as appropriate, including retrospective analyses when the models can produce one. The selection of the most reliable assessment should be explained. Assumptions and uncertainties should be specified.

3.2. Make any appropriate comments and recommendations to improve the quality of the assessment and/or to upgrade the assessment level and/or improve the quality of the data. Furthermore, advise on the ideal assessment frequency.

ToR 4. Length-based analysis

For the stocks given in Annex I-B, the STECF-EWG 16-13 is requested to assess trends in catch length composition, survey indices and catch-per-unit effort, depending on the data availability. In addition, provide size-based indicators (*e.g.* proportion of mature fish in the catch) to be used as reference points of the population status.

ToR 5. Summary sheets

Provide a synoptic overview of: (i) the fishery; (ii) the most recent state of the stock (spawning stock biomass, stock biomass, recruits, and exploitation level by fishing gear); (iii) the source of data and methods and; (iv) the management advice, including MSY value or proxies, range of values and safeguard points.

ToR 6. Data quality check

Summarize and concisely describe all data quality deficiencies, including possible limitations with the surveys of relevance for stock assessments and fisheries. Such review and description are to be based on the data format of the official DCF data call for the Mediterranean Sea launched on the 28 April 2016. Identify further research studies and data collections which would be required for improved fish stock assessments.

Contents of the EWG report

The basis of advice is dependent on the type and quality of information available. The tables below summarize the assessment work that was attempted, and the basis for advice and stock status that was chosen for each stock.

Table 1 Requested assessment level, methods tested and methods chosen by stock.

Area	Species	Suggested	Attempted analyses and basis of advice (in bold)
GSA 6	Anchovy	Level 1	Length index, XSA, ASPIC
GSA 6	Sardine	Level 1	Length index, **XSA, HR**
GSA 7	Anchovy	Level 1	Length index, XSA,a4a, ASPIC,
GSA 7	Sardine	Level 1	Length index, XSA,a4a, ASPIC,
GSAs 17-18	Anchovy	Level 1	Length index,**SAM, STF**
GSAs 17-18	Sardine	Level 1	Length index,**SAM, biomass**
GSA 1-5-6-7	Atlantic horse mackerel	Level 2	Length index, XSA, **biomass**
GSA 9-10-11	Atlantic horse mackerel	Level 2	Length index, **XSA, HR**
GSA 17-18-19-20	Atlantic horse mackerel	Level 2	Length index, XSA, **biomass**
GSA 9	Anchovy	Level 3	Length index, **XSA, HR**
GSA 10	Anchovy	Level 3	Length index, **no advice**
GSA 10	Sardine	Level 3	Length index, **no advice**
GSA 5	Sardine	Level 4	Length index, **no advice**
GSA 5	Anchovy	Level 4	Length index, **no advice**
GSA 11	Sardine	Length	Length index, **no advice**
GSA 11	Anchovy	Length	Length index, **no advice**
GSA 1-5-6-7	Atlantic mackerel	Length	Length index, **no advice**
GSA 9-10-11	Atlantic mackerel	Length	Insufficient data, **no advice**
GSA 17-18-19-20	Atlantic mackerel	Length	Length index, **no advice**

Table 2 Summary of assessment and F and catch corresponding to E=0.4 by stock. F 2015 is given in brackets for stocks where advice is based on Harvest Rates. Percentage change in F or catch is based on change in catch from 2015 to 2017 divided by catch in 2015.

Area	Species	Method/ basis	F 2015	F corresponding to E=0.4	Change in F	Catch 2015	Catch corresponding to E=0.4	Change in catch
GSA 6	Anchovy	ASPIC						same effort
GSA 6	Sardine	XSA, HR (E=0.4)	(1.77)	0.7		6309	6380	1%
GSA 7	Anchovy	Biomass In. PA Buffer				1108	1764	59%
GSA 7	Sardine	Biomass In. PA Buffer				373	656	76%
GSAs 17-18	Anchovy *	SAM, STF (E=0.4)	1.33	0.48	-64%	39449	9965	-75%
GSAs 17-18	Sardine *	SAM, HR (E=0.4)	(1.95)	0.4		87029	49487	-43%
GSA 1-5-6-7	Atlantic horse mackerel	Biomass In. PA Buffer	assessment not accepted					
GSA 9-10-11	Atlantic horse mackerel	XSA,HR (E=0.4)	assessment not accepted					
GSA 17,18,19,20	Atlantic horse mackerel	Biomass In. PA Buffer	assessment not accepted					
GSA 9	Anchovy	XSA, HR (E=0.4)	(1.1)	0.52		3957	2470	-38%
GSA 10	Anchovy	No method						No advice
GSA 10	Sardine	No method						No advice
GSA 5	Sardine	No method						No advice
GSA 5	Anchovy	No method						No advice
GSA 11	Sardine	No method						No advice
GSA 11	Anchovy	No method						No advice
GSA 1-5-6-7	Atlantic mackerel	No method						No advice
GSA 9-10-11	Atlantic mackerel	No method						No advice
GSA 17-18-19-20	Atlantic mackerel	No method						No advice

* as agreed in the plenary

STECF observes that a total of 19 GSA area/species combinations were evaluated, with most effort allocated to sardine and anchovy. For all these groupings length indicators were calculated, except for mackerel in GSA 9, 10 and 11 where data was insufficient even for this minimal evaluation.

STECF observes that two length indicators were applied for all stocks, chosen among those proposed by ICES WKLIFE V

(http://ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2015/WKLIFEV/wklifeV_2015.pdf). Length indicators are very sensitive to length infinity (L_{inf}) in the growth model, and marked inconsistencies were observed in many of the stocks analyzed, with the reported L_{inf} from DCF data call much lower than largest observed size of individuals and sometimes below mean lengths. The ICES indicators evaluated can be calculated as greater or less than 1 (exploitation above or below F_{MSY}) depending on which L_{inf} is used. Stocks with narrow catch distributions, such as the sardine (PIL) and anchovy (ANE) stocks, are more sensitive to these issues than stocks with a wider range of length in the catch.

Results from length based analyses were compared with the age-based assessments performed during the EWG, to evaluate the utility of the length indicators. While the length indicators show promising results in terms of trends in exploitation, it was not possible to determine stock exploitation status with regards to F_{MSY} because the absolute values depend on the value of L_{inf} making it difficult to draw conclusions about whether they are overexploited or not.

STECF observes that for many of these stocks this is the first attempt of having an assessment. The EWG is commended for their efforts to find solutions for these stocks. However, there are some concerns that need further exploration.

For the three areas of combined GSAs for Atlantic horse mackerel (cf. Table 1 above), there is no pelagic survey available. There was a concern that demersal trawl surveys may not be suitable, although it is acknowledged that demersal trawl surveys are sometimes used for assessing these species in the Atlantic (e.g. for the ICES stock of southern horse mackerel, found mostly in Iberian waters). The main concern is because demersal trawl surveys may be sensitive to species behaviour, for example time of day. The MEDITS survey used here is a standardized survey with a long time series. This fish behaviour may influence the variance, so the data need to be further evaluated for year-to-year consistency in order to assess whether the long term trends are appropriate. In the case of the GSAs 9-10-11 the data are considered insufficient for an assessment. The biomass index may be applicable but needs to be explored further.

For anchovy in GSA 17-18, the fishing mortality is seen to have been at a relatively low level in the early part of the time series (1995), and has increased in recent years. This signal is clearly seen also in other assessments of that stock previously performed by GFCM or STECF. The fit to the survey data using the combined area information (one unique MEDIAS survey index covering GSA 17 and most of GSA 18) results in greatly improved diagnostics compared to the assessment using multiple survey indices covering different parts of the stock distribution area. This may be an important aspect for future work. Also, merging these surveys is considered methodologically better, as then both the catches and the survey are representing the whole stock. It is though noted that the STECF assessment does not include the eastern survey in GSA 18, as this data was not made available to the group, as well as the period 2004-2008 of the echo-survey carried out in GSA 17 and western side of GSA 18. The impact of this incomplete data set is unknown so the assessment is considered still preliminary and the forecast catches may not be used as a basis for management decisions.

The historic weight at age for the catch and stock for Sardine and Anchovy in GSA 17-18 from the pre-DCF part of data (prior to 2002) was not made available to the STECF EWG, and mean weights from the DCF period were used throughout this earlier period. The effect of this was evaluated by the EWG through SoP (Sums of Products) and found to be minor and not significantly influencing the assessment. It would be preferable to use observed pre-2002 estimates of mean weights at age if they can be made available, but the results presented here do not depend on this aspect.

For sardine in GSAs 17-18 concern was expressed that the confidence intervals of F estimates were rather tight in recent years but not for in last year of the assessment. The reason for this needs further exploration. Also in the case of sardine the same lack of survey and weight data evidenced for anchovy should be taken into consideration.

For anchovy in GSA 6, the advice is based on a surplus production model. STECF acknowledges that this model fits the tuning data, but some aspects of the modelling were difficult to explore under ASPIC. Alternative models such as SPiCT and C-MSY could be evaluated.

The EWG encountered a number of difficulties in carrying out the work within the time of the workshop, consequence of the late setting of the ToRs, data quality and lack of co-ordination with the GFCM SAC. Among others, the difficulties included inability to commit time in JRC to early data extraction to do early screening; cancellation of the two day data workshop due to lack of available people at short notice; inability to attract sufficient appropriate expertise to do the assessments so some assessments that should have been attempted were not; loss of time in the EWG trying to resolve data issues resulting in insufficient time to try assessments that should have been attempted; several unresolved assessment issues that almost certainly could have been resolved if the time had been available; insufficient time to explore reference points.

In relation to the lack of co-ordination with the GFCM, STECF notes that the next GFCM WG on stock assessment of small-pelagic species will take place from 7 to 12 November, that is, five weeks after EWG-16-13.

STECF conclusions

STECF acknowledges that despite the difficulties encountered the EWG was able to address almost all the terms of reference, completing evaluations of all GSA aggregations requested. However, due to short notice and truncated meeting, evaluation of assessments of combined stock areas was not possible and proper evaluation of reference points for assessed stocks was not undertaken.

STECF also notes that GFCM SAC will assess many of these small pelagic stocks in its meeting on 7-12 November. It is expected that this meeting may provide further exploration of some of these issues. Taking into account this and considering that data used in the EWG 16-13 assessment for sardine and anchovy in the Adriatic are not complete for the echo survey coverage, both in spatial and temporal term, STECF considers that the assessment is still preliminary, and the forecast catches may not be used as a basis for management decisions. For these stocks, STECF recommends that merging of acoustic survey in the Adriatic should be considered for the future, also in the GFCM assessments. The results of doing this have been shown to improve the fit particularly for Anchovy and methodologically it is preferable that indices of parts of populations are combined before use in an assessment, not as separate indices within an assessment.

STECF concludes that apart from the issue above, the results of the accepted assessment in Table 2 provide reliable information on the status of the stock and the trends in stock biomass and fishing mortality.

STECF notes the acoustic survey includes results for other species in addition to sardine and anchovy evaluated in EWG 16-13. For the future these data should be examined to see if it can be used for assessment purposes.

STECF recommendations

STECF recommends that in the future the complete list of stocks to be considered at each of the MED assessment EWGs be established much earlier in the year. This early warning will allow data screening in advance, and maximise the possibility of participation by experts for each stock. STECF should agree with the Commission a specific date by which the initial stock lists should be made available, ideally six months prior to the EWGs. STECF notes that such an arrangement is already in place with the Commission and ICES, though STECF also accepts that modifications of this list may be needed later.

STECF reiterates the strong need for a better coordination and full harmonization among the scientific bodies of FAO-GFCM and EU, in order to develop common approaches and make the best use of the human resources.

STECF notes that some unresolved issues remain, in particular relating to the species biological information (such as L_{inf} and catch-at-age). STECF recommends that biological information provided is carefully reviewed and fully documented when submitted.

STECF recommends that merging of acoustic survey in the Adriatic should be considered in future assessments.

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Expert Working Group EWG-16-13 report

Report to the STECF

EXPERT WORKING GROUP ON
Mediterranean assessments part 1
(EWG-16-13)

Ispra, Italy, 26 - 30 Sep 2016

1. Executive summary

The working group was held in Ispra, Italy, from 26 - 30 September 2016. The original intention was to use two days prior the main working group to prepare data, but due to difficulties in obtaining participants at short notice, this part was cancelled. The work carried out in the EWG was affected by the shortage of time, in particular assessments for combined areas and evaluations of reference points were not completed.

A total of 19 area/species combinations were evaluated, with most effort allocated to sardine and anchovy. For all these groupings a length indicators were calculated, except for mackerel in GAS 9,10 and 11. While the length indicators show promise in terms of trend, it was not possible to determine stock status. For the 13 area/species combinations of anchovy and sardine no advice could be provided for six of these, two had survey indices that were used to give advice based on the ICES DLS approach. One had a surplus production model fitted to a long time series of landings data, one had a full age based assessment and short term forecast, and the rest had age based assessments, which were considered good enough to infer status but not suitable for short term forecasts. In these cases catch options based on a Harvest Rate (Catch /Total biomass) is provided. The Harvest rate approach is best suited for medium and long lived species, and is used extensively in Iceland. It is also applicable here where recruitment is observed to be highly correlated from year to year but unknown in the projection years.

The report provides: a section summarising the available data for each area/species combination; assessment or index analyses and catch options; an annex with all the length indicators and information on data deficiencies. The stock status and where possible catch advice is provided for each area/species combination.

2. Findings and Conclusions of the Working Group

Considerable difficulties were encountered in carrying out the work within the time of the workshop, detailed suggestions for future are provided in Section 3. A range of analyses were considered for all stocks based on data available to the meeting (Table 2.1). For those suggested for level 1, 2 and 3 assessments were attempted, and where these were applicable they have been used as the basis for advice; see Section 5 and the summary values in Table 2.2. For all other stocks ICES data limited approaches were examined and used where applicable these were applied, the results are given in Section 5 and summarised numerically in Table 2.2. Length analyses were carried out for all species / areas where sufficient length data was available. The results of these length analyses are summarised in Annex I, for stocks with assessments there are similarities between trends in F and trends in length indicators, but the absolute level of length index results were considered sensitive to assumptions on L infinity (Linf) and have not been used to give advice on stock status.

Table 2.1 Summary of work was attempted and basis for any advice. XSA,SAM and a4a are age based assessment methods, ASPIC is a surplus production model, and Biomass Index refers to the ICES data limited approach using a stock status indicator. STF is a standard short term projection with assumptions of status quo F and historic recruitment, HR is a harvest rate based on historic harvest rates, SSB in the final year and advice based on E=0.4 (Patterson 1992).

Area	Species	Suggested Analysis	Attempted analyses and basis of advice (in bold)
GSA 6	Anchovy	Level 1	Length index, XSA, **ASPIC**
GSA 6	Sardine	Level 1	Length index, **XSA**, **HR**
GSA 7	Anchovy	Level 1	Length index, XSA,a4a, ASPIC, **biomass index**
GSA 7	Sardine	Level 1	Length index, XSA,a4a, ASPIC, **biomass index**
GSAs 17-18	Anchovy	Level 1	Length index, **SAM, STF**
GSAs 17-18	Sardine	Level 1	Length index, **SAM, biomass index**
GSA 1-5-6-7	Atlantic horse mackerel	Level 2	Length index, XSA, **biomass index**
GSA 9-10-11	Atlantic horse mackerel	Level 2	Length index, **XSA**, **HR**
GSA 17-18-19-20	Atlantic horse mackerel	Level 2	Length index, XSA, **biomass index**
GSA 9	Anchovy	Level 3	Length index, **XSA**, **HR**
GSA 10	Anchovy	Level 3	Length index, **no advice**
GSA 10	Sardine	Level 3	Length index, **no advice**
GSA 5	Sardine	Level 4	Length index, **no advice**
GSA 5	Anchovy	Level 4	Length index, **no advice**
GSA 11	Sardine	Length analysis	Length index, **no advice**
GSA 11	Anchovy	Length analysis	Length index, **no advice**
GSA 1-5-6-7	Atlantic mackerel	Length analysis	Length index, **no advice**
GSA 9-10-11	Atlantic mackerel	Length analysis	Insufficient data, **no advice**
GSA 17-18-	Atlantic mackerel	Length	Length index, **no advice**

19-20 analysis

Table 2.2 Summary of advice from EWG 16-13 by are and species. F 2015 is terminal F in the assessment, used as Fstatus quo in the short term forecast. F 2015 in() indicates more uncertain F not used and the catch is based on harvest rate. Change in catch is from catch 2015 to catch 2017.

Area	Species	Method / basis	F 2015	F 2017 for E=0.4	Change in F	Catch 2015	Catch 2017 (see basis)	Change in catch
GSA 6	**Anchovy**	ASPIC						same effort
GSA 6	**Sardine**	XSA, HR (E=0.4)	(1.77)	0.70		6309	6380	1%
GSA 7	**Anchovy**	Biomass In. PA Buffer				1108	1764	59%
GSA 7	**Sardine**	Biomass In. PA Buffer				373	656	76%
GSAs 17-18	**Anchovy**	SAM, STF (E=0.4)	1.33	0.48	0.38	39449	9965	-75%
GSAs 17-18	**Sardine**	SAM, HR (E=0.4)	(1.95)	0.40		87029	49487	-43%
GSA 1-5-6-7	**Atlantic horse mackerel**	Biomass In. PA Buffer				2313	2078	-10%
GSA 9-10-11	**Atlantic horse mackerel**	XSA,HR (E=0.4)	(0.83)	0.13		6689	1959	-71%
GSA 17,18,19,20	**Atlantic horse mackerel**	Biomass In. PA Buffer				1803	2297	27%
GSA 9	**Anchovy**	XSA, HR (E=0.4)	(1.1)	0.52		3957	2470	-38%
GSA 10	**Anchovy**	No method						No advice
GSA 10	**Sardine**	No method						No advice
GSA 5	**Sardine**	No method						No advice
GSA 5	**Anchovy**	No method						No advice
GSA 11	**Sardine**	No method						No advice
GSA 11	**Anchovy**	No method						No advice

GSA 1-5-6-7	**Atlantic mackerel**	No method						No advice
GSA 9-10-11	**Atlantic mackerel**	No method						No advice
GSA 17-18-19-20	**Atlantic mackerel**	No method						No advice

2.1 Stock-Specific Findings & Conclusions

See the stock specific summary sheets.

2.2 Frequency of assessments

The frequency depends not only on the stock but also on the use of the information. For the short lived species (sardine and anchovy stocks) with full assessments these should be assessed annually if the advice is to be used to manage the fishery, less frequent advice is would be sufficient if monitoring stock status / exploitation rate is sufficient. For the same species with data limited trend based advice biennial evaluations are applicable. For horse mackerel biennial advice should be sufficient. For stocks currently with insufficient data the evaluation could be carried out every three years to determine if new data improves knowledge on stock status or exploitation.

3. Follow Up Items

3.1 Organisation of ToRs for future meetings

This meeting has been far from straightforward. Although there are also other causes, a substantial proportion of the difficulties encountered are the directly result of the failure to set ToRs early enough.

Late setting of the ToRs has caused.

- Inability to commit time in JRC to early data extraction to do early screening.
- Cancellation of the two day data workshop due to lack of available people a short notice.
- No time for participants to look at information prior to the meeting.
- Inability to attract sufficient appropriate expertise to do the assessments so some assessments that should have been attempted not have been.
- Loss of time in the EWG trying to resolve data issues resulting in insufficient time to try assessments that should have been attempted.
- Several unresolved assessment issues that almost certainly could have been resolved if the time had been available.
- Insufficient time to explore reference points.
- Considerable frustration among WG members who are left doing a job they feel is not as good as it could have been.

The problems highlighted above come from the process used to set ToRs, and that process must change if we are to use personnel resources wisely and make the most of the very limited WG time available.

Ideally the main choices of areas/species should be assessed at least 6 months in advance of a WG, this allows the appropriate people to agree dates for a WG that so the most suitable people can set aside the time. For comparison when the EC deals with stock list with ICES the majority of the WG dates are all set in September the year before, and the WGs are conducted March-Sept. Relatively minor modifications are made through the year to deal with late requirements.

To obtain better use of resources it is important to formally agree and adopt a longer calendar for setting ToRs and we suggest you work towards an agreement that in each year the main choice of stocks is agreed prior to STECF Spring plenary.

3.2 Investigation of options for obtaining catch numbers at age

There are a number of options available for splitting catches (and or surveys) to ages. For several stocks DCF data is supplied with catch at length, catch at age and fitted growth models. The data calls do not contain sufficient meta data to determine the exact methodology that has been used to supply the age data or the fitted growth models. In many cases the earlier assessment reports do not describe in sufficient detail the basis of the age structures used. While there are documentation issues that clearly need to be improved regarding the basis of data supplied under the data calls there are also issues with the growth models that are being supplied under the data calls.

3.2.1 Growth models:

The models are sensitive to the length range of data used. In the case of GSA 6 extending the range from a lower bound of 8cm to 4cm resulted in very big changes (factors of >1.5) in L infinity, i.e. changes in length at older ages result from data at smallest sizes. The inclusion of the juveniles (<8cm) which probably follow a different (pre-maturity) growth curve changes the perception of adult growth too. For the restricted length range for many of these small pelagic stocks the fitted growth curves given by the DCF data call are very shallow fitting the data on adults well, but intersecting with age axis with negative T0 sometimes <-2 giving a high intercept at length at age 0 (Figure 3.1). One of the reasons for this is that the catch data probably has biased samples at the youngest ages due the rapid change/rise in selection in the fishery through these sizes of fish. Thus at the youngest ages only the largest individuals at age are caught. This issue is not addressed when fitting the growth models and it may have implications when using the models to determine ages through length splicing.

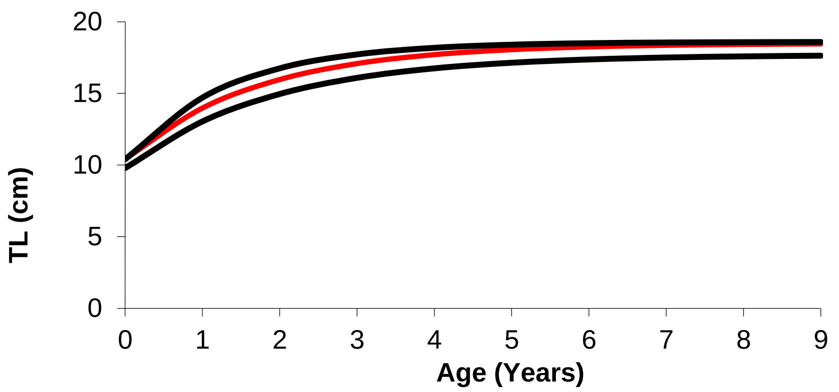

Figure 3.2.1. DCF growth curves for sardine in GSA 7, showing high intercept on the length axis at age 0.

3.2.2 Length splicing using DCF growth models:

The use of growth models for length slicing to age is resulting in not just 'smearing' of cohorts but also biased aging particularly at youngest ages. This has been fixed historically by ad hoc solutions but it would be better to use the age information directly. An example from GSA7 (Figure XX) illustrates the potential bias that can occur with length slicing using the DCF. Length slicing results in a shift / compression of ages 0-5 in both catch and survey to ages 1-5. Based on this the age data was used.

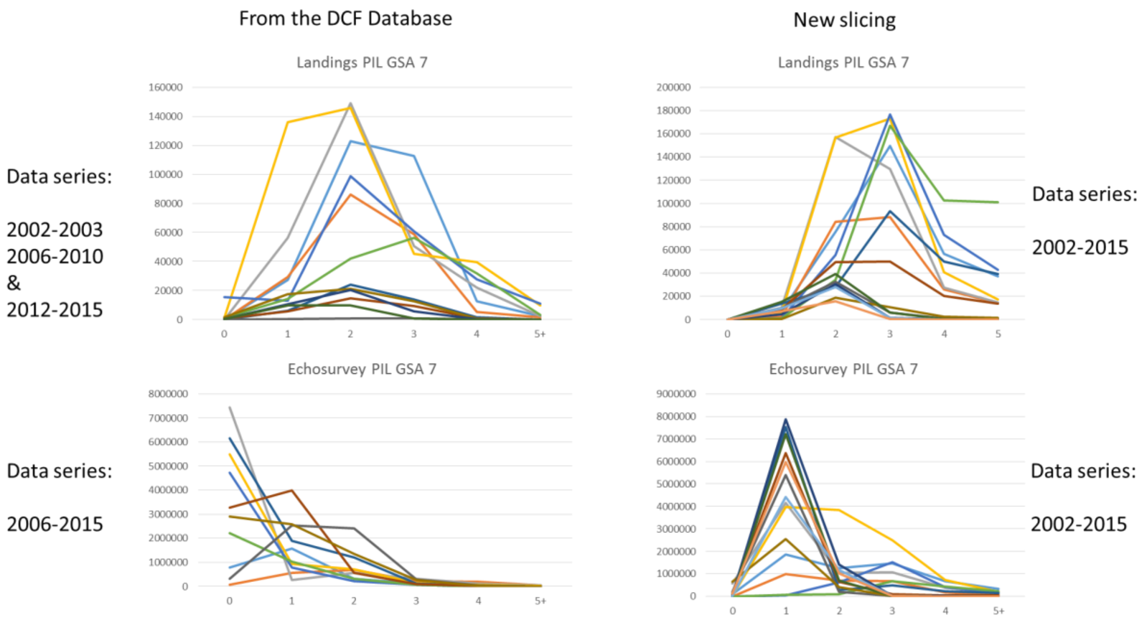

Figure 3.2. Comparison of age disaggregated catch and survey indices based on age slicing (new slicing) with DCF growth curves and DCF reported age data.

Based on these results it was considered that the reported age data was preferable. However, this example shows the importance of knowing the basis of the data and the detail of the methods used and if length slicing is to be used the methodology for defining growth curves is critical and must be done with care and fully reported.

3.2.3 Follow up recommendations

The basis of growth curves should be reported along with the parameter values.
The method used to provide catch or survey at age data should be stated.
The methodology for age slicing based on growth curves should be evaluated to establish best practice and to define documentation standards.
Comparison between age slicing / sampling at age should be done as part of exploration of assessments.

3.3 Investigation of length indicators

Annex I to this report describes length indicator analysis for stocks considered in the report. All stocks with data were included, and the analysis compared L indicators and F for stocks where F was available.

3.3.1 Conclusions to length analysis

The values of the indicators are very sensitive to the stability of the distributions, the presence of peaks in the lower tail of the catch distribution and the value of Linf. For example, the indicator Lmean/LFeM is recommended by ICES to be >= 1. However, the indicator can be greater or less than 1 depending on which Linf is used. Stocks with narrow catch distributions, such as the PIL and ANE stocks, are more sensitive to these factors.

Comparing the indicator to the estimated F from stock assessments suggests that Lmean/LFeM is not a reliable guide to the stock exploitation status. The trends of

Lmean/LFeM correspond reasonably well with estimated F (given the expected inverse relationship between them) for ANE and PIL in GSAs 17 and 18 and HOM in GSAs 9-11. However, the absolute values depend on the value of Linf making it difficult to draw conclusions about whether they are overexploited or not. For ANE in GSA 9 and PIL in GSA 6 neither the value or the trend in the indicator was not a good guide to the value or trend of F.

There is no assessment for MAC in GSAs 1-7. However, if we believe the indicators then it appears that the exploitation has been reasonably constant over time and that the stock is not overexploited. However, given the issue of scaling described above further evaluation is needed.

Although the length based indicators show some promise in getting a picture of the stock status, more work needs to be done before any firm conclusions can be drawn. In particular, given the sensitivity of the indicators to Lc a more robust method for calculating Lc needs to be developed.

3.4 FMSY for anchovy and sardine stocks

The assessment reports on sardine and anchovy contain a wide range of FMSY estimates, see for example those listed in Table 7.4.2.1 and Table 7.5.2.1, the most extreme example is F=0.08 / F=0.72 for Sardine in GSA 17 and 18.

The information on Fmsy included in STECF-16-14[1] is the following.

Stock	GSA	year	F	Fmsy	Assessmethod	F_Fmsy
ANE	1	2009	1.05	0.45	XSA	2.325736
ANE	16	2011	0.72	0.08	XSA	9
ANE	17_18	2013	1.04	0.50	SAM	2.086854
PIL	6	2013	0.93	0.56	XSA	1.66405
PIL	17_18	2013	0.53	0.23	SAM	2.321492

This table also show a wide range of values.

These different results are coming mostly from the wide range of stock recruit functions that can be fitted to the SSB and R data, see for example Fig 7.5.2.1 where R and SSB are strongly linearly correlated. Here one function has been arbitrarily fitted through mean SSB. One interpretation of the data in this figure is that R depends strongly on SSB, but the other interpretation is that R is correlated in time and for some environmental reason is declining, and SSB depends on R. The stock assessment for European Anchovy in GSAs 17-18 (Figure 7.5.1.2.) shows that the observed decline in R which occurs strongly in the early part of the series and is followed by a declining SSB, however, during this period F is between 0.2 and 0.3, not normally associated with fishery driven decline for a species with M~=0.7. Indeed one proxy for MSY would be

[1] Scientific, Technical and Economic Committee for Fisheries (STECF) – Methodology for the stock assessments in the Mediterranean Sea (STECF-16-14); Publications Office ofthe European Union, Luxembourg; EUR 27758EN; doi:10.2788/227221

F=M, or in the case of Patterson (1992) F=0.67M. So the very low values below F=0.67M are derived from S-R relationships that may not be the result of crashing the stock through the fishery, rather the result of natural decline slightly accelerated by the fishery.

There is considerable difficulty in providing robust estimates of FMSY for these stocks and its not the calculations, but the assumptions that are difficult to determine. These issues strongly suggests precautionary based exploitation with provision of advice quickly will give more satisfactory exploitation and protection for the stock.

4. Introduction

The expert working group on Mediterranean stock and fisheries assessment part 1 STECF EWG 16-13 was held Ispra (Italy), 26-30 September 2016.

The chairman opened the meeting at 09:00 on Monday, 26 September 2016, and adjourned the meeting by 13:00 on Friday, 30 September 2016. The meeting was attended by 14 experts in total, including 1 STECF members and an additional 3 JRC experts.

4.1 Structure and basis of the report

The structure of the report is organised to match the terms of reference given below in Section 4.1, with the exception of the summary sheets which are provided in Section 5, near the beginning of the report. The information listed in Annex II of the ToR on catch and CPUE and survey results is provided in Section 6. The remaining parameters listed under results are provided in the summary sheets in section 5.

The summary sheets by stock, provided in Section 5 contain catch advice. The basis of this advice depends on the type and quality of information available from the analyses and is as follows:

1) Full assessment and reference points : Catch / Effort advice at MSY based on short term forecast.
2) Full assessment without MSY reference points: : Catch / Effort advice under precautionary considerations based on short term forecast.
3) Assessment providing SSB tend information historic F evaluation, not suitable for STF: Catch / Effort advice under precautionary considerations (Patterson 1992) E=0.4 with Harvest Rate (HR) based estimated SSB in most recent year.
4) Trend based indictor with exploitation and stock status know to be OK: Catch / Effort advice under precautionary considerations based on ICES smoothed index of trend without precautionary buffer (20% reduction).
5) Trend based indictor: Catch / Effort advice under precautionary considerations based on ICES smoothed index of trend without precautionary buffer (20% reduction).
6) Valid length analysis: statement of stock status, indication of direction of change required
7) No valid analysis: no advice.

4.2 Terms Of Reference For Ewg-16-13

Stock assessments in the Mediterranean Sea, Part I

26 – 30 September 2016, Barza di Ispra, Italy

DG MARE focal persons: Xavier Vazquez & Amanda Perez

Chair: John Simmonds

GENERAL GUIDELINES: *unless the data used and information provided comes from the official DCF data calls, the experts are requested to indicate the data source from where certain information has been taken (e.g. L-W relationships, prices) or if it is an experts' reasoned deduction.*

Data collected outside the DCF shall be used as well and merged with DCF data following quality check whenever necessary. Due account shall also be taken of data used and assessments carried out within the Member States in particular when using data collected through the DCF/DCR and EU funded research projects, studies and other types of EU funding.

The raw data used to generate the input data, assessment scripts and all input files should be made available to the JRC before the end of the meeting to ensure reproducibility of the assessments and documentation.

ToR 1. Data gathering

For the stocks given in Annexes I and II, the STECF-EWG 16-13 is requested to:

1.1. Compile and provide the most updated information on stock identification, age and growth, maturity, feeding, habitat, and natural mortality.

1.2. Compile and provide complete sets of annual data on landings and discards for the longest time series available up to and including 2015. This should be presented by fishing gear as well as by size/age structure (see Annex III for more details).

1.3. Compile and provide complete sets of annual data on fishing effort for the longest time series available up to and including 2015. This should be described in terms of amount of vessels, time (days at sea, soaking time, or other relevant parameter) and fishing power (gear size, boat size, horse power, etc.) by Member State and fishing gear. Data shall be the most detailed possible to support the establishment of a fishing effort or capacity baseline (see Annex III for more details).

1.4. Compile and provide indices of abundances and biomass by year and size/age structure for the longest time series available up to and including 2015 (see Annex III for more details).

ToR 2. Stock assessments (Level 1)

For the stocks given in Annex I-A, or combinations thereof, the STECF-EWG 16-13 is requested to:

2.1. Assess trends in fishing mortality, stock biomass, spawning stock biomass, and recruitment. Different assessment models should be applied as appropriate. Models should be compared using model diagnostics including retrospective analyses when the models can produce one. The selection of the most reliable assessment should be justified. Assumptions and uncertainties should be reported.

2.2. Propose and evaluate candidate MSY value, range of values and safeguard points in terms of fishing mortality and stock biomass. The proposed values shall be related to long-term high yields and low risk of stock/fishery collapse and ensure that the exploitation levels restore and maintain marine biological resources at least at levels which can produce the maximum sustainable yield.

2.3. Provide short and medium1 term forecasts of spawning stock biomass, stock biomass and catches. The forecasts shall include different management scenarios, *inter alia*: zero catch, the status quo fishing mortality, and target to FMSY or other appropriate proxy by 2018 and 2020 (by means of a proportional reduction of fishing mortality as from 2017). In particular, predict the level of fishing effort exerted by the different fleets which is commensurate with the short- and medium-term forecasts of the proposed scenarios. (1 Medium term forecast only when an acceptable stock-recruitment relationship is identifiable.)

2.4. Make any appropriate comments and recommendations to improve the quality of the assessments. Furthermore, advise on the ideal assessment frequency.

ToR 3. Stock assessments (Levels 2-4)

For the stocks given in Annex I-A, or combinations thereof, the STECF-EWG 16-13 is requested to:

3.1. Assess trends in fishing mortality, stock biomass, spawning stock biomass, and recruitment. Based on the precautionary approach, determine proxies MSY reference points on the exploitation level and the status of the stocks. Different assessment models should be applied as appropriate, including retrospective analyses when the models can produce one. The selection of the most reliable assessment should be explained. Assumptions and uncertainties should be specified.

3.2. Make any appropriate comments and recommendations to improve the quality of the assessment and/or to upgrade the assessment level and/or improve the quality of the data. Furthermore, advise on the ideal assessment frequency.

ToR 4. Length-based analysis

For the stocks given in Annex I-B, the STECF-EWG 16-13 is requested to assess trends in catch length composition, survey indices and catch-per-unit effort, depending on the data availability. In addition, provide size-based indicators (*e.g.* proportion of mature fish in the catch) to be used as reference points of the population status.

ToR 5. Summary sheets

Provide a synoptic overview of: (i) the fishery; (ii) the most recent state of the stock (spawning stock biomass, stock biomass, recruits, and exploitation level by fishing gear); (iii) the source of data and methods and; (iv) the management advice, including MSY value or proxies, range of values and safeguard points.

ToR 6. Data quality check

Summarize and concisely describe all data quality deficiencies, including possible limitations with the surveys of relevance for stock assessments and fisheries. Such review and description are to be based on the data format of the official DCF data call for the Mediterranean Sea launched on the 28 April 2016. Identify further research studies and data collections which would be required for improved fish stock assessments.

Terms of Reference ANNEX I

(A) List of stocks given to assess Target assessment level *	Proposed stock boundaries **	Common name	Scientific name
Level 1	GSA 6	Anchovy	*Engraulis encrasicolus*
Level 1	GSA 7	Anchovy	*Engraulis encrasicolus*
Level 1	GSAs 17-18	Anchovy	*Engraulis encrasicolus*
Level 1	GSA 6	Sardine	*Sardina pilchardus*
Level 1	GSA 7	Sardine	*Sardina pilchardus*
Level 1	GSAs 17-18	Sardine	*Sardina pilchardus*
Level 2	GSA 1-5-6-7	Atlantic horse mackerel	*Trachurus trachurus*
Level 2	GSA 9-10-11	Atlantic horse mackerel	*Trachurus trachurus*
Level 2	GSA 17-18-19-20	Atlantic horse mackerel	*Trachurus trachurus*
Level 3	GSA 9	Anchovy	*Engraulis encrasicolus*
Level 3	GSA 10	Anchovy	*Engraulis encrasicolus*
Level 3	GSA 10	Sardine	*Sardina pilchardus*
Level 4	GSA 5	Sardine	*Sardina pilchardus*
Level 4	GSA 5	Anchovy	*Engraulis encrasicolus*

(B) List of stocks given to length-based analysis Target assessment level *	Proposed stock boundaries **	Common name	Scientific name
Length analysis	GSA 11	Sardine	*Sardina pilchardus*
Length analysis	GSA 11	Anchovy	*Engraulis encrasicolus*
Length analysis	GSA 1-5-6-7	Atlantic mackerel	*Scomber scomber*
Length analysis	GSA 9-10-11	Atlantic mackerel	*Scomber scomber*
Length analysis	GSA 17-18-19-20	Atlantic mackerel	*Scomber scomber*

***** *The target assessment levels come from the report of the Scientific, Technical and Economic Committee for Fisheries (STECF) - Methodology for the stock assessments in the Mediterranean Sea (STECF-16-14). 2016. Publications Office of the European Union, Luxembourg, EUR XXXX EN, JRC XXXX, 166 pp. Some flexibility shall be allowed to increase/decrease the proposed assessment levels, on the basis of data availability and experts' knowledge.*

****** *The group should consider the proposed stock boundaries as a starting point. They are based on past stock assessments, on the EU project STOCKMED and on the distribution of other species with similar fish population dynamics. For each stock assessment, it would be advisable to carry out a throughout discussion to agree on the most suitable stock boundaries. Thus, proposed stock boundaries could be merged with other GSAs or split in several GSAs when dully justified.*

Terms of Reference ANNEX II

Guidance for the preparation of the final report

SECTION	**FISHERIES**	**Landings** Total landings/year * Landings/fishing gear/year * Landings /fishing gear/year/size structure Landings /fishing gear/year/age structure **Discards** Total discards/year * Discards/fishing gear/year * Discards/fishing gear/year/size structure Discards/fishing gear/year/age structure **Fishing effort** Fishing effort (GT*days at sea)/year * Fishing effort (GT*days at sea)/fishing gear/year * Fishing effort (Days at sea)/year * Fishing effort (Days at sea)/fishing gear/year *
SECTION	**SCIENTIFIC SURVEYS**	Abundance index/year Abundance index/year/size structure Abundance index/year/age structure Biomass index/year Biomass index/year/size structure Biomass index/year/age structure
SECTION 1.7	**STOCK ASSESSMENT**	**Results** * Fishing mortality Fishing mortality/fishing gear Recruitment SSB TB **Reference points** * FMSY, Fupper and Flower BMSY, Blim, Bpa **Predictions** * *For the different scenarios,* Fishing mortality Fishing mortality/fishing gear Catches Catches/fishing gear Fishing effort/fishing gear SSB

** Please, provide these variables at least in numerical values (not only figures).*

5. Summary sheets by stock

Provide a synoptic overview of: (i) the fishery; (ii) the most recent state of the stock (spawning stock biomass, stock biomass, recruits, and exploitation level by fishing gear); (iii) the source of data and methods and; (iv) the management advice, including MSY value or proxies, range of values and safeguard points.

5.1. SUMMARY SHEET OF EUROPEAN ANCHOVY IN GSA 6

Species common name: European Anchovy

Species scientific name: *Engraulis encrasicolus*

Geographical Sub-area(s) GSA(s): 6

5.1.1 Stock development over time
State of the adult abundance and biomass

State of the adult biomass can't be determined in a production model. Estimated total biomass was high till the 1970's, declined to about 50% of B_{MSY} in 1982-83 then slightly recovered and reduced again this time to about 16% of B_{MSY} in 2005 and has been recovering since then. The acoustic biomass index derived from ECOMED and MEDIAS shows a downward trend in the early 2000's, in line with the catches and a steep increase since then.

State of the juveniles (recruits)

Not possible to evaluate juvenile abundance with available model.

State of exploitation

The EWG 16-13 proposes Fmsy = 0.39 as limit management reference point consistent with high long term yield and low risk of fisheries collapses. The stock is considered sustainably exploited (Bcurr/BMSY of about 1.077), with estimates of the current fishing mortality F2015 of 0.34 , F/Fmsy = 0.8861 (derived from ASPIC) that is lower to the estimated values that were considered limit reference point obtained with the same approach. Full time series of estimates are reported in Table 5.1.1.

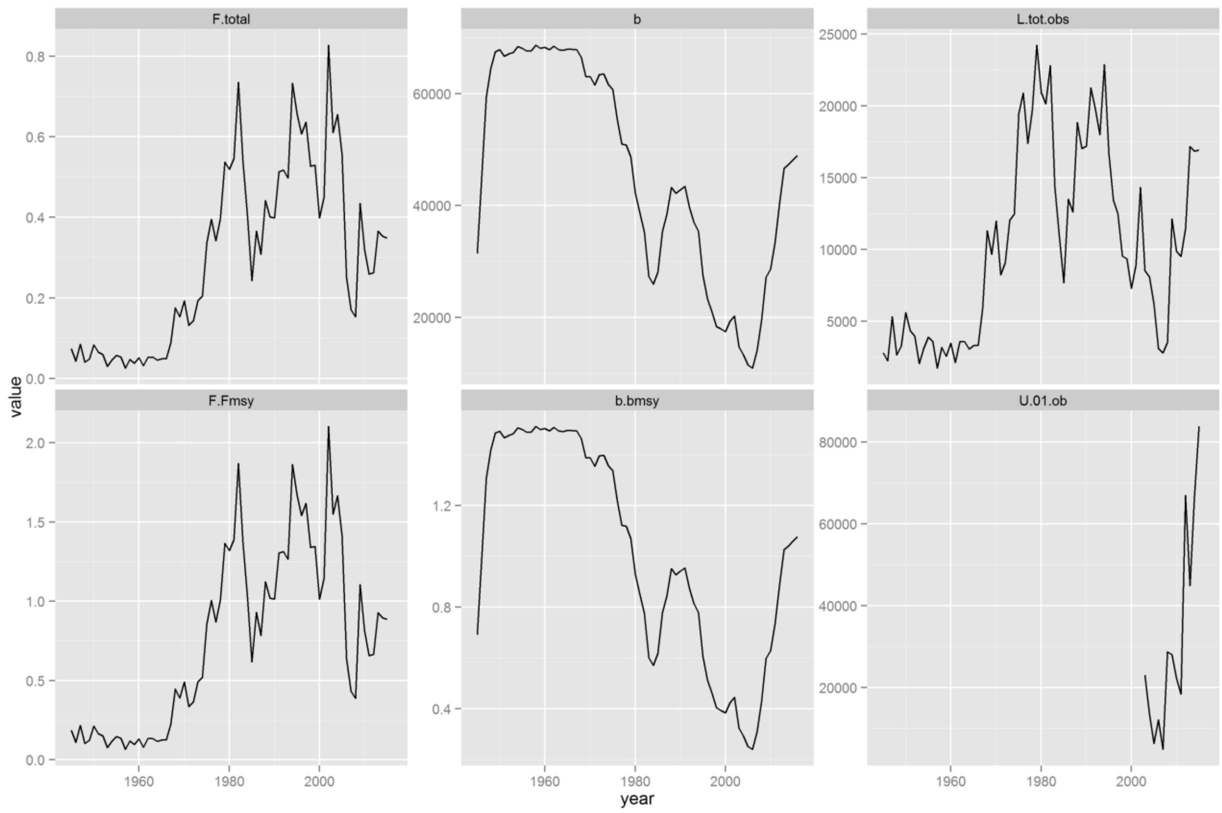

Figure 5.1.1.1. European Anchovy in GSA 6. Stock summary plot, total fishing mortality (F.total), estimated biomass in tons (b) , total Landings in tons (L.tot.obs), fishing mortality over reference point (F/Fmsy), biomass over MSY reference point (b.bmsy) and observed acoustic biomass index (U.01.ob)

Table 5.1.1.1. European Anchovy in GSA 6. ASPIC results for total F, estimated average Biomass, total Yield, surplus production, F/Fmsy and B/Bmsy.

Year	Estimated total F mort	Estimated average biomass	Model total yield	Estimated surplus production	Ratio of F mort to Fmsy	Ratio of biomass to Bmsy
1945	0.074	3.82E+04	2.81E+03	1.66E+04	1.87E-01	6.91E-01
1946	0.043	5.28E+04	2.25E+03	1.64E+04	1.09E-01	9.96E-01
1947	0.085	6.24E+04	5.32E+03	1.04E+04	2.17E-01	1.31E+00
1948	0.04	6.64E+04	2.68E+03	5.70E+03	1.03E-01	1.42E+00
1949	0.048	6.77E+04	3.27E+03	3.60E+03	1.23E-01	1.49E+00
1950	0.084	6.71E+04	5.61E+03	4.43E+03	2.12E-01	1.49E+00
1951	0.065	6.70E+04	4.35E+03	4.78E+03	1.65E-01	1.47E+00
1952	0.059	6.73E+04	3.97E+03	4.27E+03	1.50E-01	1.48E+00
1953	0.03	6.81E+04	2.06E+03	3.12E+03	7.68E-02	1.48E+00
1954	0.046	6.82E+04	3.11E+03	2.77E+03	1.16E-01	1.51E+00
1955	0.057	6.78E+04	3.89E+03	3.42E+03	1.46E-01	1.50E+00
1956	0.053	6.77E+04	3.62E+03	3.67E+03	1.36E-01	1.49E+00
1957	0.026	6.83E+04	1.75E+03	2.73E+03	6.49E-02	1.49E+00

1958	0.047	6.83E+04	3.20E+03	2.63E+03	1.19E-01	1.51E+00
1959	0.038	6.83E+04	2.58E+03	2.79E+03	9.59E-02	1.50E+00
1960	0.051	6.81E+04	3.50E+03	3.06E+03	1.31E-01	1.50E+00
1961	0.031	6.83E+04	2.14E+03	2.76E+03	7.96E-02	1.49E+00
1962	0.053	6.81E+04	3.59E+03	2.96E+03	1.34E-01	1.51E+00
1963	0.053	6.78E+04	3.59E+03	3.47E+03	1.34E-01	1.49E+00
1964	0.045	6.79E+04	3.08E+03	3.32E+03	1.15E-01	1.49E+00
1965	0.049	6.80E+04	3.32E+03	3.24E+03	1.24E-01	1.50E+00
1966	0.049	6.79E+04	3.35E+03	3.31E+03	1.25E-01	1.50E+00
1967	0.089	6.70E+04	5.96E+03	4.56E+03	2.26E-01	1.49E+00
1968	0.176	6.44E+04	1.13E+04	7.90E+03	4.46E-01	1.46E+00
1969	0.153	6.31E+04	9.67E+03	9.63E+03	3.90E-01	1.39E+00
1970	0.193	6.22E+04	1.20E+04	1.05E+04	4.90E-01	1.39E+00
1971	0.132	6.27E+04	8.24E+03	1.01E+04	3.34E-01	1.36E+00
1972	0.143	6.35E+04	9.08E+03	9.17E+03	3.64E-01	1.40E+00
1973	0.193	6.24E+04	1.20E+04	1.02E+04	4.90E-01	1.40E+00
1974	0.204	6.11E+04	1.25E+04	1.15E+04	5.19E-01	1.36E+00
1975	0.338	5.76E+04	1.94E+04	1.41E+04	8.58E-01	1.34E+00
1976	0.395	5.29E+04	2.09E+04	1.65E+04	1.00E+00	1.22E+00
1977	0.342	5.09E+04	1.74E+04	1.72E+04	8.69E-01	1.12E+00
1978	0.397	4.96E+04	1.97E+04	1.75E+04	1.01E+00	1.12E+00
1979	0.537	4.51E+04	2.42E+04	1.78E+04	1.37E+00	1.07E+00
1980	0.519	4.03E+04	2.09E+04	1.74E+04	1.32E+00	9.29E-01
1981	0.546	3.69E+04	2.01E+04	1.67E+04	1.39E+00	8.52E-01
1982	0.735	3.10E+04	2.28E+04	1.49E+04	1.87E+00	7.76E-01
1983	0.541	2.66E+04	1.44E+04	1.30E+04	1.38E+00	6.01E-01
1984	0.405	2.70E+04	1.10E+04	1.32E+04	1.03E+00	5.71E-01
1985	0.243	3.17E+04	7.69E+03	1.49E+04	6.18E-01	6.19E-01
1986	0.366	3.69E+04	1.35E+04	1.66E+04	9.30E-01	7.77E-01
1987	0.308	4.09E+04	1.26E+04	1.75E+04	7.84E-01	8.46E-01
1988	0.441	4.27E+04	1.88E+04	1.77E+04	1.12E+00	9.52E-01
1989	0.401	4.25E+04	1.71E+04	1.77E+04	1.02E+00	9.28E-01
1990	0.399	4.32E+04	1.72E+04	1.78E+04	1.01E+00	9.43E-01
1991	0.513	4.15E+04	2.13E+04	1.76E+04	1.30E+00	9.55E-01
1992	0.517	3.83E+04	1.98E+04	1.70E+04	1.31E+00	8.75E-01
1993	0.498	3.62E+04	1.80E+04	1.65E+04	1.27E+00	8.14E-01
1994	0.732	3.12E+04	2.29E+04	1.49E+04	1.86E+00	7.80E-01
1995	0.658	2.54E+04	1.67E+04	1.25E+04	1.67E+00	6.06E-01
1996	0.606	2.22E+04	1.34E+04	1.11E+04	1.54E+00	5.14E-01
1997	0.636	1.96E+04	1.25E+04	9.88E+03	1.62E+00	4.62E-01
1998	0.527	1.81E+04	9.56E+03	9.11E+03	1.34E+00	4.04E-01
1999	0.53	1.77E+04	9.36E+03	8.88E+03	1.35E+00	3.94E-01
2000	0.399	1.84E+04	7.32E+03	9.16E+03	1.01E+00	3.84E-01
2001	0.45	1.98E+04	8.90E+03	9.87E+03	1.14E+00	4.24E-01

2002	0.827	1.73E+04	1.43E+04	8.82E+03	2.10E+00	4.46E-01
2003	0.61	1.40E+04	8.54E+03	7.09E+03	1.55E+00	3.24E-01
2004	0.655	1.24E+04	8.10E+03	6.28E+03	1.67E+00	2.92E-01
2005	0.555	1.12E+04	6.22E+03	5.67E+03	1.41E+00	2.52E-01
2006	0.249	1.24E+04	3.10E+03	6.20E+03	6.34E-01	2.40E-01
2007	0.17	1.66E+04	2.82E+03	8.23E+03	4.32E-01	3.09E-01
2008	0.153	2.31E+04	3.53E+03	1.13E+04	3.88E-01	4.28E-01
2009	0.435	2.79E+04	1.21E+04	1.35E+04	1.11E+00	5.99E-01
2010	0.319	3.10E+04	9.89E+03	1.47E+04	8.12E-01	6.29E-01
2011	0.259	3.69E+04	9.53E+03	1.65E+04	6.58E-01	7.34E-01
2012	0.262	4.36E+04	1.14E+04	1.77E+04	6.66E-01	8.88E-01
2013	0.365	4.70E+04	1.72E+04	1.78E+04	9.29E-01	1.03E+00
2014	0.352	4.78E+04	1.69E+04	1.78E+04	8.96E-01	1.04E+00
2015	0.348	4.86E+04	1.69E+04	1.77E+04	8.86E-01	1.06E+00

5.1.2. Stock advice

STECF EWG 16-13 advises that when MSY considerations are applied the fleet fishing effort should be kept at the current level to maintain fishing mortality at or below the estimated Fmsy level.

5.1.3. Basis of the assessment

A dynamic Biomass Production model (ASPIC) using both a time series from 1945 to 2015 of catch (provided by P. Torres and A. Giraldez from IEO) and an acoustic biomass index (from DCF) covering 2002-2015 were used to estimate FMSY, q for each CPUE, BMSY, FMSY and a value of F for each year along the time series.

5.1.4. Catch options

No short term forecast is available for this stock.

5.1.5. Reference points

The EWG 16-13 proposes Fmsy = 0.39 and Bmsy= 4.544E+04 tons as limit management reference point consistent with high long term yield and low risk of fisheries collapses.

Table 5.1.5.1. European Anchovy in GSA 6. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source

MSY approach	MSY $B_{trigger}$			
	F_{MSY}	0.3933	ASPIC	This report
	Bmsy	4.544E+04	ASPIC	This report
Precautionary approach	B_{lim}			
	B_{pa}			
	F_{lim}			
	F_{pa}			
EU - GFCM management plan	SSB_{lower}			
	SSB_{upper}			
	F_{lower}			
	F_{upper}			

5.1.6. Data Deficiencies

Growth parameters should be revised (see section 10).

5.2. SUMMARY SHEET OF SARDINE IN GSA 6

Species common name: Sardine

Species scientific name: *Sardina pilchardus*

Geographical Sub-area(s) GSA(s): 6

5.2.1. Stock development over time

State of the adult abundance and biomass

SSB in the period 2003-2013, oscillated between 73.4 and 653.5 thousand tons. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 16-13 is unable to evaluate the status of the stock spawning biomass in respect to these.

State of the juveniles (recruits)

Recruitment oscillated between a peak of 59794.8*10^6 in 2003 and a minimum of 72108.8*10^6 in 2008.

State of exploitation

F vector show a variable and upward trend in the recent years. The exploitation rate is estimated as higher than the reference E=0.4 since 2007 to 2015 (except 2012), which indicates that sardine in GSA 6 is exploited well above candidate values for $F_{MSY,}$ and may be exploited unsustainably.

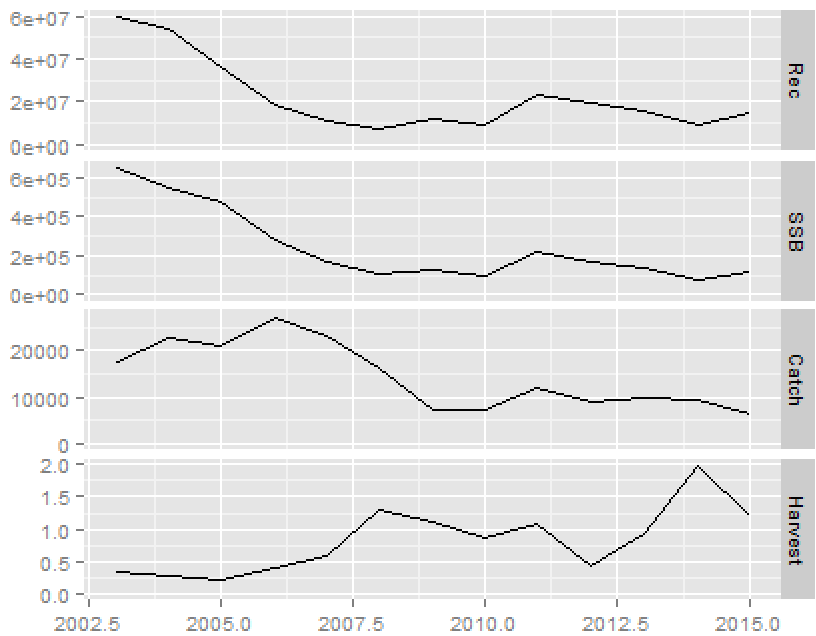

Figure 5.2.1.1. Sardine in GSA 6. XSA summary results. SSB and catch are in tons, recruitment in 1000s individuals.

Table 5.2.1.1. Sardine in GSA 6. XSA summary results. SSB and catch are in tons, recruitment in 1000s individuals.

Year	Stock number (thousands)	Stock biomass (tons)	Recruitment (thousands)	SSB (tons)	Fbar(0-2)
2003	62446627	904686	59794837	653547	0.50
2004	58469001	745878	54365754	550161	0.40
2005	40453838	644002	36297269	480665	0.29

2006	21551703	366576	18331550	284084	0.60
2007	12700353	216216	10935547	167006	0.86
2008	8113209	134202	7210876	101753	1.90
2009	12143027	173277	11692426	124169	1.62
2010	9559882	128981	8868706	94393	1.26
2011	23412596	310687	22845945	221588	1.56
2012	20325252	234791	19005963	172071	0.64
2013	16729103	192110	15397552	141298	1.39
2014	9947070	97348	8865797	73410	2.92
2015	14964404	167906	14387416	120428	1.77

5.2.2. Stock advice

STECF EWG 16-13 advises that when precautionary considerations are applied the fishing mortality should be no more than 0.70, (E=0.4) equivalent to a Harvest Rate of 0.038 on total biomass and a catch of 6380 t implemented either through catch restrictions or effort reduction for the relevant fleets. This could be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

5.2.3. Basis of the assessment

Input data for the assessment were taken from DCF: Purse (PS) catch at age data from 2003-2015, mean maturity ogive, ECOMED and MEDIAS surveys data. The values of M vector were the same used in the last approved assessment for sardine in GSA 6 and compiled in STECF Med Ass part 2 (STECF-15-06, 2015). The analysis was carried out for the ages 0 to 5+ class. The Fbar used was 0-2. XSA was performed in R using FLR routines.

Due to instability of vector in recent years, EWG 16-13 is unable to propose an FMSY value.

5.2.4. Catch options

Due to the uncertainty in the assessment, particularly in F and R, catch options have been calculated based of HR and 2015 SSB. Options are provided in table 5.2.2 for exploitation rates E= F/(F+M)=0 to 1.0. Precautionary option of E=0.4 (Patterson 1992) is chosen as the basis of advice

Table 5.2.4.1. Sardine in GSA 6. Relationship between HR and E and resulting catch options based on total biomass in 2015. Change in catch is relative to catch in 2015.

Exploitation Rate	Harvest Ratio on total biomass	Catch options Related to E	Change in catch
0	0.000	0	-100%
0.2	0.019	3190	-49%
0.4	0.038	6380	1%
0.6	0.057	9571	52%
0.8	0.076	12761	102%
1	0.095	15951	153%

Purse Seine (PS) landings from 2003-2015 were used for analyses. PS represents more than 97% of total landings. No discards data of this fleet was reported.

5.2.5. Reference points

Reference points have not been defined for this stock. E=0.4 (Patterson 1992) is used as a precautionary limit to exploitation

5.2.6. Data Deficiencies

It would be useful update the length-age keys used in GSA 6 for sardine to construct catch at age matrix in DCF. Growth data submitted under the DCF is not directly applicable for use in length slicing for assessments as it seems unlike that age class 0 begins in 10 cm as this is the consequences of the parameters supplied. An update of growth parameters using a more realist approach would be also useful.

5.3. SUMMARY SHEET OF EUROPEAN ANCHOVY IN GSA 7

Species common name: European Anchovy

Species scientific name: *Engraulis encrasicolus*

Geographical Sub-area(s) GSA(s): 7

5.3.1. Stock development over time

State of the adult abundance and biomass

The results of the analytical assessment were not accepted due to model poor fitting (see details in section 7.3 of this report). Following the ICES approach on data limited stocks recent stock trends are inferred from an acoustic survey biomass index (Fig 5.3.1.1).

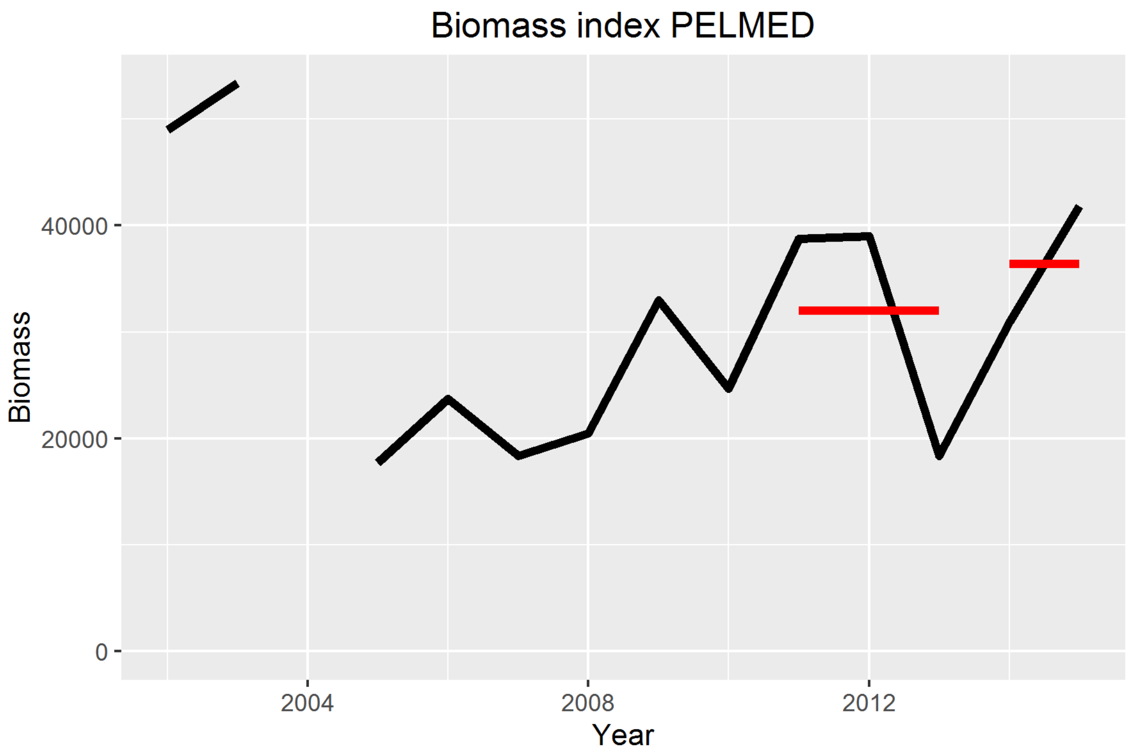

Figure 5.3.1.1. European Anchovy in GSA 7. Biomass index estimated by direct acoustic method from PELMED survey. In red the mean of the last two years compared to the previous three years.

State of the juveniles (recruits)

Not known.

State of exploitation

Not known.

5.3.2. Stock advice

STECF EWG 16-13 advises that when precautionary considerations are applied catches should be no more than 1764 t in each of 2017 and 2018 implemented either through catch restrictions or effort reduction for the relevant fleets.

5.3.3 .Basis of the assessment

Data from PELMED acoustic abundance indices for 2005-2015 (Figure 5.3.1.1).

5.3.4. Catch options

Following the ICES procedures for data limited stocks the change in biomass over the last five years was used to provide an index for change (1.14, Figure 5.3.1.1). As this index is less than 1.2 the value is used to multiply the catch to provide an initial catch advice. The exploitation rate is unknown and the state of the stock relative to B_{msy} is unknown therefore a precautionary buffer (0.8) is applied. The resulting catch advice taken from the average of the last three years (1942 t) is 1764.

5.3.5. Reference points

Reference points are not defined for this stock.

5.3.6. Data Deficiencies

There were a numbers of data deficiencies and errors in the data submitted through DCF. Detailed information can be found in section 6.3.

The most critical issues appear to be the missing data in 2004 in both landings and survey data.

5.4. SUMMARY SHEET OF SARDINE IN GSA 7

Species common name: Sardine

Species scientific name: *Sardina pilchardus*

Geographical Sub-area(s) GSA(s): 7

5.4.1. Stock development over time

State of the adult abundance and biomass

The results of the analytical assessment were not accepted due to missing data in the data series. Following the ICES approach on data limited stocks recent stock trends are inferred from an acoustic survey biomass index (Fig 5.4.1.).

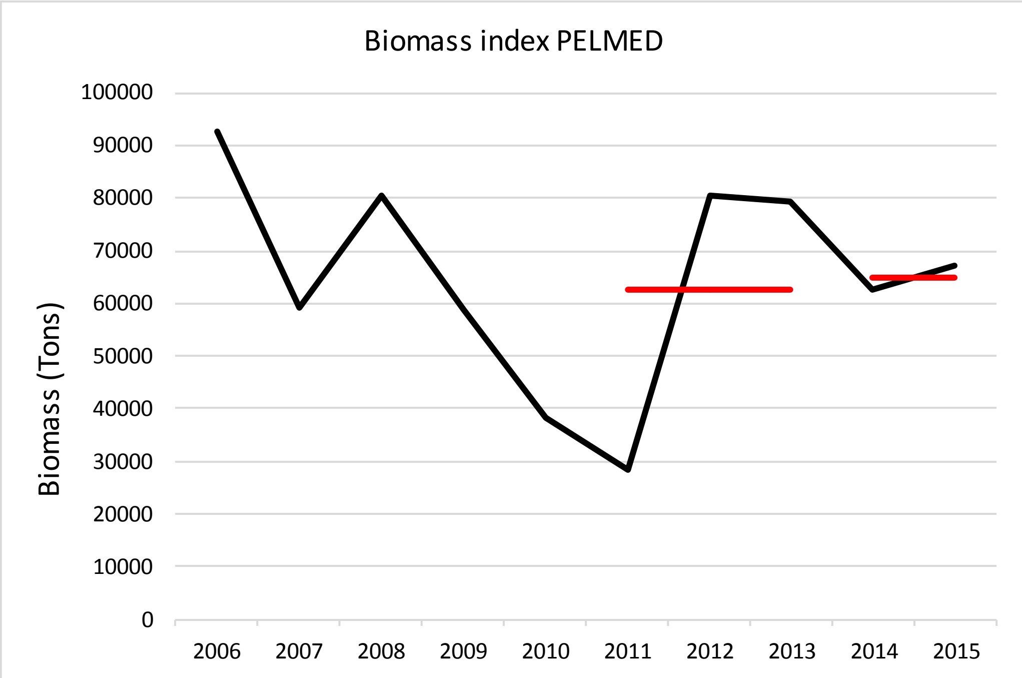

Figure 5.4.1.1. Sardine in GSA 7. Biomass index estimated from acoustic PELMED survey. In red the mean of the last two years compared with that of the previous three years.

State of the juveniles (recruits)

Not assessed

State of exploitation

Not assessed

5.4.2. Stock advice

STECF EWG 16-13 advises that when precautionary considerations are applied catches should be no more than 565 t in each of 2017 and 2018 implemented either through catch restrictions or effort reduction for the relevant fleets.

5.4.3. Basis of the assessment

Data used for the stock advice come from PELMED acoustic survey. Abundance indices for the period 2006-2015 have been used.

5.4.4. Catch options

Following the ICES procedures for data limited stocks the change in biomass over the last five years was used to provide an index for change (1.03, Figure 5.4.1.). As this index is less than 1.2 the value is used to multiply the catch to provide an initial catch advice. The exploitation rate is unknown and the state of the stock relative to B_{msy} is unknown therefore a precautionary buffer (0.8) is applied. The resulting catch advice taken from the average of the last three years (685.7 tons) is 565 tons.

5.4.5. Reference points

Reference points are not defined for this stock.

5.4.6. Data Deficiencies

Concerning sardine in GSA 7, some errors and deficiencies have been detected in the DCF official database coming from the Data Call performed in 2016 (See section 10).

The lack of some important data did not allow carrying out the assessment. In particular:

- no length structure data of French pelagic trawling (OTM_SPF) are available for 2011, taking into account that this metier represents more than 90% of the landing of the species in that year.
- Age structure data are not available for French pelagic trawling (OTM_SPF) in the years 2004, 2005 and 2011.
- Biomass index form PELMED acoustic survey is not available for the period 2002-2005. This means that stock assessment applying PELMED data as tuning can only be performed starting from 2006.

5.5. SUMMARY SHEET OF EUROPEAN ANCHOVY IN GSAs 17-18

Species common name: European Anchovy

Species scientific name: *Engraulis encrasicolus*

Geographical Sub-area(s) GSA(s): 17-18

5.5.1. Stock development over time

State of the adult abundance and biomass

The assessment indicates that the anchovy stock size fluctuated over the time period examined. Maximum values of the SSB were obtained in 1977 (1,525,983 t). After that, the stock started to decline reaching a minimum level in 1987 (around 140,243 t). In the following years the stock started recovering until 2004, when the biomass reached another maximum (SSB at 970,202 tons). From 2005, the stock started to decline again, reaching in 2015 a SSB biomass level of 214,255 tons.

State of the juveniles (recruits)

The assessment shows fluctuations in the number of recruits since the beginning of the time series, similar to those observed for the SSB. The recruitment (age 0 – Figure 4.2.11.11, bottom) reached a maximum in 1977 (251 million individuals) and a minimum value of 20 million individuals in 1986. A second peak was registered in 2004, with a value of 175 million individuals. Since then, recruitment decreased until 2015 (29 million individuals).

State of exploitation

F has increased from the 1980s and is estimated to have peaked at 1.5 in 2011, since then F has remained high and is estimated to be at 1.3 in 2015.

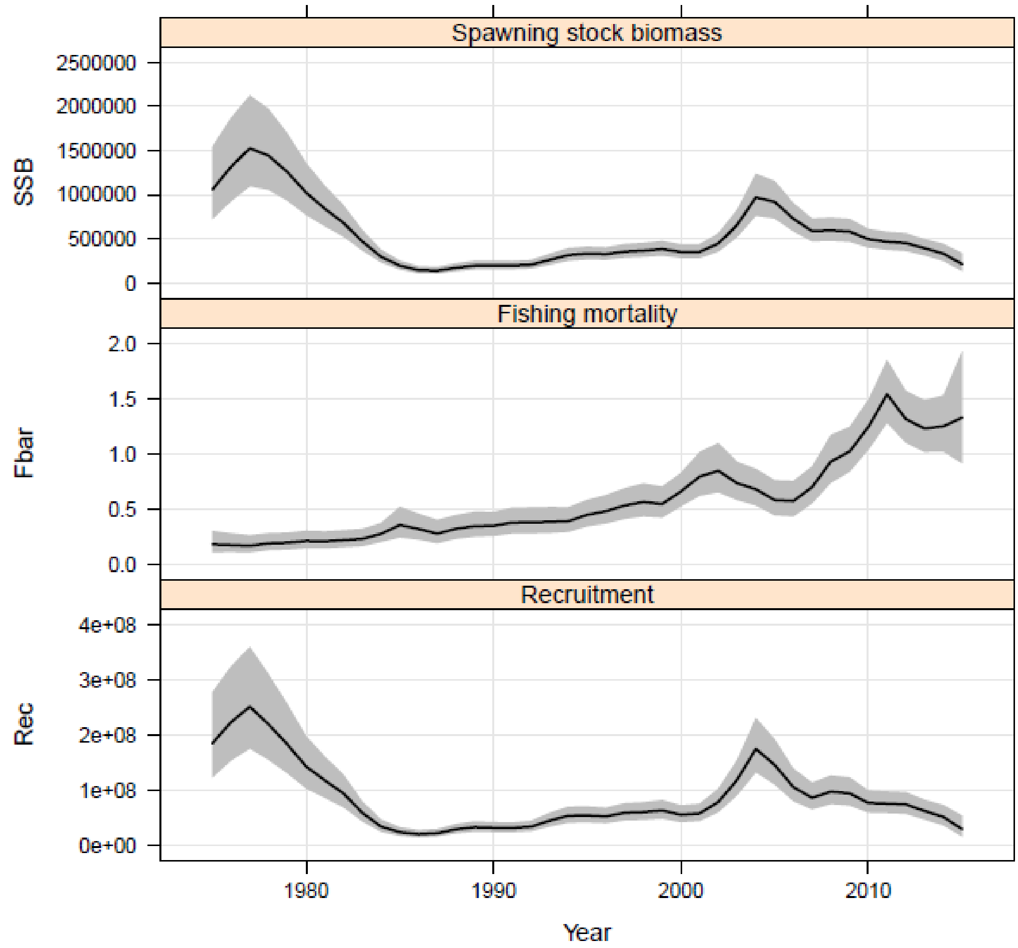

Figure 5.5.1.1. European Anchovy in GSAs 17-18**.** SAM assessment main outputs.

Table 5.5.1.1. European Anchovy in GSAs 17-18. SAM assessment summary results.

Year	F_{bar} (1-2)	Recruitment (thousands)	SSB (t)	Catch (t)	Total biomass (t)	Year	F_{bar} (1-2)	Recruitment (thousands)	SSB (t)	Catch (t)	Total biomass (t)
1975	0.18	184839789	1057058	23365	1908828	1996	0.48	52483007	326766	24662	568638
1976	0.17	223517440	1318493	30822	2347825	1997	0.53	58879292	354690	27092	625934
1977	0.17	251260297	1525755	40782	2681803	1998	0.56	60128831	365858	26823	643064
1978	0.19	219091498	1441219	53423	2450984	1999	0.54	63085405	383464	28453	674010
1979	0.19	182817693	1256700	57011	2099060	2000	0.66	55284327	351161	31351	605615
1980	0.21	142949217	1023767	55381	1682851	2001	0.79	57771146	352216	29792	617849
1981	0.21	117623570	840708	46028	1383324	2002	0.85	78687904	447307	27474	809361
1982	0.22	93924328	679424	40741	1112366	2003	0.73	118805707	658685	32112	1206218

1983	0.23	58879292	470241	34544	741181	2004	0.68	174773254	969950	44400	1774448
1984	0.27	33834786	295966	29941	451802	2005	0.58	145691219	918962	54885	1589611
1985	0.35	23700341	195830	24125	304980	2006	0.57	105476633	727231	59576	1213477
1986	0.32	20095370	145219	13412	237756	2007	0.70	86184422	587129	57240	984609
1987	0.28	21900061	140225	8599	241108	2008	0.93	97172664	594812	48874	1042362
1988	0.32	28976624	172129	10021	305590	2009	1.02	94206525	581869	48243	1015610
1989	0.34	32801998	196222	11599	347319	2010	1.24	76821876	496332	51380	850007
1990	0.35	31832553	198194	12516	344897	2011	1.54	75602507	466494	46397	815046
1991	0.38	31421408	197205	13758	341806	2012	1.32	74179619	451802	40498	793334
1992	0.38	33733434	206489	12539	361855	2013	1.23	62146186	393564	37609	680103
1993	0.38	44857439	260928	13579	467428	2014	1.25	51495243	332369	35739	569777
1994	0.39	53650428	315527	17717	562418	2015	1.33	29326438	214272	30333	349410
1995	0.45	54135461	331705	22925	581287						

5.5.2. Stock advice

Although STECF EWG 16-13 was not able to provide a reliable estimate F_{MSY}, based on SAM results, the current fishing mortality (1.33) is larger than any of the estimates of F_{MSY} proposed by the previous working groups, which gives an indication that anchovy in GSAs 17-18 is exploited well above F_{MSY} and maybe unsustainably.

Therefore, STECF EWG 16-13 advises that when precautionary considerations are applied the fishing mortality should be reduced to no more than F=0.48 (corresponding to E = 0.4) , this implies catches of no more than 9965 tons implemented either through catch restrictions or effort reduction for the relevant fleets. This could be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

5.5.3. Basis of the assessment

The stock of anchovy in GSAs 17-18 was assessed using the State-space Assessment Model (SAM) (Nielsen *et al*., 2012) in FLR environment with catch data from 1975 to 2015. A single tuning fleet based on combined acoustic surveys covering the western and eastern GSA 17, and western GSA 18 with data from 2009 to 2015.

Since the spawning takes place mostly in spring-summer (Zorica *et al*., 2013), previous assessments (STECF EWG 15-11) were carried out taking into account a conventional birth date on the first of June (split-year), as in Santojanni *et al*. (2003). Consequently, all data were shifted by 6 months in order to have each year compounded by the time interval ranging from the first of June, up to May 31st of the following year; the tuning indices were shifted as well.

Following the suggestions by STECF EWG 14-09, the present assessment was based on the calendar-year data. This approach is expected to simplify calculations, limiting the errors, and it will allow using the most recent survey index available. In addition a new mean weight-at-age matrix was estimated using DCF data, and applied to the whole time series of data.

Assessment was performed with version 0.99-3 of FLSAM, together with version 2.5 of the FLR library (FLCore).

5.5.4. Catch options

Short-term prediction results are shown in the following table (Table 5.5.4.1).

Table 5.5.4.1. European Anchovy in GSAs 17-18. Short-term forecasts showing catch options at different level of F.

Rationale	Ffactor	Fbar	Catch 2015	Catch 2016	Catch 2017	Catch 2018	SSB 2017	SSB 2018	Change SSB 2017-2018(%)	Change Catch 2015-2017(%)
Zero catch	0.00	0.00	39449	21348	0	0	270523	288081	6.5	-100.0
E = 0.4	0.38	0.48	39449	21348	9965	14344	270523	281465	4.0	-74.7
Status quo	1.00	1.27	39449	21348	21036	24050	270523	275006	1.7	-46.7
Different Scenarios	0.10	0.13	39449	21348	2975	5160	270523	286025	5.7	-92.5
	0.20	0.25	39449	21348	5664	9111	270523	284226	5.1	-85.6
	0.30	0.38	39449	21348	8113	12233	270523	282636	4.5	-79.4
	0.40	0.51	39449	21348	10362	14772	270523	281217	4.0	-73.7
	0.50	0.63	39449	21348	12441	16889	270523	279941	3.5	-68.5
	0.60	0.76	39449	21348	14377	18696	270523	278783	3.1	-63.6
	0.70	0.89	39449	21348	16189	20269	270523	277724	2.7	-59.0
	0.80	1.01	39449	21348	17894	21661	270523	276749	2.3	-54.6
	0.90	1.14	39449	21348	19506	22912	270523	275847	2.0	-50.6
	1.10	1.39	39449	21348	22494	25096	270523	274219	1.4	-43.0
	1.20	1.52	39449	21348	23888	26068	270523	273479	1.1	-39.4
	1.30	1.65	39449	21348	25224	26978	270523	272781	0.8	-36.1
	1.40	1.77	39449	21348	26507	27835	270523	272120	0.6	-32.8
	1.50	1.90	39449	21348	27744	28647	270523	271492	0.4	-29.7
	1.60	2.03	39449	21348	28937	29420	270523	270895	0.1	-26.6
	1.70	2.16	39449	21348	30089	30160	270523	270325	-0.1	-23.7
	1.80	2.28	39449	21348	31206	30871	270523	269780	-0.3	-20.9
	1.90	2.41	39449	21348	32287	31555	270523	269258	-0.5	-18.2
	2.00	2.54	39449	21348	33337	32217	270523	268758	-0.7	-15.5

5.5.5. Reference points

The assessment is based on a new combined survey time series and reference points need to be re-evaluated. Historic reference points are included below for information.

Table 5.5.5.1 European Anchovy in GSAs 17-18. Reference points, values and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$			
	F_{MSY}	0.50	Eqsim	STECF EWG 14-09
	F_{MSY}	0.30	Eqsim	STECF EWG 15-11
	F_{MSY}	0.55	Eqsim	GFCM WGSASP 2015
Precautionary approach	B_{lim}	140,000	Bloss	Present assessment
Precautionary approach EU-GFCM management strategy	B_{pa}	196,000	Blim x 1.4	Present assessment
	F_{lim}			
	F_{pa}			
	SSB_{lower}			
EU-GFCM management strategy	SSB_{upper}			
	F_{lower}			
	F_{upper}			

5.5.6. Data Deficiencies

No particular deficiencies were found in the data provided. The use of standardized and common age reading procedure by the different Member States is recommended.

5.6. SUMMARY SHEET OF SARDINE IN GSAs 17-18

Species common name: Sardine

Species scientific name: *Sardina pilchardus*

Geographical Sub-area(s) GSA(s): 17-18

5.6.1. Stock development over time

State of the adult abundance and biomass

The SAM analyses indicate that the sardine stock size fluctuated over the time period examined. Maximum value of SSB was estimated to be in 1982 (1,246,687 t). After that, the stock declined reaching a minimum level in 2000 (around 210,449 t). In the following years the stock started increasing, reaching in 2015 a SSB biomass level of 383,080 tons.

State of the juveniles (recruits)

SAM model estimates show fluctuations in the number of recruits since the beginning of the time series, similar to those observed for the SSB. The recruitment (age 0 – Figure 5.6.1.1, bottom) reached a maximum in 1981 (59.7 million individuals) and a minimum value of 9.5 million individuals in 1999. Since then, recruitment is constantly increasing until 2015 (23.7 million individuals).

State of exploitation

Based on the assessment results F is estimated to have remained below 0.5 until 2010, the current F (F_{bar} ages 1-3) is estimated to be 1.95. Although STECF EWG 16-13 was not able to provide a reliable estimate of F_{MSY} reference point, taking into account the estimates of F_{MSY} obtained by previous assessments, it is evident that sardine stock in GSAs 17-18 is exploited well above F_{MSY} and may be unsustainably.

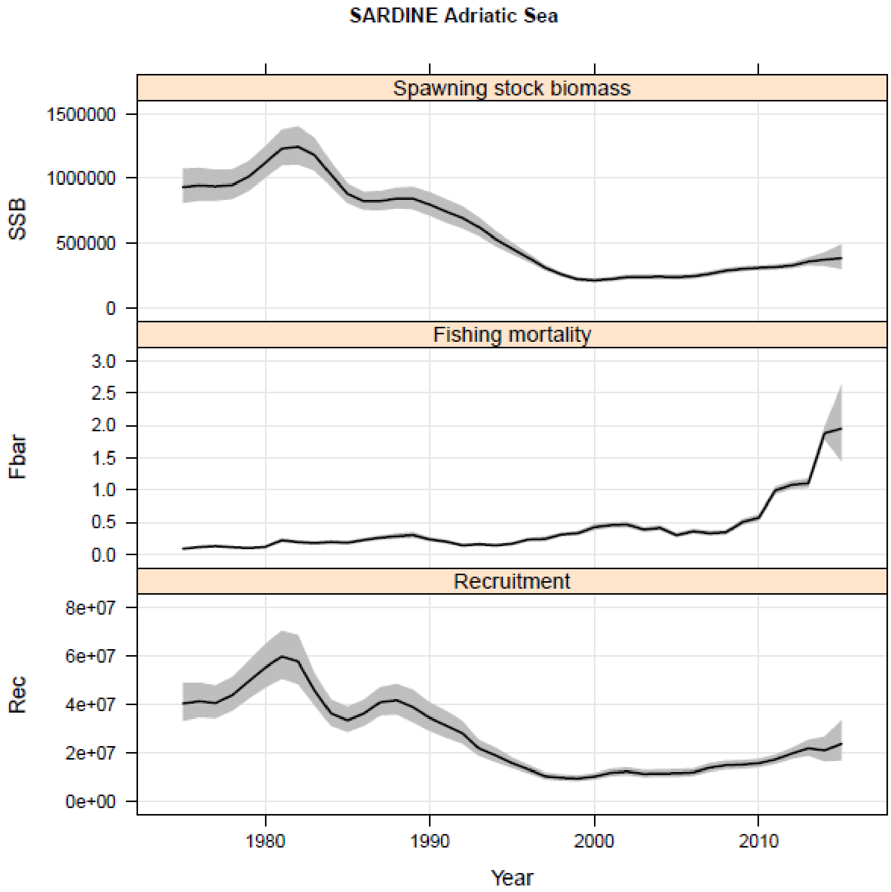

Figure 5.6.1.1. Sardine in GSAs 17-18**.** SAM assessment main outputs.

Table 5.6.1.1. Sardine in GSAs 17-18. SAM assessment summary results.

Year	F_{bar} (1-3)	Recruitment (thousands)	SSB (t)	Catch (t)	Total biomass (t)	Year	F_{bar} (1-3)	Recruitment (thousands)	SSB (t)	Catch (t)	Total biomass (t)
1975	0.09	40305561	934718	35348	1257958	1996	0.23	13137746	386544	43695	491885
1976	0.11	41243332	946949	48050	1276969	1997	0.24	10365567	309279	36026	392385
1977	0.13	40507593	940343	53852	1264263	1998	0.31	9722954	256786	36316	334369
1978	0.11	43837492	949794	46305	1300163	1999	0.33	9454487	218600	26903	294196
1979	0.10	49575137	1013581	40823	1409859	2000	0.42	10231687	210449	25235	292436
1980	0.11	55118722	1119060	48436	1559694	2001	0.45	11769241	219476	23435	313640
1981	0.22	59709399	1231816	91126	1708284	2002	0.46	12261809	235861	24909	334035
1982	0.19	57655719	1246687	80580	1708284	2003	0.38	11341737	236807	22404	327420
1983	0.17	45809406	1182333	84626	1548814	2004	0.41	11490142	238470	26984	330380
1984	0.19	36179384	1027871	92967	1317175	2005	0.30	11559290	235155	20032	327420

1985	0.18	33464643	882929	80258	1150837	2006	0.36	11923240	241832	22561	337055
1986	0.22	36143222	824886	85050	1113479	2007	0.33	13811332	260928	22675	371387
1987	0.26	40873807	826537	82043	1153141	2008	0.34	14827587	285786	27861	404335
1988	0.28	41657834	845768	75811	1178791	2009	0.50	15112005	300139	35561	421258
1989	0.30	38763902	844922	77111	1154295	2010	0.57	15665948	308045	47667	433220
1990	0.23	34414894	798109	64023	1073033	2011	0.99	17192779	313953	64796	451351
1991	0.20	31264693	743408	54339	993511	2012	1.08	19697455	326113	64926	483594
1992	0.14	28092129	693842	41357	918962	2013	1.10	21856305	356825	67778	531788
1993	0.16	21747296	621568	45252	794923	2014	1.88	20978318	372131	88168	539825
1994	0.14	18906191	531256	37235	682829	2015	1.95	23700341	383080	87029	572633
1995	0.16	15728737	458172	39458	584201						

5.6.2. Stock advice

STECF EWG 16-13 advises that when precautionary considerations are applied exploitation should be no more than fishing mortality = 0.4 (E=0.4), equivalent to a Harvest Rate of 0.086 on total biomass and a catch of 49487 t implemented either through catch restrictions or effort reduction for the relevant fleets. This could be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

5.6.3. Basis of the assessment

The stock of sardine was assessed using the State-space Assessment Model (SAM) (Nielsen *et al*., 2012) in FLR environment with data from 1975 to 2015. A combined tuning index (acoustic survey covering the western and eastern sides in GSA 17 from 2009 to 2015, as well as acoustic survey covering the west part of the GSA 18 from 2009 to 2015) was used in the assessment. All the analyses were performed with version 0.99-3 of FLSAM, together with version 2.5 of the FLR library (FLCore).

5.6.4. Catch options

No short term forecast was carried out by STECF EWG 16-13 due to uncertainty in terminal F needed to estimate catches in the intermediate year. However, SSB appears relatively stable and much better estimated, using HR a range of catch options can be estimated

Table 5.6.4.1. Sardine in GSAs 17-18. Catch options based on HR relative to total biomass in 2015 and selected Exploitation rate E=F/(F+M) from 0 to 1.0

Exploitation Rate	Harvest Rate on total biomass	Catch options related to E
0	0.012	6929
0.2	0.049	28208
0.4	**0.086**	**49487**
0.6	0.124	70766
0.8	0.161	92045
1.0	0.198	113324

5.6.5. Reference points

The assessment is based on a revised survey time series and reference points need to be re-evaluated. Historic reference points are included below.

Table 5.6.5.1 Sardine in GSAs 17-18. Reference points, values and their technical basis.

Framework	Reference point	Value	Technical basis	Source

MSY approach	MSY $B_{trigger}$			
	F_{MSY}	0.23	Eqsim	STECF EWG 14-09
	F_{MSY}	0.08	Eqsim	STECF EWG 15-11
	F_{MSY}	0.72	Eqsim	GFCM WGSASP 2015
Precautionary approach	B_{lim}			
	B_{pa}			
	F_{lim}			
	F_{pa}			
EU-GFCM management strategy	SSB_{lower}			
	SSB_{upper}			
	F_{lower}			
	F_{upper}			

5.6.6. Data Deficiencies

No particular deficiencies were found in the data provided. The use of standardized and common age reading procedure by the different Member States is recommended.

5.7. SUMMARY SHEET OF ATLANTIC HORSE MACKEREL IN GSAs 1-5-6-7

Species common name: Atlantic horse mackerel

Species scientific name: *Trachurus trachurus*

Geographical Sub-area(s) GSA(s): 1, 5, 6, and 7

5.7.1 Stock development over time

5.7.1.1 State of the adult abundance and biomass

Trend of adult abundance and biomass were estimated by analysing Medits data. The index fluctuates rapidly, a peak in abundance and biomass was detected in 2007, while both indices drop down to minimum in 2014. In the last year the indices increase again. Fluctuations are considered to be high.

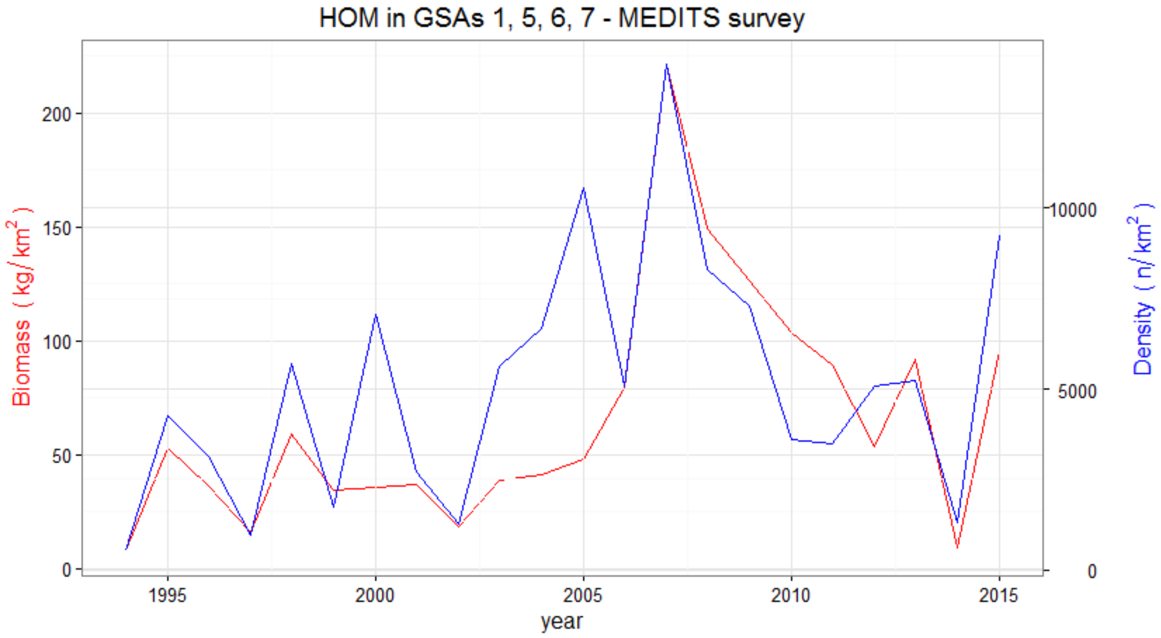

Figure 5.7.1.1.1 Trend in abundance (blue) and biomass (red) for HOM in GSAs 1, 5, 6, 7 (Medits survey data).

The evaluation of length indicators (Annex I) indicate that horse mackerel in this area are close being exploited at or below MSY and the exploitation rate appears to be increasing. However, the results are sensitive to assumptions on Linf and need to be explored further before firm conclusions can be drawn.

5.7.1.2 State of the juveniles (recruits)

Not assessed during EWG16-13

5.7.1.3 State of exploitation

Not assessed during EWG16-13

5.7.2 Stock advice

STECF EWG 16-13 advises that when precautionary considerations are applied catches should be no more than 2078 t in each of 2017 and 2018 implemented either through catch restrictions or effort reduction for the relevant fleets.

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5.7.3 Basis of the assessment

Data from MEDITS abundance indices (1994-2015, Figure 5.7.1.1.1).

5.7.4 Catch options

Following the ICES procedures for data limited stocks the change in biomass over the last five years was used to provide an index for change (0.67, Figure 5.7.3.1). As the decrease in the index is more than 0.8 the value of the factor is limited to 0.8 the catch to provide an initial catch advice. The exploitation rate is unknown and the state of the stock relative to B_{msy} is unknown therefore a precautionary buffer (0.8) is applied giving an overall factor of 0.64. The resulting catch advice taken from the average of the last three years (3247 t) is 2078 tonnes

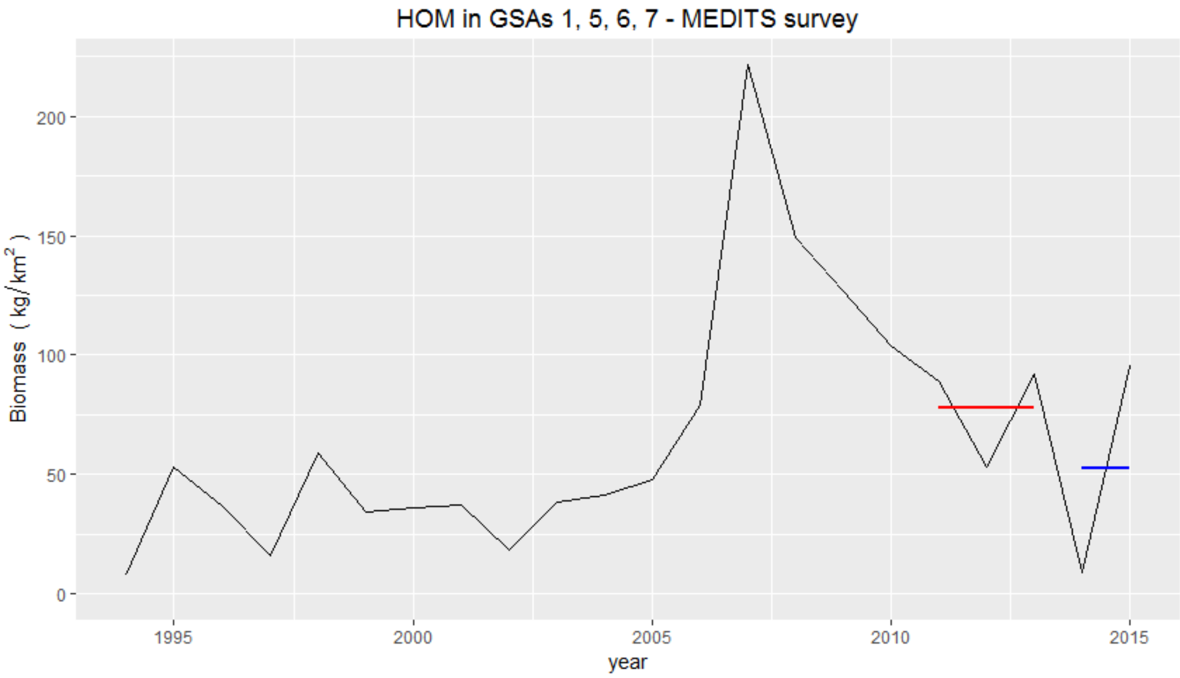


Figure 5.7.3.1.Trend in biomass (black) mean of 2011-2013 (red) and mean of 2014-2015 (blue) for HOM in GSAs 1, 5, 6, 7 (Medits survey data).

5.7.5 Reference points

No reference points have been calculated for this stock

5.7.6 Data Deficiencies

Data utilised for the analyses come from the last DCF official data call (2016). Some errors and deficiencies have been detected and the detailed list is reported in section 10 (Data quality check). The main issues are related to the missing length structure data for discards although total discards are reported for most years (2005, 2008-2015).

5.8. SUMMARY SHEET OF ATLANTIC HORSE MACKEREL IN GSAs 9,10,11

Species common name: Atlantic horse mackerel

Species scientific name: *Trachurus trachurus*

Geographical Sub-area(s) GSA(s): 9, 10, and 11

5.8.1 Stock development over time

5.8.1.1 State of the adult abundance and biomass

Summary results for HOM in GSAs 9, 10, 11. by year are shown in table 5.8.1.1. and figure 5.8.1.1. The SSB has fluctuated between 2416 and 13000 t over the 7 years assessed and is currently estimated to be at 13000 t.

5.8.1.2 State of the juveniles (recruits)

The XSA results show a decreasing trend in recruitment with a minimum in 2015 (Figure 5.8.1.1 and Table 5.8.1.1).

5.8.1.3 State of exploitation

The E_{curr} (0.67, ages 2-6 Table 5.8.1.2) is higher than the precautionary limit reference of 0.4 (Patterson 1992) the exploitation reference point consistent with high long term yields, which indicates that HOM in GSAs 9, 10, 11 is overexploited.

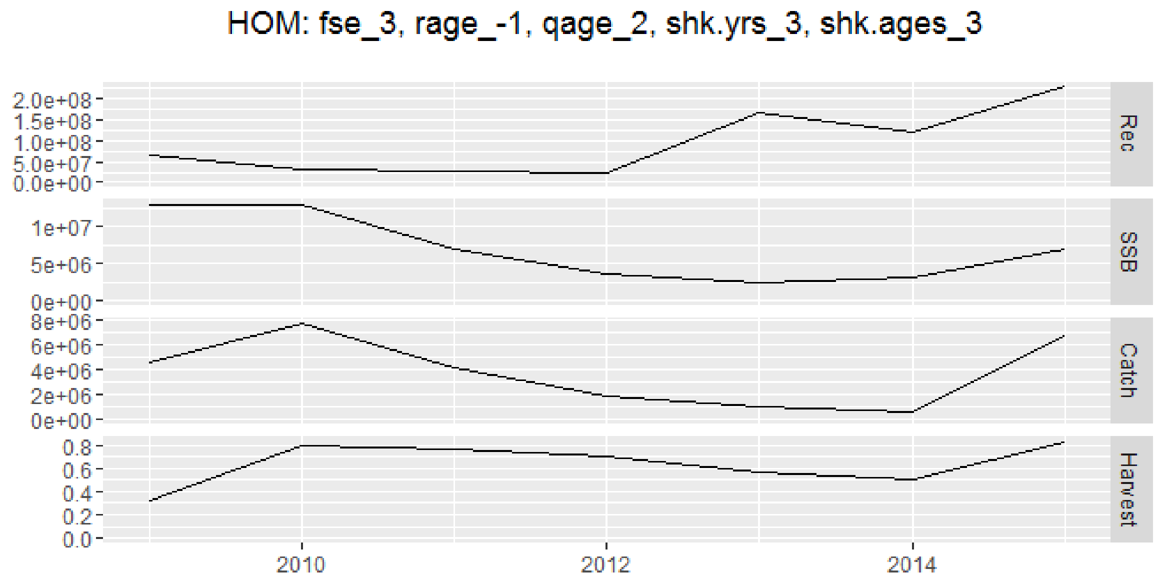


Figure 5.8.1.1. Summary results for HOM in GSAs 9. 10. 11. By year SSB and catch are in tonnes, recruitment in 1000s individuals.

Table 5.8.1.1. Summary results for HOM in GSAs 9, 10, 11. By year SSB and catch are in kg, recruitment in 1000s individuals.

	2009	2010	2011	2012	2013	2014	2015
ssb	12936	12925	7029	3650	2416	3234	7037
fbar	0.32	0.8	0.76	0.71	0.56	0.5	0.83
rec	64923676	32563939	27752786	23782861	167160053	121413603	228131220

catch	4583	7641	4173	1901	955	564	6689

Table 5.8.1.2 Estimation of exploitation rate E=F/(F+M)

```
     year
age   2009 2010 2011 2012 2013 2014 2015
  all 0.45 0.67 0.66 0.64 0.58 0.55 0.67
```

5.8.2 Stock advice

STECF EWG 16-13 advises that when precautionary considerations are applied exploitation rate E should be no more than 0.4, equivalent to a Harvest Rate of 0.28 on SSB and a catch of 1959 t implemented either through catch restrictions or effort reduction for the relevant fleets. This could be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

5.8.3 Basis of the assessment

Data from DCF provided at EWG-16-13 containing information on horse mackerel landings and the respective age structure for 2009-2015 were used. A vector of natural mortality value by age was obtained from ICES WGHANSA (2013). Catch at age, weight at age, mortality at age and maturity at age data for the 2009-2015 period were compiled for age classes 0 to 10+ and used as input data for an XSA based assessment. Abundance indexes by age derived from MEDITS (otter trawl survey) from 2011 to 2015 were used as tuning data. Based on Von Bertalanffy growth parameters catch and tuning data by length were split by using a knife technique to derive matrices by age.

The computation was made by R-project software and the FLR libraries.

5.8.4 Catch options

Due to the uncertainty in the assessment, particularly in F and R, catch options have been calculated based of HR and 2015 SSB. Options are provided in table 5.8.4.1 for exploitation rates E= F/(F+M)=0 to 1.0. Precautionary option of E=0.4 (Patterson 1992) is chosen as the basis of advice

Table 5.8.4.1. Horse mackerel in GSA 9,10 and 11. Relationship between HR and E and resulting catch options based on total biomass in 2015. Change in catch is relative to catch in 2015.

Exploitation Rate	Harvest Ratio on SSB	Catch options Related to E	Change in catch
0	0.000	0	-100%
0.2	0.139	980	-85%
0.4	0.278	1959	-71%

0.6	0.418	2939	-56%
0.8	0.557	3918	-41%
1	0.696	4898	-27%

5.8.5 Reference points

No reference points were estimated for this stock

5.8.6 Data Deficiencies

Data utilised for the analyses come from the last DCF official data call (2016). Some errors and deficiencies have been detected and the detailed list is reported in section 10 (Data quality check). Total discards and discards at length are missing for 2014, while reported for all other years in time frame (2009-2015). Total landings are reported from 2005 to 2015 while structures at length from 2007 to 2015. A check and eventually an update on catch data would improve the assessment.

5.9. SUMMARY SHEET OF ATLANTIC HORSE MACKEREL IN GSAs 17,18,19,20

Species common name: Atlantic horse mackerel

Species scientific name: *Trachurus trachurus*

Geographical Sub-area(s) GSA(s): 17, 18, 19, and 20

5.9.1 **Stock development over time**

State of the adult abundance and biomass

Due to a poor fitting of the model the assessment was not accepted. EWG 16-13 was only able to analyse the biomass indices from the fishery independent survey (Medits).

Trends in abundance and biomass show a main peak in the middle of the time series (2004), an increasing pattern in the last 5 years and a drop in 2015 (figure 5.9.1.1).

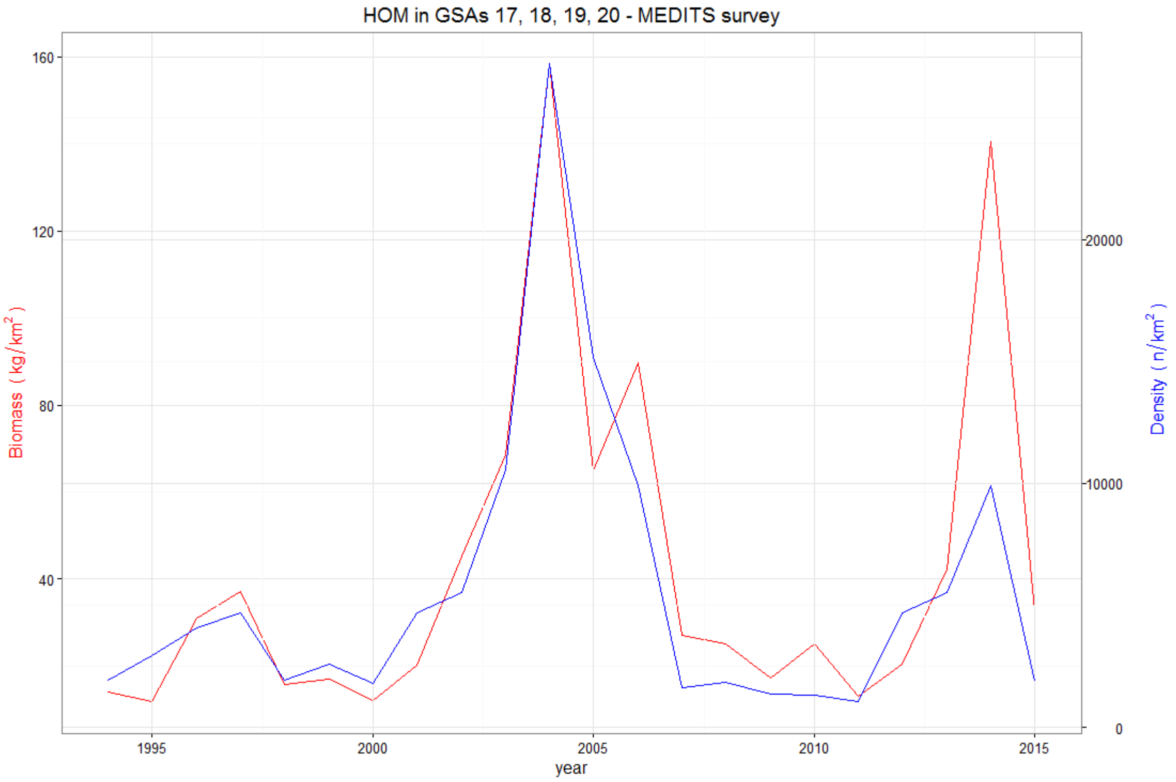


Figure 5.9.1.1. Trend in abundance (blue) and biomass (red) for HOM in GSAs 17, 18, 19, 20 (Medits survey data).

State of the juveniles (recruits)

State of juveniles is unknown

State of exploitation

State of exploitation is unknown.

5.9.2 Stock advice

STECF EWG 16-13 advises that when precautionary considerations are applied catches should be no more than 2297 t in each of 2017 and 2018 implemented either through catch restrictions or effort reduction for the relevant fleet

.

5.9.3 Basis of the assessment

Data from MEDITS abundance indices (1994-2015, Figure 5.9.1.1).

5.9.4 Catch options

Following the ICES procedures for data limited stocks the change in biomass over the last five years was used to provide an index for change (1.12, Figure 5.9.1.1). As the increase in the index is less than 1.2 the value of the factor is used the catch to provide an initial catch advice. The exploitation rate is unknown and the state of the stock relative to B_{msy} is unknown therefore a precautionary buffer (0.8) is applied. The resulting catch advice taken from the average of the last three years (2564 t) is 2297 t.

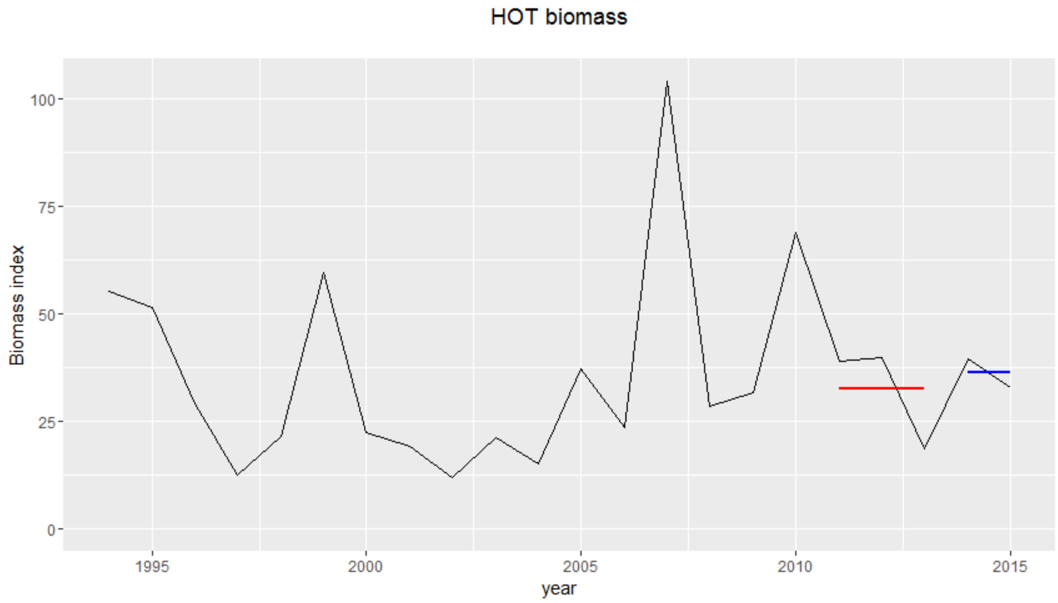


Fig. 5.9.4.1 Atlantic Horse Mackerel in region 3 (GSAs 17-20). Biomass index estimated from MEDITS survey. In blue the mean of the last two years compared with that of the previous three years (in red).

5.9.5 Reference points

No reference points were estimated.

5.9.6 Short term forecasts

No short term predictions were performed.

5.9.7 Data Deficiencies

Data utilised for the analyses come from the last DCF official data call (2016). Some errors and deficiencies have been detected and the detailed list is reported in section 10 (Data quality check). The main issues are related to the missing of length data for landings (2008).

5.10. SUMMARY SHEET OF EUROPEAN ANCHOVY IN GSA 9

Species common name: European Anchovy

Species scientific name: *Engraulis encrasicolus*

Geographical Sub-area(s) GSA(s): 9

5.10.1. Stock development over time

State of the adult abundance and biomass

The estimated biomass estimates are only available for the most recent 10 years and fluctuate in time: decreasing in the first part of the period analysed (2006-2008), increasing in the second part (2009-2012), decreasing again in 2013-2014 and, eventually, showing the highest values in the last year (Figure 5.10.1).

State of the juveniles (recruits)

The XSA results show also for recruitment a changing pattern: an increasing trend in the recruitment from 2007 to 2011, a decreasing trend in the following two years and the highest value of the whole series in the 2015 (Fig. 5.10.1).

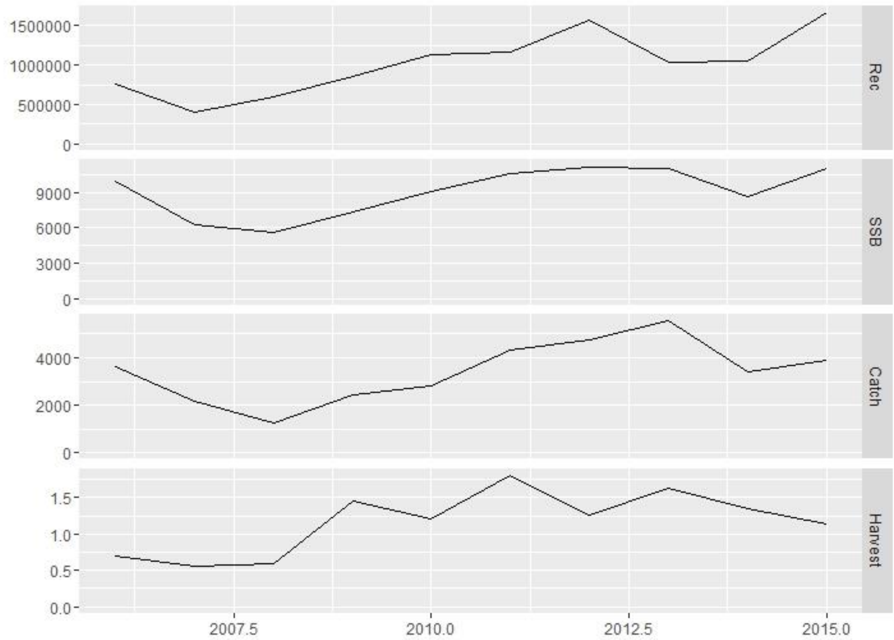


Figure 5.10.1 European Anchovy in GSA 9**.** XSA main output SSB, catch ate in tonnes.

State of exploitation

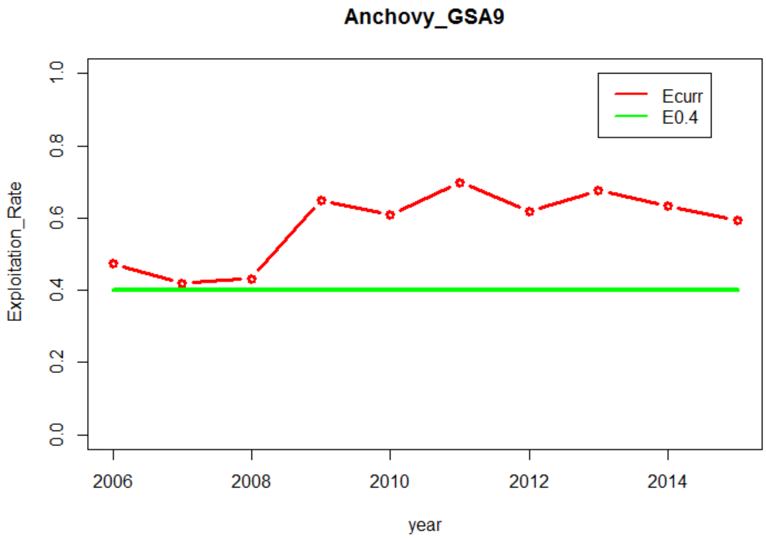


Figure 5.10.2. European Anchovy in GSA 9**.** Trend in the exploitation rate compare to E=0.4.

Table 5.10.1. European Anchovy in GSA 9. XSA assessment summary results.

	Fbar (0-2)	**Ebar (0-2)**	**Recruitment (thousands)**	**SSB (t)**	**Catch (t)**	**Total Biomass (t)**
2006	0.706	0.474	759269	9907	3724.5	12944
2007	0.564	0.418	404766	6265	2289.5	8086
2008	0.596	0.432	604505	5578	1349.8	8298
2009	1.448	0.649	862260	7278	2503.7	11159
2010	1.211	0.607	1125898	9047	2999.1	14114
2011	1.811	0.698	1170248	10540	4449.3	15806
2012	1.266	0.618	1560274	11170	4912.4	17411
2013	1.631	0.676	1026680	11057	5402.3	15677
2014	1.347	0.632	1051436	8596	3440.2	13327
2015	1.139	0.592	1664877	11001	3957.8	17661

5.10.2. Stock advice

STECF EWG 16-13 advises that when precautionary considerations are applied Fishing mortality should be less than 0.40 (F=0.52), catches should be no more than 2740 t implemented either through catch restrictions or effort reduction for the relevant fleets.

5.10.3. Basis of the assessment

Data from DCF provided at EWG-16-13 containing information on anchovy landings and the respective age structure for 2006-2015 were used. A vector of natural mortality value by age was obtained using Gislason method (Gislason et al.,2010). Catch at age, weight at age, mortality at age and maturity at age data for the 2006-2015 period were compiled for age classes 0 to 3+ and used as input data for an XSA based assessment. Nevertheless, the acoustic surveys (MEDIAS) are likely the best source of fishery independent information for small pelagic species, only few years were available for the area (2009, 2011 and 2014-2015) and so, based on the main results obtained by Sbrana et al.,2010, also abundance indexes by age derived from MEDITS (otter trawl survey) from 2011 to 2015 were used as tuning data.

The computation was made by R-project software and the FLR libraries.

5.10.4. Catch options

Catch options have been calculated based of Harvest Ratio and 2015 SSB. Options are provided in table 5.2.2 for exploitation rates E= F/(F+M)=0 to 1.0. Precautionary option of E=0.4 (Patterson 1992) is chosen as the basis of advice.

Table 5.10.4.1. European Anchovy in GSA9. Relationship between HR and E and resulting catch options based on SSB in 2015.

Exploitation rate	Harvest Ratio on total biomass	Catch options based on E	Change in catch
0.0	0.000	0	-100%
0.2	0.078	1370	-65%
0.4	0.155	**2740**	-31%
0.6	0.233	4109	4%
0.8	0.310	5479	38%

5.10.5. Reference points

E=0.4 (Patterson 1992) is used as a precautionary limit to exploitation

5.10.6. Data Deficiencies

No particular deficiencies were found in the data provided.

5.11. SUMMARY SHEET OF EUROPEAN ANCHOVY IN GSA 10

Species common name: European Anchovy

Species scientific name: *Engraulis encrasicolus*

Geographical Sub-area(s) GSA(s): 10

5.11.1. Stock development over time

Data on catches at age were extracted from the repository of the Data Collection Framework for anchovy (*Engraulis encrasicolus*) to create data files for subsequent stock assessment modelling. Data ranged from 2002 to 2015. Comparison of age structure from landings and from MEDIAS surveys showed a quite scarce degree of consistency in age class proportion between Catch at age data and MEDIAS samples (see below). While differences in catches at young ages might be explained by different selection patterns in survey and fishery, the difference at old ages is not seen in other areas to the same extreme degree. These differences suggest rather different exploitation rates and need to be further explored before conclusions on stock status can be drawn.

Evaluation of length indicators (Annex I) indicate that anchovy in this area are close to exploitation at MSY and the exploitation rate appears to be declining. However, the results are sensitive to assumptions on Linf and need to be explored further before firm conclusions can be drawn.

5.11.2. Stock advice

It is currently not possible to provide advice for this stock.

5.11.3 Basis of the assessment

Analysis of catch at length is given in Annex I.

5.11.4. Catch options

No catch options are provided.

5.11.5. Reference points

No reference points are provided.

5.11.6. Data Deficiencies

Age structure from landings and from MEDIAS surveys available data (2014 and 2015) were compared in order to evaluate the opportunity to use both datasets with the XSA approach. Results showed a quite scarce degree of consistency in age class proportion between catch at age data and MEDIAS samples. Namely, the number of age classes were quite higher than in survey data: from survey were observed 3 year classes (0-2) while from catch at age there were 5 classes in 2014 and 9 classes in 2015 (Figure 8.5.2.1).

5.12. SUMMARY SHEET OF SARDINE IN GSA 10

Species common name: Sardine

Species scientific name: *Sardina pilchardus*

Geographical Sub-area(s) GSA(s): 10

5.12.1. Stock development over time

The evaluation of length indicators (Annex I) indicate that sardine in this area are close to exploitation at MSY and the exploitation rate appears to be declining. However, the results are sensitive to assumptions on Linf and need to be explored further before firm conclusions can be drawn.

5.12.2. Stock advice

It is currently not possible to provide advice for this stock.

5.12.3. Basis of the assessment

Length analysis of MEDITS survey data was carried out, but this was inconclusive. Analysis of catch at length is given in Annex I.

5.12.4. Catch options

No catch options are provided.

5.12.5. Reference points

No reference points are provided.

5.12.6. Data Deficiencies

Data on catches at age were extracted from the repository of the Data Collection Framework of Sardine (*Sardina pilchardus*) to create data files for subsequent stock assessment modelling. Data ranged from 2002 to 2015.
Catch at age data provided cover too many age classes, ranging from 4 to 21 age classes. This is quite unusual for short living species like sardine. Moreover, age data from the neighbouring GSA 9 are composed by quite lower number of age classes, suggesting that these data have to be questioned and checked.

5.13. SUMMARY SHEET OF SARDINE IN GSA 5

Species common name: Sardine

Species scientific name: *Sardina pilchardus*

Geographical Sub-area(s) GSA(s): 5

5.13.1. Stock development over time

Evaluates of length data were carried out for this stock but there is insufficient data to conclude on stock status.

5.13.2. Stock advice

It is currently not possible to evaluate the status of this stock.

5.13.3. Basis of the assessment

Length analysis of MEDITS survey data was carried out, but this was inconclusive.

5.13.4. Catch options

No catch options are provided.

5.13.5. Reference points

No reference points are provided.

5.13.6. Data deficiencies

It seems unlikely that additional data will allow assessment of this species in this area in the near future, combining GSA 5 with GSAs 6 and 7 should be explored before appropriate data deficiencies can be defined.

5.14. SUMMARY SHEET OF EUROPEAN ANCHOVY IN GSA 5

Species common name: European Anchovy

Species scientific name: *Engraulis encrasicolus*

Geographical Sub-area(s) GSA(s): 5

5.14.1. Stock development over time

Evaluates of length data were carried out for this stock but there is insufficient data to conclude on stock status.

5.14.2. Stock advice

It is currently not possible to evaluate the status of this stock.

5.14.3. Basis of the assessment

Length analysis of MEDITS survey data was carried out, but this analysis was inconclusive.

5.14.4. Catch options

No catch options are provided.

5.14.5. Reference points

No reference points are provided.

5.14.6. Data deficiencies

It seems unlikely that additional data will allow assessment of this species in this area in the near future. There is evidence for continuity of stock with adjacent GSAs combining GSA 5 with GSAs 6 and 7 should be explored before appropriate data deficiencies can be defined.

5.15. SUMMARY SHEET OF SARDINE IN GSA 11

Species common name: Sardine

Species scientific name: *Sardina pilchardus*

Geographical Sub-area(s) GSA(s): 11

5.15.1. Stock development over time

There was no data on catch length composition available in the DCF data base for sardine in GSA 11, so neither trends in catch length composition nor size-based indicators could be provided for this stock. In addition, there was no acoustic data available, so only a short time series of MEDITS indices and the relevant trends were available.

Data on landings and discards were only available for years 2011 and 2012 for OTB. Since sardine is a by-catch species for this fishery, calculating CPUE based on the effort from OTB was not considered suitable for indicating trends of sardine stock status.

Based on the StockMed results on sardine stock unit encompassing GSAs 8 - 11, 15, 16, majority of GSA 19 and a part of GSA 7, given the considerable lack of data in this area and considering the high vulnerability of small pelagic species, data collection effort should be considered to make at least Level 4 assessment possible in the future.

On the other hand, if available data from GSA 11 are reliable, it can be concluded that catch and landings of sardine are negligible and stock assessment is not currently needed for this area/stock.

5.15.2. Stock advice

It is currently not possible to evaluate the status of this stock.

5.15.3. Basis of the assessment

Analysis of MEDITS survey data was carried out, but this analysis was inconclusive.

5.15.4. Catch options

No catch options are provided.

5.15.5. Reference points

No reference points are provided.

5.15.6. Data deficiencies

Based on the StockMed results establishing that a single sardine stock unit in the NW Mediterranean encompasses populations in GSAs 1, 5, 6 and a part of GSA 7, it would be advisable to put more effort in collecting reliable fisheries data, at least length frequencies, as well as to extend the already existing acoustic surveys to cover the whole area in question. In the long run this would enable a joint stock assessment for sardine and a better small pelagic fisheries management in the NW Mediterranean.

5.16. SUMMARY SHEET OF EUROPEAN ANCHOVY IN GSA 11

Species common name: European Anchovy

Species scientific name: *Engraulis encrasicolus*

Geographical Sub-area(s) GSA(s): 11

5.16.1. Stock development over time

Only MEDITS data was available for anchovy in GSA 11, so a short time series of MEDITS indices and the relevant trends were evaluated, however, they should not be considered indicative of stock status.
Based on the StockMed results on sardine stock unit encompassing GSAs 11 and a part of GSA 9, given the considerable lack of data in this area and considering the high vulnerability of small pelagic species, data collection effort should be considered to make at least Level 4 assessment possible in the future.

On the other hand, if available data from GSA 11 are reliable, it can be concluded that catch and landings of anchovy are negligible and stock assessment is not needed for this stock.

5.16.2. Stock advice

It is currently not possible to evaluate the status of this stock

5.16.3. Basis of the assessment

Analysis of MEDITS survey data was carried out, but this analysis was inconclusive.

5.16.4. Catch options

No catch options are provided.

5.16.5. Reference points

No reference points are provided.

5.16.6. Data deficiencies

Based on the fairly reliable StockMed results establishing that anchovy in GSAs 1, 5, 6, 7 and 9 compose a single stock unit it would be advisable to put more effort in collecting reliable fisheries data, at least length frequencies, as well as to extend the already existing acoustic surveys to cover the whole area in question. In the long run this would enable a joint stock assessment for anchovy and a better small pelagic fisheries management in the NW Mediterranean.

5.17. SUMMARY SHEET OF ATLANTIC MACKEREL IN GSA 1,5,6,7

Species common name: Atlantic Mackerel

Species scientific name: *Scomber scombrus*

Geographical Sub-area(s) GSA(s): 1,5,6,7

5.17.1. Stock development over time

A limited length-based analysis (Annex 1) was carried out for *Scomber* spp. in GSAs 1, 5, 6 and 7 but this should be treated with caution due to the unknown relative contribution of *S. scombrus* and *S. japonicus* in the total catch, and the lack of consistent landings data from all GSAs and gears. CPUE trends from PS catches were examined, indicating an overall decreasing trend in 2004-2015 (Fig. 9.3.1) which could be indicative of some degree of overexploitation. Also, the fact that the landings are dominated by fish aged 0-1 which are juveniles, indicates the possible occurrence of growth overfishing.

5.17.2. Stock advice

It is currently not possible to evaluate the status of this stock.

5.15.3. Basis of the assessment

Analysis of MEDITS survey data was carried out, but this analysis was inconclusive.

5.17.4. Catch options

No catch options are provided.

5.17.5. Reference points

No reference points are provided.

5.17.6. Data deficiencies

For a length-based analysis or a stock assessment to be carried out for this stock in the future, relevant data need to be collected at the species level (S. scombrus and S. japonicus). Also, more comprehensive catch-at-length and catch-at-age data are needed, that would cover all relevant areas and gears. Such data are currently available for consecutive years only from purse seiners (PS) in GSAs 1 and 6, albeit at a genus level (Scomber spp.), while data from other areas/gears are absent or sporadic. Furthermore, the trends of the MEDITS indices in GSA 6 generally did not agree with the respective CPUE trend indicating a limited suitability of MEDITS to infer trends of Scomber spp. in the area, and that indicates that enhanced surveys might be needed if fishery independent data is required. PS CPUE trends in GSA 7 could not be calculated after 2013 due to the absence of Spanish PS catch data in 2014 and 2015, and of French PS effort data in 2014.

5.18. SUMMARY SHEET OF ATLANTIC MACKEREL IN GSA 9,10,11

Species common name: Atlantic Mackerel

Species scientific name: *Scomber scombrus*

Geographical Sub-area(s) GSA(s): 9,10,and 11

5.18.1. Stock development over time

No length-based analysis was carried out for Scomber spp. in GSAs 9-11 due to the unknown relative contribution of S. scombrus and S. japonicus in the total catch, and the lack of consistent landings data from all GSAs and gears. Scomber spp. CPUE of PS in GSA 10 in 2009-2015 exhibited a peak in 2009 followed by lower values in the following years (Fig. 9.4.1). This trend was not in line with the MEDITS-derived biomass trend which exhibited high values in 2013 and 2014 (Fig. 6.18.4.2).

5.18.2. Stock advice

It is currently not possible to evaluate the status of this stock.

5.18.3. Basis of the assessment

Analysis of MEDITS survey data was carried out, but this analysis was inconclusive.

5.18.4. Catch options

No catch options are provided.

5.18.5. Reference points

No reference points are provided.

5.18.6. Data deficiencies

For a length-based analysis or a stock assessment to be carried out for this stock in the future, relevant data need to be collected at the species level (S. scombrus and S. japonicus). Also, more comprehensive catch-at-length and catch-at-age data are needed, that would cover all relevant areas and gears. Currently, relevant data are absent or sporadic, with the most severe data deficiencies observed in GSAs 9 and 11. Furthermore, the trends of the MEDITS indices in GSA 10 generally did not agree with the respective CPUE trend indicating a limited suitability of MEDITS to infer trends of Scomber spp. in the area, and that if fishery independent data is required enhanced surveys might be needed. CPUE trends could not be calculated in GSAs 9 and 11 due to the lack of consistent total catch data for consecutive years.

5.19. SUMMARY SHEET OF ATLANTIC MACKEREL IN GSA 17,18,19,20

Species common name: Atlantic Mackerel

Species scientific name: *Scomber scombrus*

Geographical Sub-area(s) GSA(s): 17,18,19,20

5.19.1. Stock development over time

A limited length-based analysis (Annex 1) was carried out for *Scomber* spp. in GSAs 17, 18, 19 and 20 but this should be treated with caution due to the unknown relative contribution of *S. scombrus* and *S. japonicus* in the total catch, and the lack of consistent landings data from all GSAs and gears. Evaluation of length indicators (Annex I) indicate that scomber spp. in this area are close to exploitation at MSY and the exploitation rate appears to be declining. However, the results are sensitive to assumptions on Linf and need to be explored further before firm conclusions can be drawn.

CPUE trends were examined in GSAs 18-19, where there were consistent catch and effort data available. The CPUE of *Scomber* spp. in Italian OTBs exhibited a somewhat decreasing trend in 2006-2015 in GSA 18, but no trend was observed in GSA 19 (Fig. 9.5.1). There was no particular agreement between the CPUEs and the MEDITS-derived indices. Based on the data available there can be no assessment of the exploitation status of *Scomber* spp. in GSAs 17-20.

5.19.2. Stock advice

It is currently not possible to evaluate the status of this stock.

5.19.3. Basis of the assessment

Analysis of MEDITS survey data was carried out, but this analysis was inconclusive.

5.19.4. Catch options

No catch options are provided.

5.19.5. Reference points

No reference points are provided.

5.19.6 Data deficiencies

For a length-based analysis or a stock assessment to be carried out for this stock in the future, relevant data need to be collected at the species level (S. scombrus and S. japonicus). Also, more comprehensive catch-at-length and catch-at-age data are needed, that would cover all relevant areas and gears. Currently, relevant data are absent or sporadic, with the most severe data deficiencies observed in GSA 20. Furthermore, the trends of the MEDITS indices in GSAs 18-19 generally did not agree with the respective CPUE trends indicating a limited suitability of MEDITS to infer trends of Scomber spp. in these areas, and that enhanced surveys might be needed. CPUE trends were not calculated in GSA 17 due to limited catch data availability from Italy and Croatia and very low catches of the Slovenian fleet, and in GSA 20 where total catch data were only available for 2014.

6. Data gathering

The following ToRs are addressed by stock below

ToR: 1.1 Compile and provide the most updated information on stock identification, age and growth, maturity, feeding, habitat, and natural mortality.

ToR: 1.2 Compile and provide complete sets of annual data on landings and discards for the longest time series available up to and including 2015. This should be presented by fishing gear as well as by size/age structure.

ToR 1.3 Compile and provide complete sets of annual data on fishing effort for the longest time series available up to and including 2015. This should be described in terms of amount of vessels, time (days at sea, soaking time, or other relevant parameter) and fishing power (gear size, boat size, horse power, etc.) by Member State and fishing gear. Data shall be the most detailed possible to support the establishment of a fishing effort or capacity baseline

ToR 1.4 Compile and provide indices of abundances and biomass by year and size/age structure for the longest time series available up to and including 2015).

6.1. DATA GATHERING OF EUROPEAN ANCHOVY IN GSA 6

6.1.1. Stock Identity and Biology

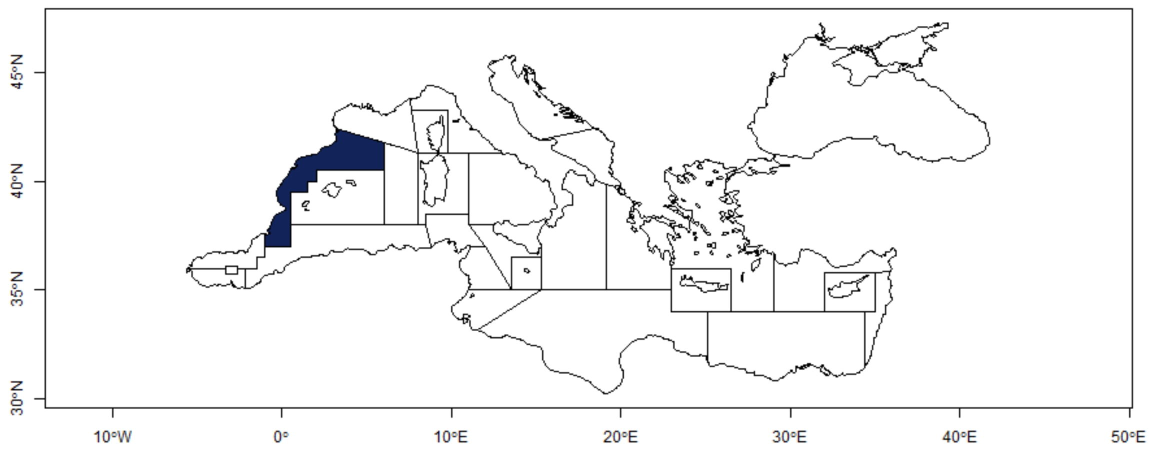


Figure 6.1.1.1. Geographical location of GSA 6.

Anchovy (*Engraulis encrasicolus)* and sardine (*Sardina pilchardus*) are the main target species of purse seining. Both species are very well adapted to the productivity mechanisms characteristic of their respective spawning seasons, that is, spreading of continental runoff at the surface in spring–summer and vertical mixing on the shelf in winter (Sabatés *et al*. 2007b). The Gulf of Lions is one of the main anchovy spawning areas in the NW Mediterranean, along with the shelf surrounding the Ebro river delta. During the spring, low-salinity surface water from the outflow of the Rhône is adverted by the shelf-slope current along the continental slope off the Catalan coast. Anchovy larvae from the Gulf of Lions spawning area have been demonstrated to be adverted southwards (i.e. towards GSA 6) in the low salinity waters (Sabatés *et al*. 2007a). The relative importance of this larval transport mechanism in relation to the larvae resulting from the local spawning in GSA 6 remains unknown.

Trophic studies of adult anchovy and larvae have shown that this species feeds on small zooplankton. The main prey of adults are copepods, and to a lesser extent, molluscs, cladocerans, other crustaceans and appendicularians while stomach contents of larvae consist mostly of copepod eggs, nauplii and copepodites (Plouvenez and Champalbert 2000; Tudela *et al*. 2002; Tudela and Palomera 1997). In the western Mediterranean spawning takes place during the warmest period, mainly from July to September (Sabatés *et al*. 2006). The species matures on completion of its first year of life, therefore, during the peak spawning season, most recruits are mature (Somarakis *et al*. 2004). Recruitment size to the fishery is 10 cm TL (Giráldez *et al*, 2015).

According to STOCKMED project results, the hypotheses of five stocks units within the Mediterranean (EU waters) would be the most suitable, one of them merging GSAs 1, 5, 6, 7 and 9, although the view gathered should be regarded as "working in progress".

6.1.2. Catch data

Anchovy landings in GSA 6 come from PS. PS discards are nil. OTB discards are reported some years, and when reported, the OTB discards are high in relation to OTB landings. In 2015 relative high OTB discards were reported (6% of the total catch), but no OTB landings were recorded.

Landings

Table 6.1.2.1. European Anchovy in GSA 6. Landings by gear and all gears combined (tonnes). The relative importance of PS in the landings and in the discards in relation to total catch is also shown.

	LANDINGS (t)							
	GNS	OTB	PS	all gear-landings	catch	disc	% PS(landings)	% disc/catch
2002			10664.0	10664.0	10664.0	0.0	100.0	0.0
2003		28.8	6390.0	6418.7	6418.7	0.0	99.6	0.0
2004		168.4	6342.6	6511.0	6511.0	0.0	97.4	0.0
2005		128.2	5702.5	5830.6	5830.6	0.0	97.8	0.0
2006		145.5	2463.2	2608.7	2608.7	0.0	94.4	0.0
2007		178.2	1913.3	2091.5	2091.5	0.0	91.5	0.0
2008		75.8	3124.2	3199.9	3200.0	0.0	97.6	0.0
2009		64.5	9235.0	9299.5	9299.5	0.0	99.3	0.0
2010		51.3	8399.2	8450.5	8450.6	0.1	99.4	0.0
2011	1.0	266.2	9468.0	9735.2	10006.3	271.1	97.3	2.7
2012		29.2	11433.9	11463.1	11463.1	0.0	99.7	0.0
2013		77.5	17177.9	17255.4	17308.0	52.5	99.6	0.3
2014	2.3	495.5	16849.6	17347.3	17936.0	588.6	97.1	3.3
2015	0.1		16599.7	16599.7	17661.7	1062.0	100.0	6.0

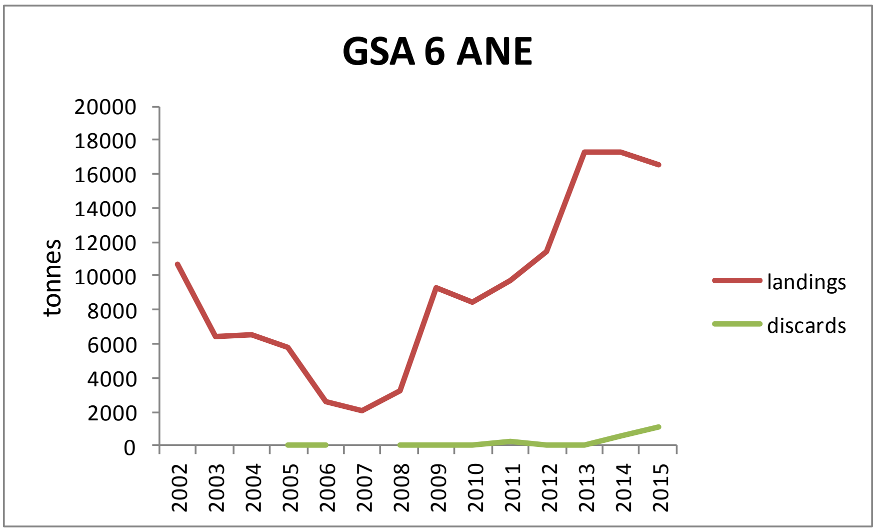


Figure 6.1.2.1. European Anchovy in GSA 6. Total landings and discards over the period 2002-2015 (tonnes).

An additional source of landings for anchovy is from the historical catch reconstruction performed and kindly made available to EWG 16-13 by Pedro Torres and Ana Giraldez from IEO. These series go back to 1945 and cover the entire GSA 6. A comparison of the reconstructed series and DCF landings is pictured in Figure 6.1.2.2, it shows a good degree of overlap in the recent years, although there are some slight differences in 3 points of the series (2002-2003, 2007 and 2009). In figure is reported the DCF landings (green line) and the DCF catch in dots. In the last two years, 2014 and 2014 the catches are higher than the reported landings due to discarding.

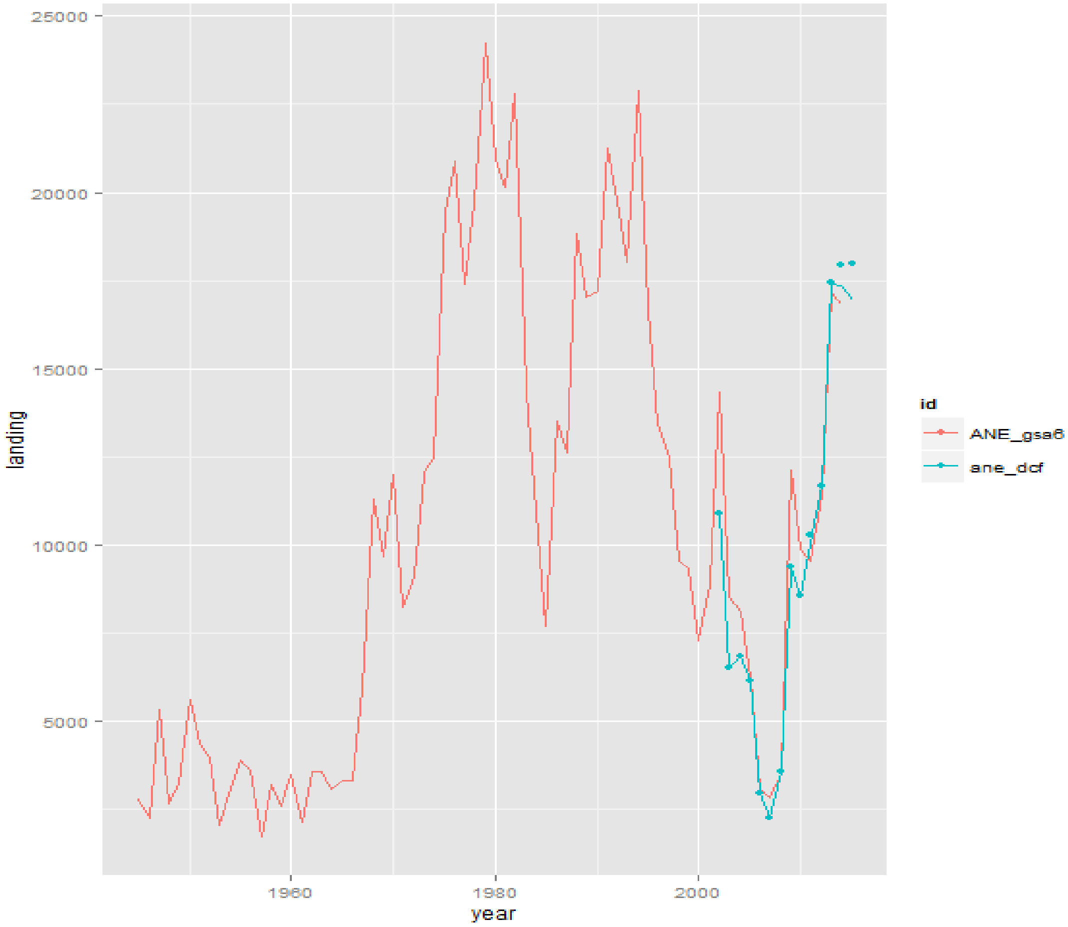


Figure 6.1.2.2. European Anchovy in GSA 6. Landings and catches according to different data sources.

Table 6.1.2.2. European Anchovy in GSA 6. Landings and catches according to different data sources.

year	landings_ IEO	landings_ DCF	year	Landings _IEO	Landings _DCF	year	landings_ IEO	landings_ DCF
1945	2809	NA	1969	9671	NA	1993	18011	NA
1946	2253	NA	1970	11986	NA	1994	22876	NA

1947	5319	NA	1971	8244	NA	1995	16686	NA
1948	2677	NA	1972	9081	NA	1996	13430	NA
1949	3268	NA	1973	12032	NA	1997	12500	NA
1950	5607	NA	1974	12480	NA	1998	9558	NA
1951	4352	NA	1975	19444	NA	1999	9361	NA
1952	3974	NA	1976	20898	NA	2000	7315	NA
1953	2057	NA	1977	17393	NA	2001	8898	NA
1954	3114	NA	1978	19696	NA	2002	14338	10907.67
1955	3888	NA	1979	24229	NA	2003	8538	6501.46
1956	3617	NA	1980	20932	NA	2004	8097	6854.07
1957	1745	NA	1981	20138	NA	2005	6216	6162.13
1958	3199	NA	1982	22802	NA	2006	3096	2953.6
1959	2575	NA	1983	14391	NA	2007	2820	2254.19
1960	3496	NA	1984	10947	NA	2008	3532	3570.74
1961	2139	NA	1985	7692	NA	2009	12137	9366.95
1962	3593	NA	1986	13498	NA	2010	9886	8572.81
1963	3585	NA	1987	12616	NA	2011	9534	10280.52
1964	3077	NA	1988	18843	NA	2012	11434	11693.78
1965	3315	NA	1989	17045	NA	2013	17178	17438.72
1966	3345	NA	1990	17204	NA	2014	16849	17935.47
1967	5960	NA	1991	21261	NA	2015	NA	17996.28
1968	11304	NA	1992	19793	NA			

Table 6.1.2.3. European Anchovy in GSA 6. Landings /fishing gear PS /year/size structure (TL cm; thousands).

	2002	2003	2004	2005	2006	2007	2008
5	0	0	0	0	0	0	0
6	0	49	0	0	0	0	5.3
7	0	63.7	4.7	9.7	0	4.5	427
8	988.6	1831.6	1925.6	19.8	0	22.7	1688.2
9	5362.5	5868.4	17558.8	320.6	0	170.1	8683.3
10	19628	9689.2	24814.6	5003.3	1183.3	325.9	23898.1
11	31194.6	21812.5	36786.5	14000.5	11712.6	311.6	38064.4
12	34604.5	43421.6	83114.3	30092	21282.1	2974.8	42465.1
13	81583.4	74892.4	121996.9	43827.8	30508.7	10046.7	47563.6
14	154357.2	109776.6	80441.3	73339.8	28272.9	20641.3	37068.4
15	110115.3	60172.2	24989.1	71363	20322.6	25618.9	16579.6
16	31360.2	7629.8	3299	24756.2	9323.1	15111.8	2560.2
17	20203.7	260.9	0.5	2831.1	2037.7	2201.4	94.6
18	6140.2	0	0	17.3	152.4	8	143.1
19	25.6	0	0	0	0	0	0
total numbers	495563.9	335468	394931.3	265581.2	124795.4	77437.6	219241.1

	2009	2010	2011	2012	2013	2014	2015
5	0	0	0	26.3	0	42.4	0
6	0	0	355.7	129.2	0	735.3	207.9
7	56	34.5	730.9	2386.3	494.4	3015.5	1192.6
8	1148.3	285	17259	14435.7	9321.4	9890.6	7230.7
9	5688.1	3494.1	51015.4	68206.4	37840.7	49123.9	53156.1
10	18908.6	18745.4	63249.7	151042.2	136027.8	214890.6	242624.4
11	31429.5	44216.1	92070.6	168499.5	300374.1	335722.7	480129.4
12	58478.4	123188.5	134960.3	152358.5	402900.2	370170.6	424609.9
13	136129.8	185481.8	171980.6	158671.1	320810	289825.5	265198.8
14	160569	114544.3	131724.2	126113.4	148712.1	143805.1	73935.2
15	86262.6	35516.1	47682.4	65126.7	40830.8	31325.9	7920.4
16	13889.2	3513.5	4710.7	15279.2	3860.7	2446.5	53.8
17	388.7	264.6	71	882	99.4	78.9	0
18	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0
total numbers	512948.1	529283.9	715810.6	923156.5	1401272	1451074	1556259

Table 6.1.2.4. European Anchovy in GSA 6. Landings (thousands) /fishing gear PS by year and by age.

	2002	2003	2004	2005	2006	2007	2008
0	150286,841	125071,809	105024,661	37264,966	58753,637	11547,445	131615,917
1	245371,651	199514,739	189298,122	74888,969	35321,849	41705,116	86122,633
2	84556,12	10881,415	90491,182	129843,292	28661,476	23176,38	1359,375
3	15349,31	0,0001	10116,856	23574,234	2058,477	1008,687	143,14
total numbers	495563,922	335467,963	394930,821	265571,461	124795,439	77437,628	219241,065
	2009	2010	2011	2012	2013	2014	2015
0	215314,381	311114,22	541538,821	255971,448	984364,321	1187595,32	894764,158
1	291658,094	200465,086	163611,658	266597,639	416907,355	263174,077	661495,047
2	5975,588	17704,561	10659,718	217495,235	0,0001	304,135	0,0001
3	0,0001	0,0001	0,0001	183092,198	0,0001	0,0001	0,0001
total numbers	512948,063	529283,867	715810,197	923156,52	1401271,68	1451073,54	1556259,21

Figure 6.1.2.3. European Anchovy in GSA 6. Landings /fishing gear PS /year/age structure. Note the absence of ages >1 in the last years (thousands).

Discards

Table 6.1.2.5. European Anchovy in GSA 6. Discards/fishing gear/year (tonnes).

DISCARDS (t)	OTB	PS	all gear
2002			0.0
2003			0.0
2004			0.0
2005	0.0		0.0
2006		0.0	0.0
2007			0.0
2008	0.0		0.0
2009	0.0	0.0	0.0
2010	0.1	0.0	0.1
2011	271.1		271.1
2012	0.0		0.0
2013	52.5		52.5
2014	588.6		588.6
2015	1062.0		1062.0

Discards/fishing gear/year/size structure

No discards reported for purse seine.

Discards/fishing gear/year/age structure

No discards reported for purse seine.

6.1.3. Fishing effort data.

Fishing effort

Anchovy catches in GSA 6 come from the PS fleet.

Table 6.1.3.1. PS Fishing effort in GSA 6 over 2004-2015: (GT*days at sea)/year and (Days at sea)/year

	gt_daysatsea	days_at_sea
2004	883665,6	20359
2005	762915,5	17345
2006	810575,1	17243
2007	445302,7	11031
2008	754749,3	16643
2009	813051,2	17563
2010	794730,8	16985
2011	830722,2	17831
2012	796035,1	17339
2013	846341,7	18956
2014	873988,6	19556
2015	808240,9	17589

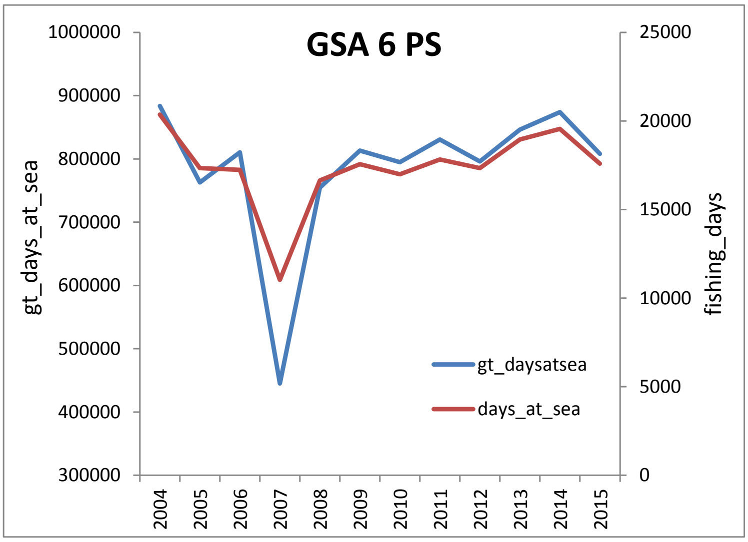


Figure 6.1.3.1. PS Fishing effort in GSA 6 over 2004-2015: (GT*days at sea)/year and (Days at sea)/year

6.1.4. Survey Indices of abundance and biomass by year and size/age

Two acoustic surveys data series are available for the period 2003-2015 in GSA 6. ECOMED surveys (2003-2008) were conducted in late autumn and MEDIAS surveys (2009-2015) in summer. The different timing of the surveys explains the differences in the distributions by size and age. Anchovy has a protracted spawning period. In the western Mediterranean spawning takes place during the warmest period, mainly from July to September (Sabatés *et al.* 2006). Thus, the ECOMED surveys in late autumn focused on recruitment and MEDIAS surveys in summer focused in the spawning stock biomass.

Table 6.1.4.1. European Anchovy in GSA 6. Abundance index/year /size structure from the acoustic surveys ECOMED (2003-2008) and MEDIAS (2009-2015) (thousands).

ECOMED

TL (cm)	2003	2004	2005	2006	2007	2008
4	0.0	0.0	0.0	0.0	0.0	0.0
5	556.5	2107.4	0.0	0.0	2677.6	0.0
6	1855.2	14521.4	472.7	0.0	14199.9	9921.0
7	37523.1	93032.7	3753.2	746.3	88478.2	645793.3
8	632871.3	242909.3	20207.2	33581.4	269775.2	1467839.1
9	1197207.5	446395.1	172307.0	390665.7	326836.5	1749175.0
10	1155084.5	439593.2	157724.5	352740.2	174102.0	1536152.7
11	565626.1	287694.5	157543.8	423084.3	51887.7	440632.0
12	161813.4	141610.8	97453.3	182839.3	16761.1	90723.5
13	47486.9	74017.5	70135.8	50133.1	5318.9	31257.4
14	27370.6	80823.9	37845.5	22553.1	6868.1	0.0
15	9500.6	38216.5	15675.0	25249.5	11995.4	0.0
16	0.0	8315.2	7375.4	11375.8	1834.3	0.0
17	0.0	0.0	270.3	8130.1	0.0	0.0
18	0.0	0.0	0.0	337.7	0.0	0.0
total no	3836895.6	1869237.7	740763.7	1501436.5	970735.0	5971493.8

MEDIAS

TL (cm)	2009	2010	2011	2012	2013	2014	2015
4	0.0	0.0	1714.0	0.0	0.0	0.0	0.0
5	330.2	0.0	3436.3	0.0	0.0	5211.2	0.0
6	0.0	0.0	12984.5	0.0	55.5	10017.2	215.7
7	35349.5	0.0	8847.1	0.0	1826.5	31292.7	2479.5
8	225940.6	3009.4	11086.6	33243.9	333685.7	250415.5	70470.1
9	264187.3	52680.8	155314.0	695757.6	1422757.2	905097.4	420673.8
10	551060.8	297901.1	197447.0	3597638.6	1701813.7	2017288.7	2340105.0
11	783514.8	450561.8	357057.6	3301866.7	1611856.2	2185708.0	4799645.0
12	563647.2	259758.5	318456.6	631879.6	691569.7	882899.0	2092745.1
13	312954.5	253074.2	255082.4	122000.3	159651.5	793303.6	526515.3
14	94155.3	277235.3	194464.1	22779.0	13095.1	291788.5	56851.2
15	17259.0	125522.6	67261.4	0.0	3549.8	49282.5	2815.9
16	1026.5	18316.2	3419.9	0.0	0.0	5537.0	0.0
17	73.9	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
total no	2849499.4	1738059.9	1586571.3	8405165.7	5939860.8	7427841.2	10312516.6

Table 6.1.4.2. European Anchovy in GSA 6. Abundance index/year /age structure from the acoustic surveys ECOMED (2003-2008) and MEDIAS (2009-2015) (thousands). Note the presence of age class 2 in the last years.

ages	0	1	2	total number
2003	3778218.4	58677.3	0.0	3836895.6
2004	1750339.6	118898.1	0.0	1869237.7
2005	700729.7	40034.0	0.0	740763.7
2006	1463024.5	37765.7	646.4	1501436.6
2007	963350.7	7384.3	0.0	970735.0
2008	5966946.0	4547.8	0.0	5971493.8
2009	0.0	2844482.9	5016.5	2849499.4
2010	0.0	1670960.5	67099.4	1738059.9
2011	0.0	1586571.3	0.0	1586571.3
2012	551766.0	6863417.5	989982.2	8405165.7
2013	3353883.5	2459817.6	126159.7	5939860.8
2014	117630.6	6189779.4	1120431.3	7427841.2
2015	506438.2	8629914.6	1176163.8	10312516.6

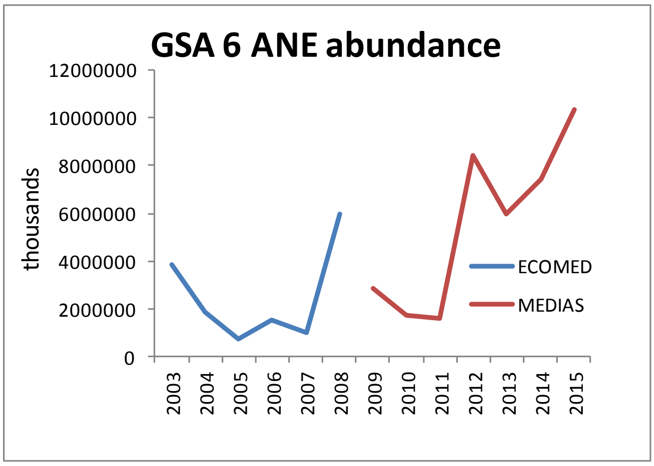


Figure 6.1.4.1. European Anchovy in GSA 6. Abundance index/year from the acoustic surveys ECOMED (2003-2008) and MEDIAS (2009-2015) (thousands).

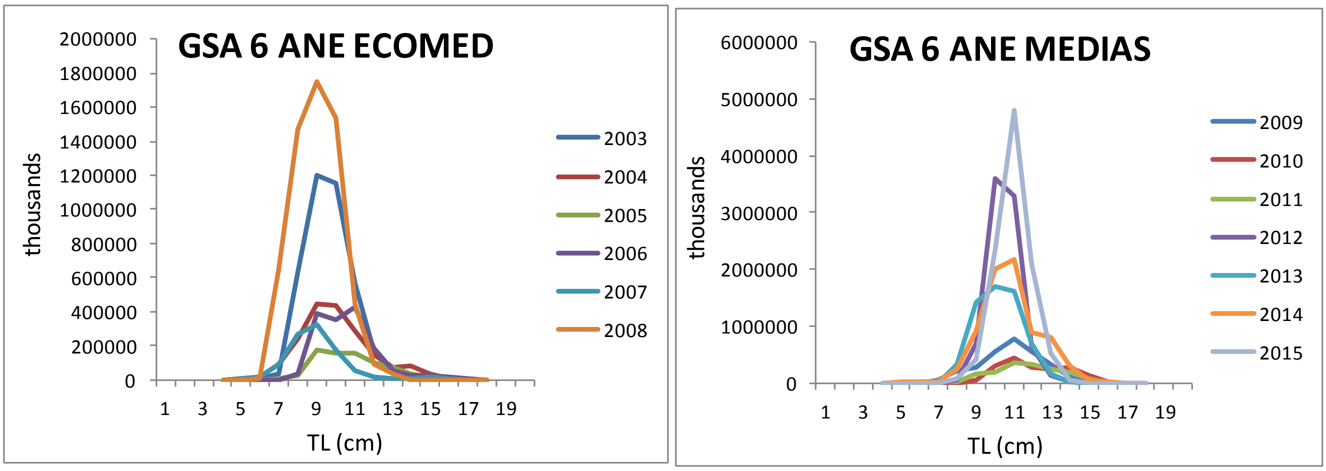


Figure 6.1.4.2. European Anchovy in GSA 6. Abundance index/year/size structure from the acoustic surveys ECOMED (2003-2008) and MEDIAS (2009-2015) (thousands). Note the shift in the length classes resulting from the different timing of the two surveys.

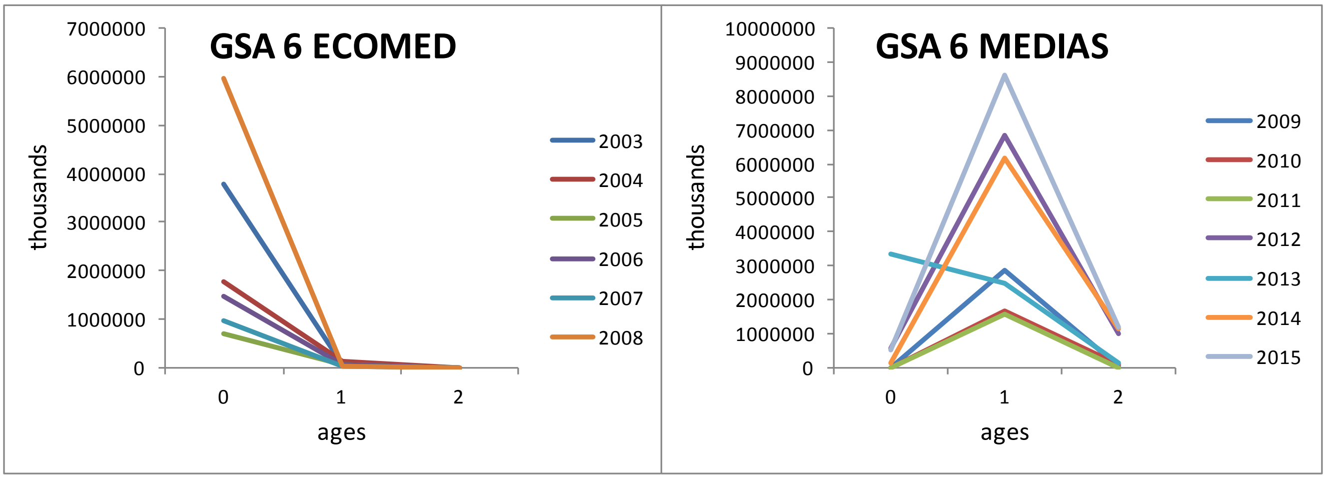


Figure 6.1.4.3. European Anchovy in GSA 6. Abundance index/year/age structure from the acoustic surveys ECOMED (2003-2008) and MEDIAS (2009-2015) (thousands). Note the shift in the ages resulting from the different timing of the two surveys.

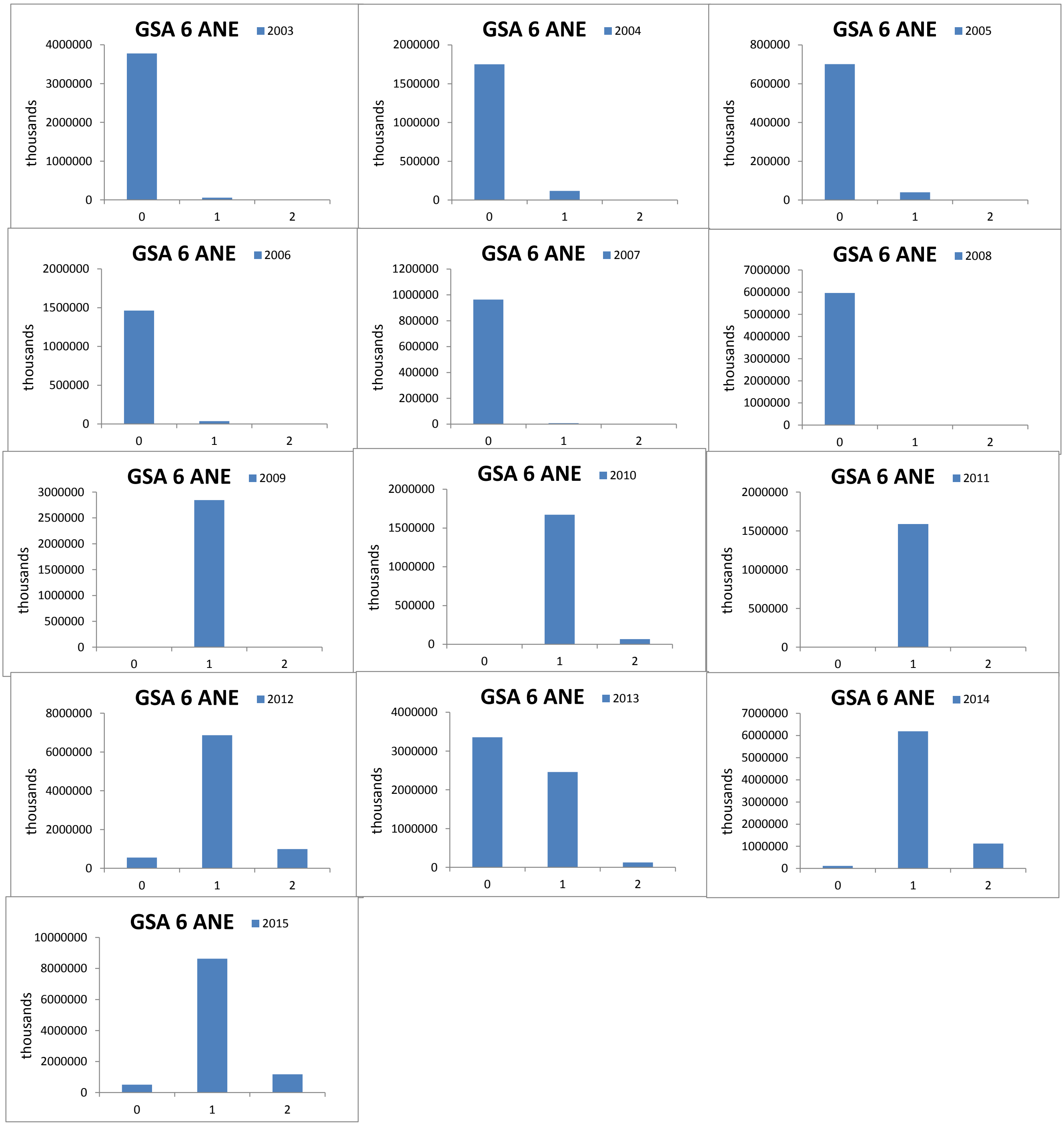


Figure 6.1.4.4. European Anchovy in GSA 6. Age structure from the acoustic surveys ECOMED (2003-2008) and MEDIAS (2009-2015) (thousands). Note the presence of age class 2 in the last years.

Table 6.1.4.3. European Anchovy in GSA 6. Biomass index/year /size structure from the acoustic surveys ECOMED (2003-2008) and MEDIAS (2009-2015) (tonnes).

ECOMED

TL(cm)	2003	2004	2005	2006	2007	2008
4	0.0	0.0	0.0	0.0	0.0	0.0
5	0.5	1.9	0.0	0.0	2.2	0.0
6	2.9	21.2	0.6	0.0	21.3	15.6
7	92.1	208.8	8.4	1.8	206.6	1456.6
8	2181.8	802.5	65.8	116.9	907.6	4777.4
9	5621.2	2054.9	770.8	1888.4	1551.9	8095.9
10	7364.3	2816.5	971.9	2263.1	1099.2	9504.0
11	4737.7	2445.9	1317.8	3631.9	427.7	3552.8
12	1724.5	1588.1	1063.3	2017.3	183.5	935.0
13	677.1	1072.2	983.9	695.2	73.7	430.2
14	485.6	1470.0	674.0	407.5	122.6	0.0
15	205.6	852.9	348.4	561.6	261.3	0.0
16	0.0	227.0	198.7	301.9	48.5	0.0
17	0.0	0.0	8.6	261.2	0.0	0.0
18	0.0	0.0	0.0	12.8	0.0	0.0
total(t)	23093.4	13562.0	6412.1	12159.4	4906.0	28767.5

MEDIAS

TL(cm)	2009	2010	2011	2012	2013	2014	2015
4	0.0	0.0	1.0	0.0	0.0	0.0	0.0
5	0.3	0.0	3.1	0.0	0.0	5.2	0.0
6	0.0	0.0	20.2	0.0	0.1	14.1	0.4
7	84.3	0.0	19.6	0.0	4.4	76.9	5.5
8	780.9	10.8	41.3	117.9	1173.0	886.7	240.0
9	1328.8	262.5	783.8	3404.3	6895.5	4504.2	1998.5
10	3871.4	2038.6	1367.3	24613.6	11469.9	13647.1	14632.3
11	7414.9	4027.3	3257.3	29140.9	14484.6	19303.9	38301.9
12	7103.8	3085.5	3749.0	7385.4	8096.6	10165.6	21076.8
13	5085.3	3941.2	3866.4	1851.6	2415.3	11675.9	6576.6
14	1952.3	5411.3	3656.9	434.5	251.1	5307.4	867.9
15	433.8	2996.9	1556.9	0.0	83.9	1096.2	54.3
16	31.8	531.6	93.2	0.0	0.0	147.4	0.0
17	2.8	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
total(t)	28090.4	22305.7	18416.0	66948.1	44874.3	66830.6	83754.1

Table 6.1.4.4. European Anchovy in GSA 6. Biomass index/year /age structure from the acoustic surveys ECOMED (2003-2008) and MEDIAS (2009-2015) (tonnes).

ages	0	1	2	total biomass
2003	22352.7	739.5	0.0	23092.3
2004	11459.1	2102.9	0.0	13562.0
2005	5630.3	781.6	0.0	6411.9
2006	11290.8	856.3	12.3	12159.4
2007	4752.6	153.4	0.0	4906.0
2008	28703.9	63.6	0.0	28767.5
2009	0.0	27984.0	106.4	28090.4
2010	0.0	20765.4	1540.4	22305.7
2011	0.0	18416.0	0.0	18416.0
2012	4330.3	52459.6	10158.1	66948.1
2013	25179.7	18722.1	972.5	44874.3
2014	599.8	56099.6	10131.2	66830.6
2015	3804.8	70158.3	9791.0	83754.1

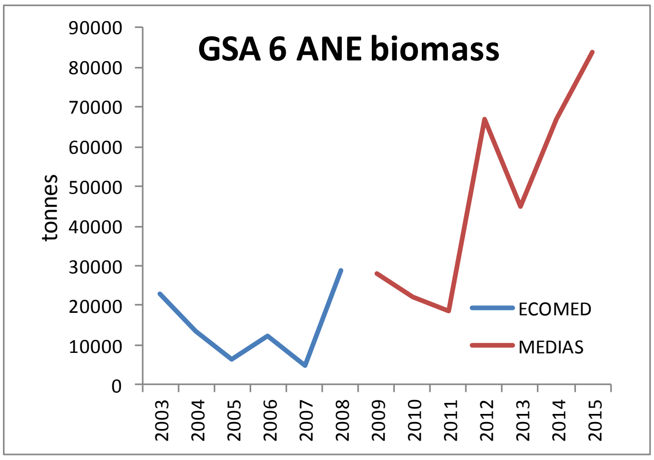


Figure 6.1.4.5. European Anchovy in GSA 6. Biomass index/year from the acoustic surveys ECOMED (2003-2008) and MEDIAS (2009-2015) (tonnes).

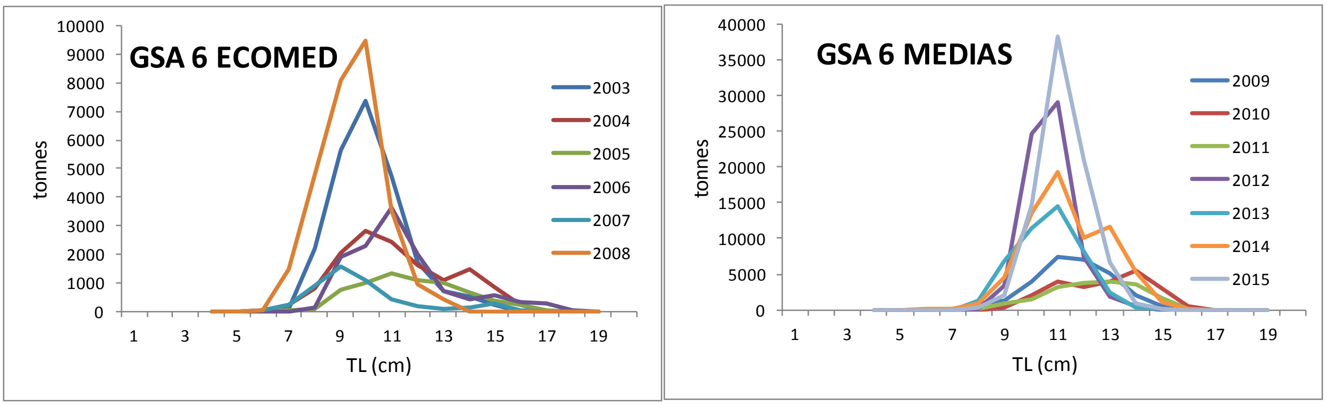


Figure 6.1.4.6. European Anchovy in GSA 6. Biomass index/year/size structure from the acoustic surveys ECOMED (2003-2008) and MEDIAS (2009-2015) (tonnes).

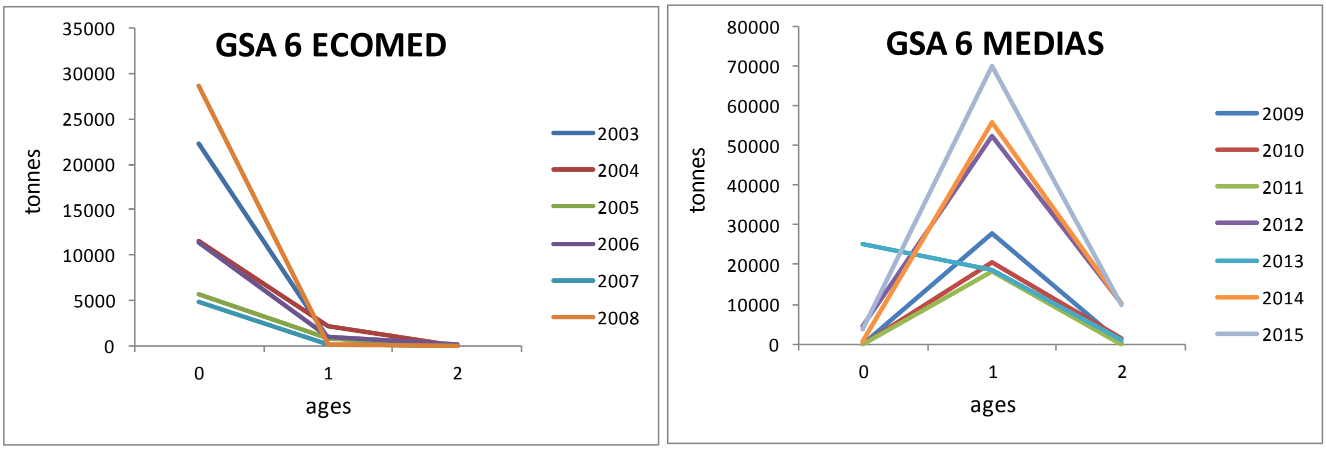


Figure 6.1.4.7. European Anchovy in GSA 6. Biomass index/year/age structure from the acoustic surveys ECOMED (2003-2008) and MEDIAS (2009-2015) (tonnes).

6.2. DATA GATHERING OF SARDINE IN GSA 6

6.2.1. Stock Identity and Biology

No information was provided on stock identification of sardine in GSA 6 during EWG 16-13 meeting. This stock was assumed to be confined within the GSA boundaries.

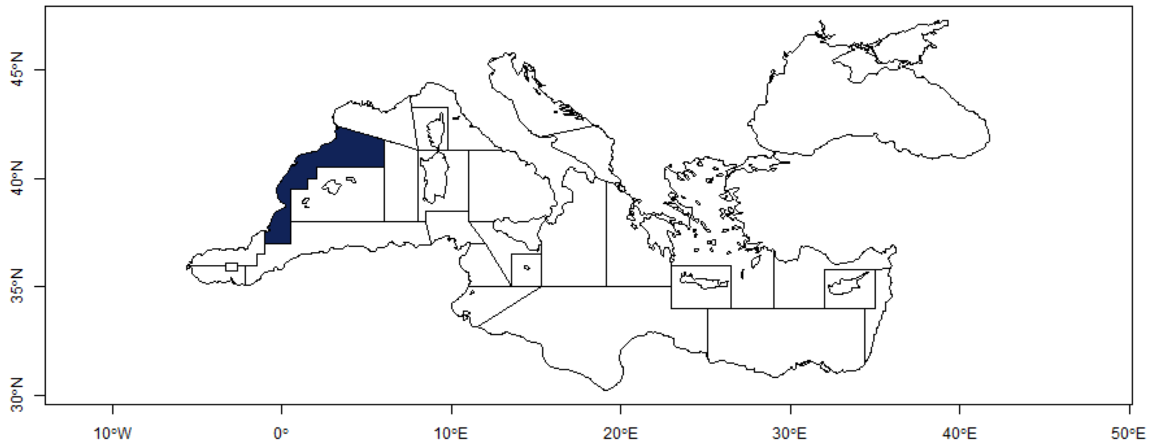


Figure 6.2.1.1. Geographical location of GSA 6

Age and maturity data were used from DCF provided during EWG 16-13. Maturity at age was estimated as a mean of annual ogives from GSA 6.

Table 6.2.1.1. Sardine in GSA 6. Maturity ogive.

Ages	0	1	2	3	4	5+
Fraction of mature	0.7	1	1	1	1	1

Natural mortality vector used was the vector that has been applied in the last approved assessment (STECF – Med. Ass. part 2 (STECF-15-06), 2015).

Table 6.2.1.2. Sardine in GSA6. Natural mortality vector.

Ages	0	1	2	3	4	5+
M	2.8	1.14	0.78	0.6	0.53	0.48

6.2.2. Catch data

Landings

Sardine landings in GSA 6 are provided to EWG 16-13 from DCF for the period 2002 to 2015. Lowest landings were around 7500 tons in 2009-2010 and 7000 tons in 2015 (Table 6.2.2.1). The majority of landings reported are from purse seine fleet (more than 97%), being the landings of other fleet negligible (Table 6.2.2.2). Over 2002-2015, landed sardines ranged between 5 and 23 cm total length (Fig. 6.2.2.2). Concerning the age structure, age classes 5, 6 and 7 are not present in the last years (2013-15) (Table 6.2.2.3).

Table 6.2.2.1. Sardine in GSA 6. Total landings/year in tons.

Year	Total	**Year**	Total
2002	17168	**2009**	7507
2003	17523	**2010**	7627
2004	23172	**2011**	12795
2005	21230	**2012**	10902
2006	27800	**2013**	10210
2007	23552	**2014**	10035
2008	16672	**2015**	6891

Table 6.2.2.2. Sardine in GSA 6. Landings/fishing gear/year (in tons).

Year	GNS	OTB	PS	%PS/all gears
2002	-	170	16998	99
2003	-	163	17360	99
2004	-	338	22834	99
2005	-	247	20983	99
2006	-	655	27145	98
2007	-	641	22911	97
2008	-	485	16185	97
2009	-	101	7406	99
2010	26	126	7475	98

2011	**31**	**402**	**12135**	**97**
2012	**10**	**192**	**9194**	**98**
2013	**28**	**168**	**9734**	**98**
2014	**9**	**209**	**9660**	**98**
2015	**2**	**138**	**6309**	**98**

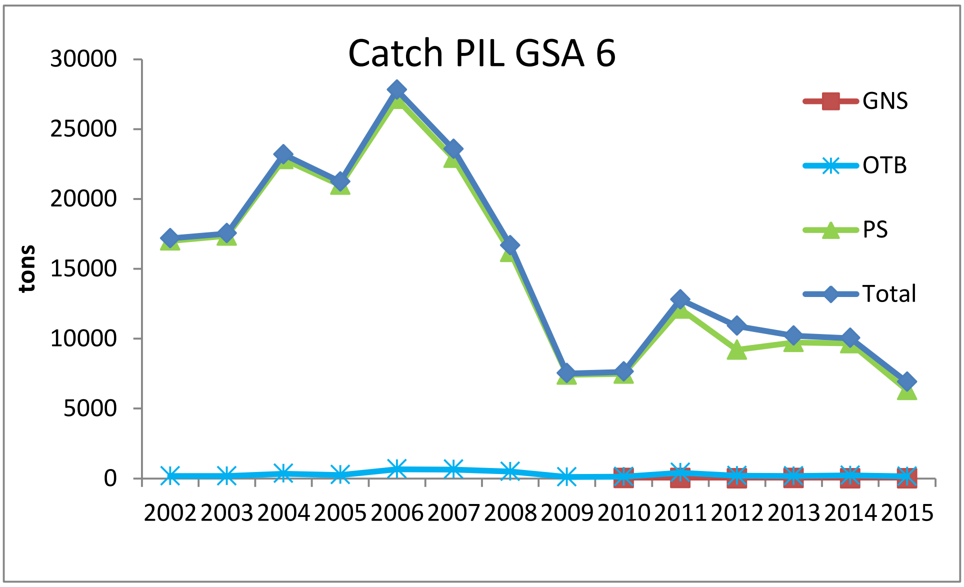


Figure 6.2.2.1. Sardine in GSA 6. Landings/fishing gear/year (in tons).

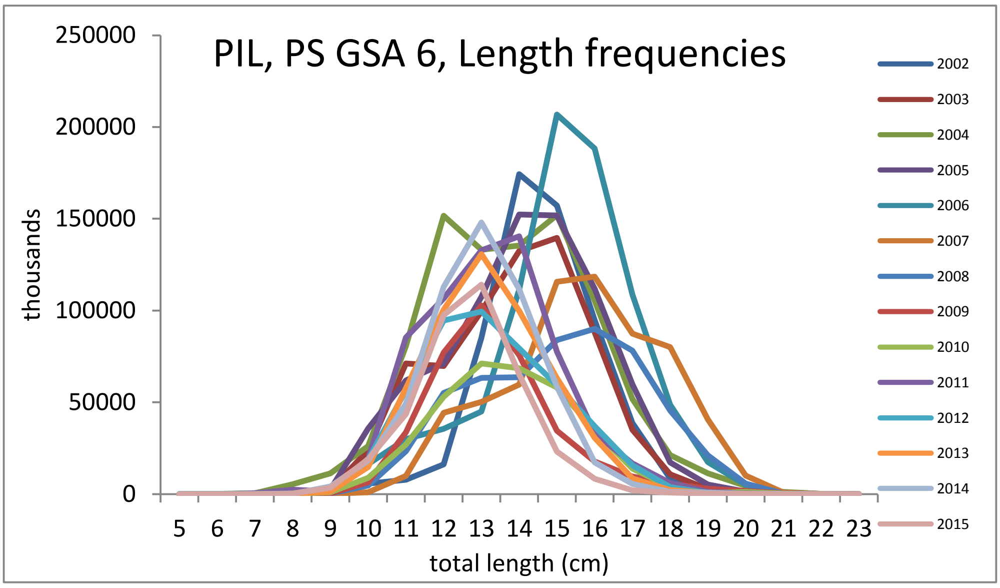


Figure 6.2.2.2. Sardine in GSA 6. Landings /year/size structure.

Table 6.2.2.3. Sardine in GSA 6. Landings /year/age structure

Age/year	0	1	2	3	4	5	6	7
2002	110357	399539	65009	12519	1989	331	0	0
2003	215131	384115	59922	12987	3775	664	7	0
2004	306081	470162	77497	21871	13625	2077	131	0
2005	338376	287683	127139	21525	3084	1160	0	0
2006	129262	355651	241042	73699	14065	1042	0	0
2007	109821	198232	165099	100084	38697	5722	546	0
2008	133899	255378	106594	35972	2951	42	0	0
2009	183806	160658	17614	5423	816	64	0	0
2010	100226	229452	9752	1676	982	176	24	0
2011	404484	191607	25599	1436	137	104	49	4
2012	170241	286247	10387	1364	266	12	1	0
2013	97253	297512	108476	5844	794	0	0	0
2014	94412	335423	89136	8360	103	0	0	0
2015	144199	199296	33157	586	0	0	0	0

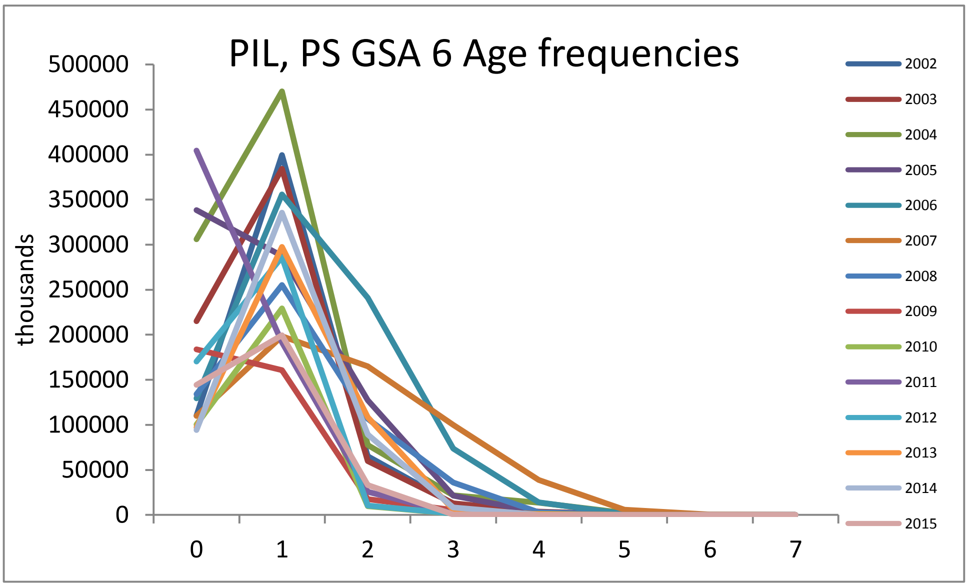


Figure 6.2.2.3. Sardine in GSA 6. Landings /year/age structure

Discards

Small amount of discards were reported in some years for OTB fleet from 2005 to 2015 (Tables 6.2.2.4 and 6.2.2.5). No data available on discards size and age structure.

Table 6.2.2.4. Sardine in GSA 6. Total discards/year. Data are in tons.

Year	Total Catch	Discards OTB
2002	17168	-
2003	17523	-
2004	23172	-
2005	21230	0.3
2006	27800	0
2007	23552	0
2008	16672	1.4
2009	7507	0.2
2010	7627	0.04
2011	12795	227
2012	10902	1506
2013	10210	281
2014	10035	158
2015	6891	442

Table 6.2.2.5. Sardine in GSA 6. Discards/fishing gear/year. Data are in tons.

Year	OTB	Discards OTB
2002	170	-
2003	163	-
2004	338	-
2005	247	0.3
2006	655	0

2007	641	0
2008	485	1.4
2009	101	0.2
2010	126	0.04
2011	402	226.8
2012	192	1506
2013	168	281
2014	209	158
2015	138	442

6.2.3. Fishing effort data.

Data of fishing effort were available to EWG 16-13 in GSA 6 for the period 2004-2015.

Fishing effort

Fishing effort data were related to Purse Seine vessels that represents more than 97% of the sardine landings. During the period from 2004 to 2016, the number of vessels has been decreasing whereas the fishing effort has maintained more constant.

Table 6.2.3.1. Sardine in GSA 6. Purse Seine fishing effort (GT*days at sea)/year, Days at sea and No vessels

Year	GT x days at sea (000s)	Days at sea	No Vessels
2004	883666	20359	239
2005	762916	17345	222
2006	810575	17243	200
2007	445303	11031	125
2008	754749	16643	173
2009	813051	17563	153
2010	794731	16985	151
2011	830778	17831	155
2012	796035	17339	144
2013	846342	18956	140

2014	873989	19556	138
2015	808241	17589	133

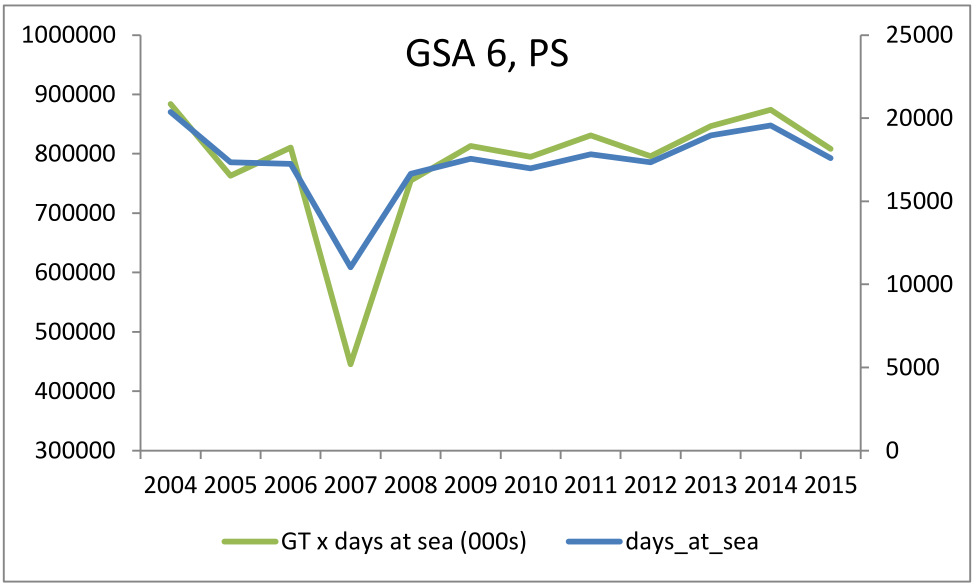


Figure 6.2.3.1. Sardine in GSA 6. Purse Seine fishing effort (GT*days at sea) and Days at sea/year.

6.2.4. Survey Indices of abundance and biomass by year and size/age

ECOMED and MEDIAS acoustic surveys allow the estimation of abundance and biomass indices in GSA 6. ECOMED data were available for the period 2003-2008, and MEDIAS data were available for 2009-2015. ECOMED and MEDIAS surveys were conducted at different time of the year, in November-December and in early summer, respectively.

Abundance and biomass indices are oscillating during this period with a no clear trend, being the minimum of the series in 2008 for ECOMED survey and in 2014 for MEDIAS survey (Table 6.2.4.1, Fig. 6.2.4.1 for abundance and Table 6.2.4.2, Fig. 6.2.4.3 for biomass).

Length and age distributions are different due to these different sampling seasons. MEDIAS abundance distributions are conducted in the recruitment period and concentrates smallest individuals on the distribution (Table 6.2.4.2 and Figs. 6.2.4.2, 6.2.4.3). The same pattern can be observed in biomass indices distribution by size and age (Table 6.2.4.4 and Figs. 6.2.4.5 and 6.2.4.6). Data from ECOMED and MEDIAS were used for XSA tuning.

Table 6.2.4.1. Sardine in GSA 6. Survey abundance index/year.

Survey	Year	Abundance (thousands)
ECOMED	2003	4112067
ECOMED	2004	2177170
ECOMED	2005	2008591
ECOMED	2006	1995372
ECOMED	2007	750460
ECOMED	2008	459180
MEDIAS	2009	3696356
MEDIAS	2010	2180164
MEDIAS	2011	4323010
MEDIAS	2012	5944598
MEDIAS	2013	6650900
MEDIAS	2014	789294
MEDIAS	2015	3658412

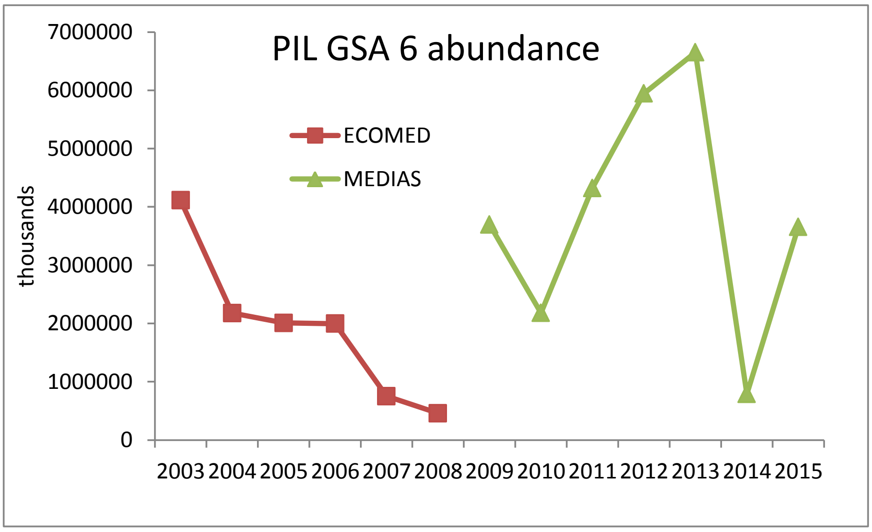
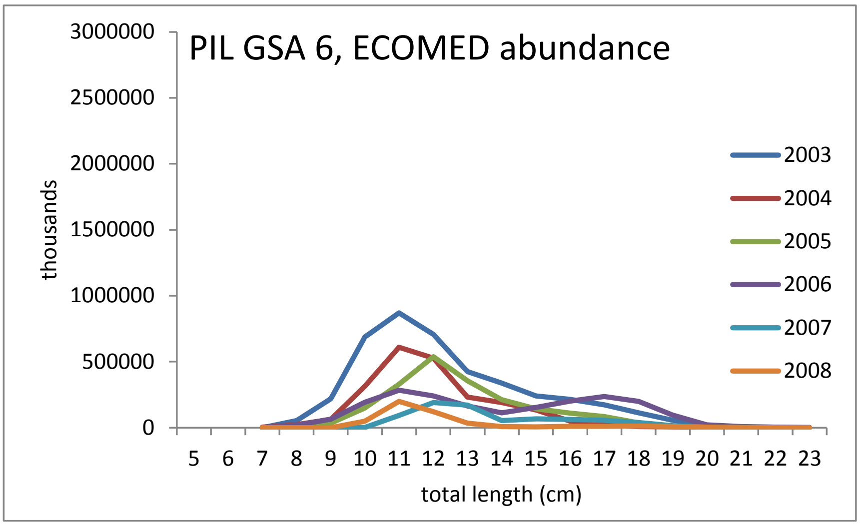


Figure 6.2.4.1. Sardine in GSA 6. Survey abundance index/year.



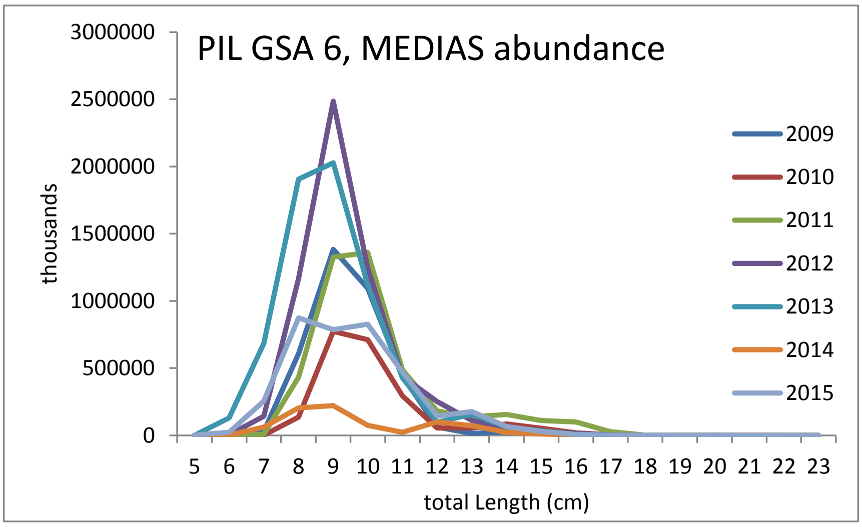
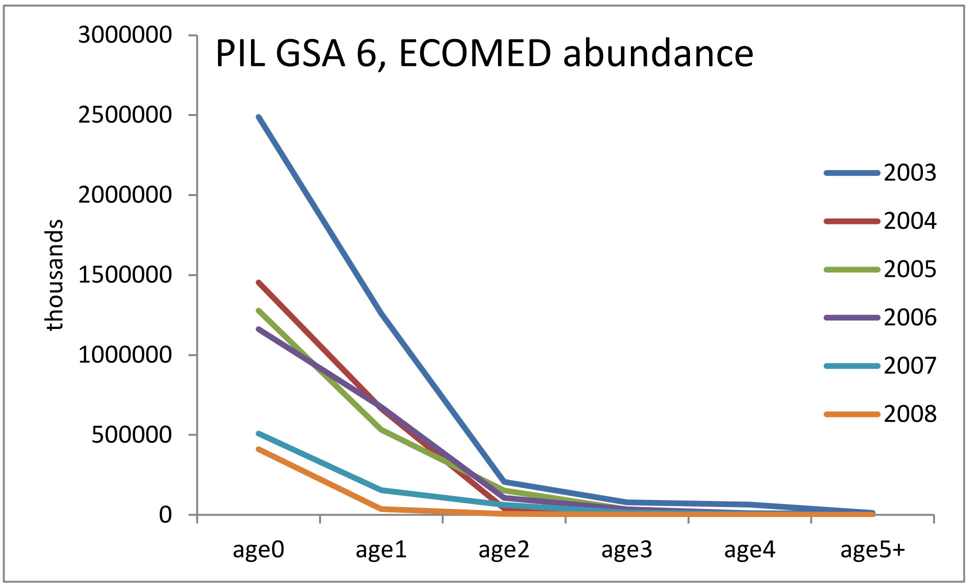


Figure 6.2.4.2. Sardine in GSA 6. ECOMED and MEDIAS abundance index/year/size structure.

Table 6.2.4.2. Sardine in GSA 6. ECOMED and MEDIAS abundance index/year/age structure. Numbers are in thousands.

Name survey	year	age0	age1	age2	age3	age4	age5	age6	age7
ECOMED	2003	2489245	1259398	206650	79375	64396	13003	0	0
ECOMED	2004	1452950	665679	41285	7767	7812	1677	0	0
ECOMED	2005	1276577	533431	152533	34723	7415	3912	0	0
ECOMED	2006	1162345	674689	106773	34419	9700	2139	3672	1635
ECOMED	2007	508217	155257	62100	15067	6626	2001	489	702
ECOMED	2008	411195	37240	7071	2422	734	135	194	189
MEDIAS	2009	3622843	67341	5614	516	40	0	0	0
MEDIAS	2010	1925819	238062	14919	903	114	348	0	0
MEDIAS	2011	3817869	452391	49658	2972	120	0	0	0
MEDIAS	2012	5136729	729875	72323	5672	0	0	0	0
MEDIAS	2013	6237760	313753	79291	19121	975	0	0	0
MEDIAS	2014	510166	260377	17873	879	0	0	0	0
MEDIAS	2015	3089951	275404	266153	24207	2697	0	0	0



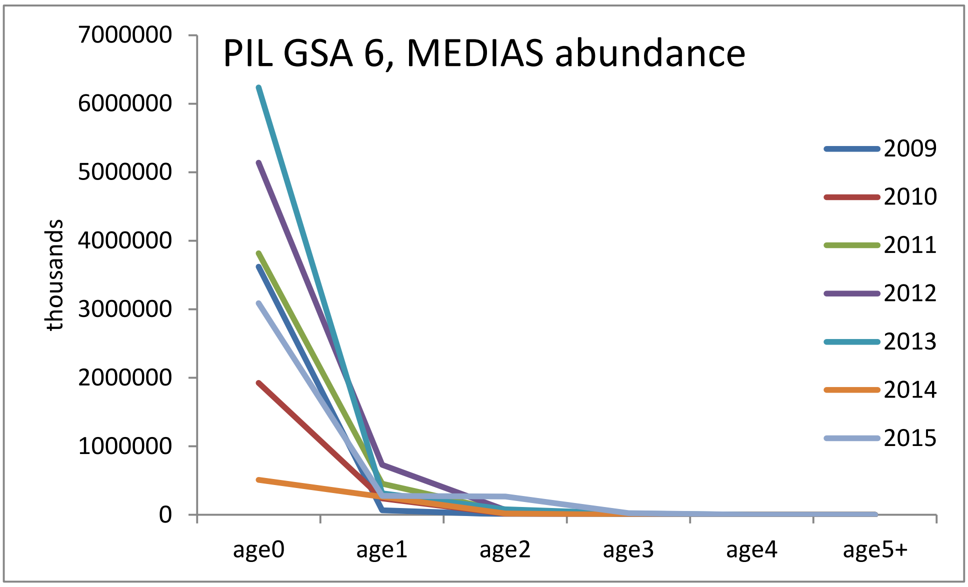


Figure 6.2.4.3. Sardine in GSA 6. ECOMED and MEDIAS abundance index/year/age structure. Ages are shown from 0 to 5+ group.

Table 6.2.4.3. Sardine in GSA 6. ECOMED and MEDIAS biomass index/year.

Survey	year	Biomass (tons)
ECOMED	2003	65679
ECOMED	2004	30997
ECOMED	2005	35277
ECOMED	2006	47114
ECOMED	2007	15298
ECOMED	2008	6518
MEDIAS	2009	26640
MEDIAS	2010	19022
MEDIAS	2011	31746
MEDIAS	2012	43296
MEDIAS	2013	41871
MEDIAS	2014	6215
MEDIAS	2015	25627

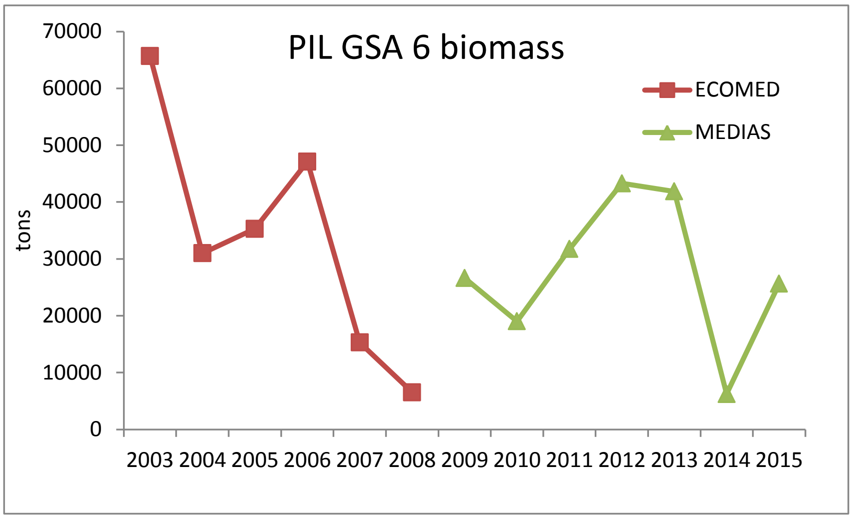


Figure 6.2.4.4. Sardine in GSA 6. ECOMED and MEDIAS biomass index/year.

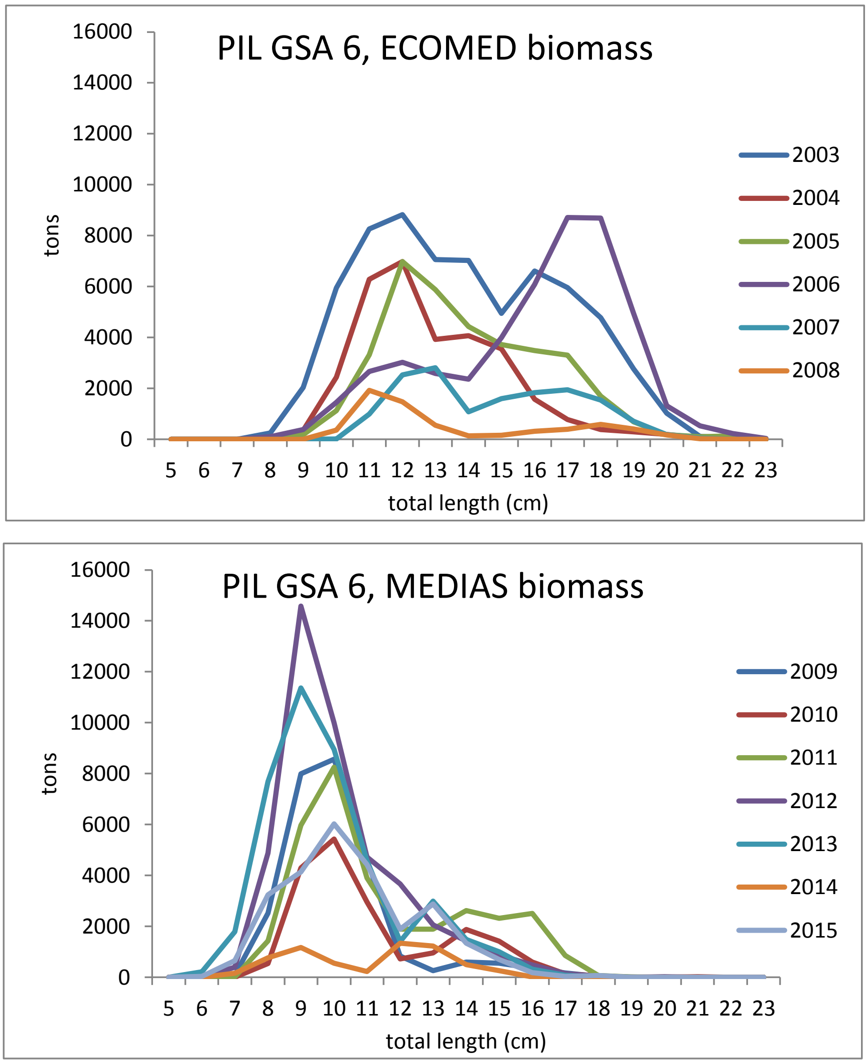
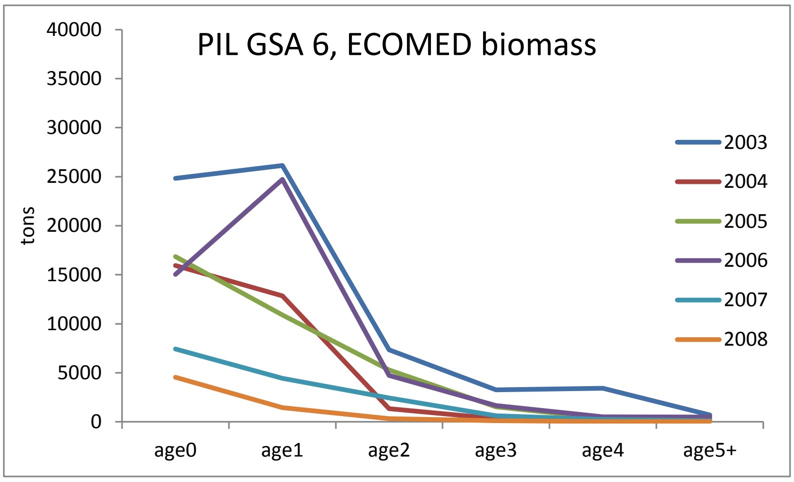


Figure 6.2.4.5. Sardine in GSA 6. ECOMED and MEDIAS, biomass index/year/size structure.

Table 6.2.4.4. Sardine in GSA 6. ECOMED and MEDIAS, biomass index/year/age structure. Data are in tons.

Name survey	year	age0	age1	age2	age3	age4	age5	age6	age7
ECOMED	2003	24829	26125	7341	3267	3427	690	0	0
ECOMED	2004	15927	12831	1334	330	466	109	0	0
ECOMED	2005	16851	10892	5287	1532	393	323	0	0
ECOMED	2006	15030	24715	4718	1649	511	148	239	104
ECOMED	2007	7425	4448	2430	613	259	75	15	33
ECOMED	2008	4556	1439	330	121	40	9	12	12
MEDIAS	2009	24654	1726	235	23	2	0	0	0
MEDIAS	2010	13539	4984	434	34	4	27	0	0
MEDIAS	2011	22037	8447	1171	85	5	0	0	0
MEDIAS	2012	31294	9957	1819	226	0	0	0	0
MEDIAS	2013	34858	5115	1514	365	19	0	0	0
MEDIAS	2014	3200	2694	307	15	0	0	0	0
MEDIAS	2015	17644	3878	3714	354	38	0	0	0



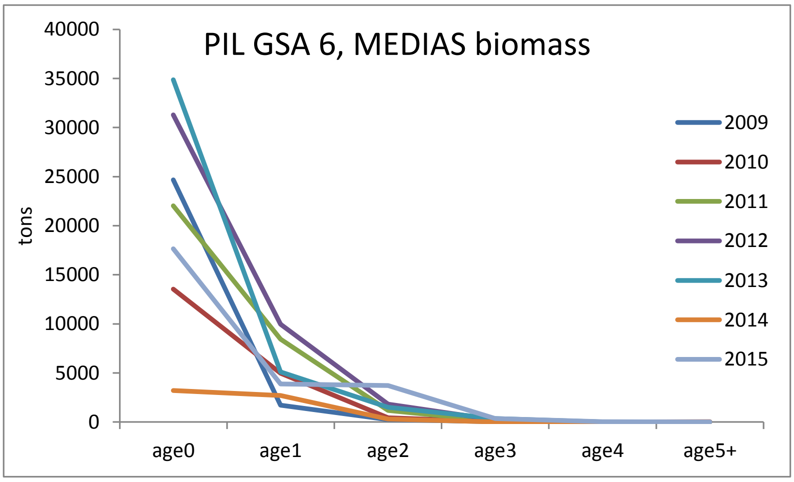


Figure 6.2.4.6. Sardine in GSA 6. ECOMED and MEDIAS, biomass index/year/age structure.

6.3. DATA GATHERING OF EUROPEAN ANCHOVY IN GSA 7

6.3.1. Stock Identity and Biology

The assessment covers the entire GSA 7 area corresponding to the Gulf of Lions. However, the Gulf of Lions may not correspond to a single stock unit. Hydrological exchanges between the Gulf of Lions and the Catalan Sea for instance are well known, which should at least affect larval transport (Ospina-Alvarez *et al.* 2013) and then recruitment of juvenile anchovy in both areas. Similarly, part of the young recruited in the Gulf of Lions anchovy population may come from larval transport from spawners of the Ligurian Sea. However, due to a lack of specific information about the stock structure of the anchovy population in the western Mediterranean, this stock was assumed to be confined within the GSA 7 boundaries in this assessment.

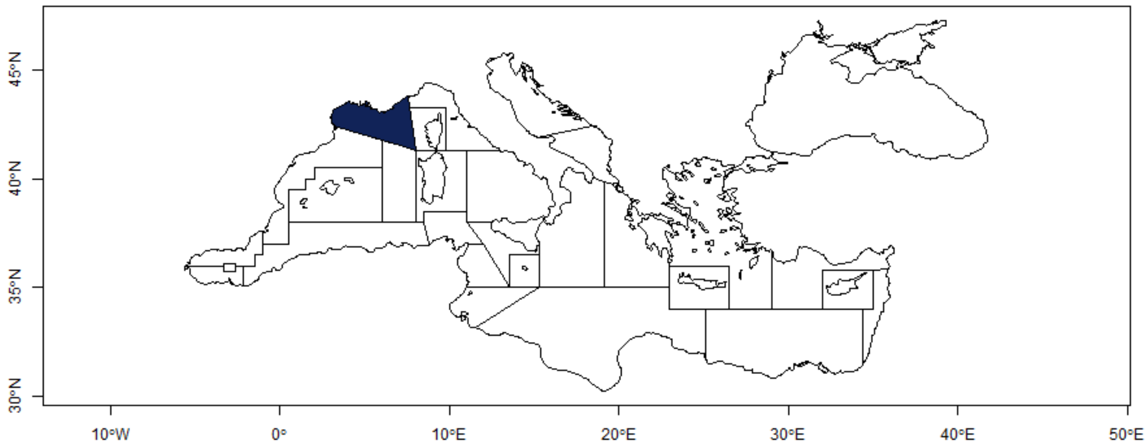


Figure 6.3.1.1. Geographical location of GSA 7.

Growth

Growth parameters are those used in the GFCM assessment done in 2014 evaluated from PELMED survey data on the 2008-2013 period (Linf = 16.02, k = 0.58, t0 =-1.38).

Maturity

Maturity ogives were taken from DCF data.

Table 6.3.1.1. European Anchovy in GSA 7. Proportion of mature fish by age and sex.

Age	Male	Female	Mean
0	0.41	0.37	0.39
1	0.65	0.69	0.67
2	0.84	0.89	0.86
3	0.93	0.97	0.95
4	0.97	0.99	0.98

Natural mortality

Natural mortality was estimated using Gislason (2010) and is shown in Table 6.3.1.3.1. The input parameters used were L_{inf} = 16.02, k = 0.58, t_0 =-1.38.

Table 6.3.1.2. European Anchovy in GSA 7. Natural mortality.

Age	M
0	1.24
1	0.90
2	0.77
3	0.71
4	0.68

6.4.2. Catch data

Landings and discards by fleet are described in the following sections 6.3.2.2 and 6.3.2.3.

General description of the fisheries

The number of French pelagic trawlers strongly decreased a few years ago. Only 1 of the French pelagic trawler targets small pelagics all year round, the others alternate between small pelagics and demersal species. As a consequence, the total catches remained low in 2015. They have been fluctuating around 2000 t for the last 5 years. Most regulations (no fishing activity during the week-end, length of trawlers, etc.) are fully respected, with the exception of the limitation of engine power for trawlers.

Landings

Landings data were reported to STECF EWG 16-13 through the DCF. In GSA 7 the landings come from French bottom trawls, French mid-water trawls, Spanish bottom trawls and Spanish purse seines. The bulk of the landings come from the French mid-water trawls. Landings data are presented in the following tables and figures.

Table 6.4.2.1. European Anchovy in GSA 7. Landings in tonnes by year and fishing gear.

Year	ESP_OTB	ESP_PS	FRA_OTB	FRA_OTM	Total
2002	82.1	754.1	-	6941.3	7777.4
2003	94.3	714.4	-	6253.5	7062.2
2004	69.6	950.8	-	4497.1	5517.5
2005	5.0	522.0	-	2238.9	2765.8
2006	6.7	188.5	-	2124.8	2319.9
2007	16.2	234.6	-	4133.3	4384.1
2008	17.1	212.3	-	4003.0	4232.5
2009	2.3	17.5	-	2459.9	2479.6
2010	2.7	4.1	-	2306.5	2313.3
2011	6.2	297.5	-	1600.0	1903.8
2012	4.0	35.2	-	1537.5	1576.7
2013	2.0	47.8	-	2434.1	2483.9
2014	2.0	-	-	2232.8	2234.8
2015	9.5	-	305.6	793.3	1108.4

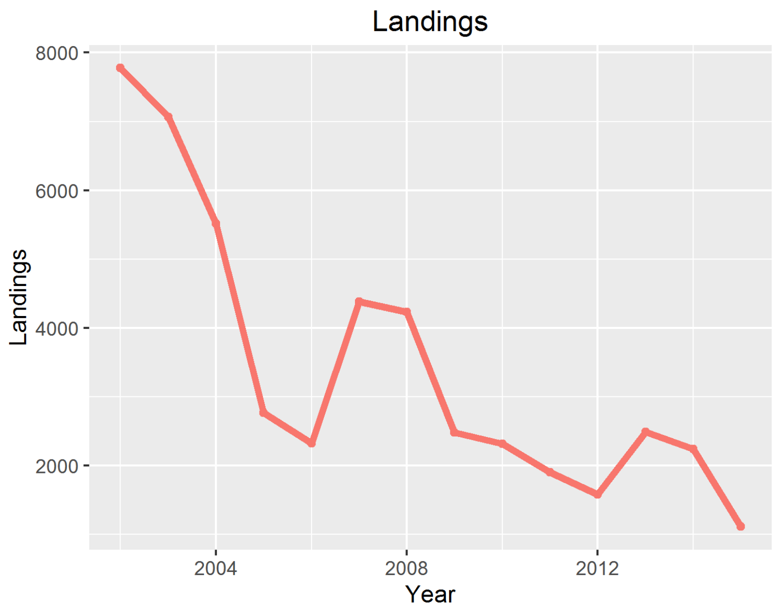


Figure 6.4.2.1. European Anchovy in GSA 7. Landings data in tonnes.

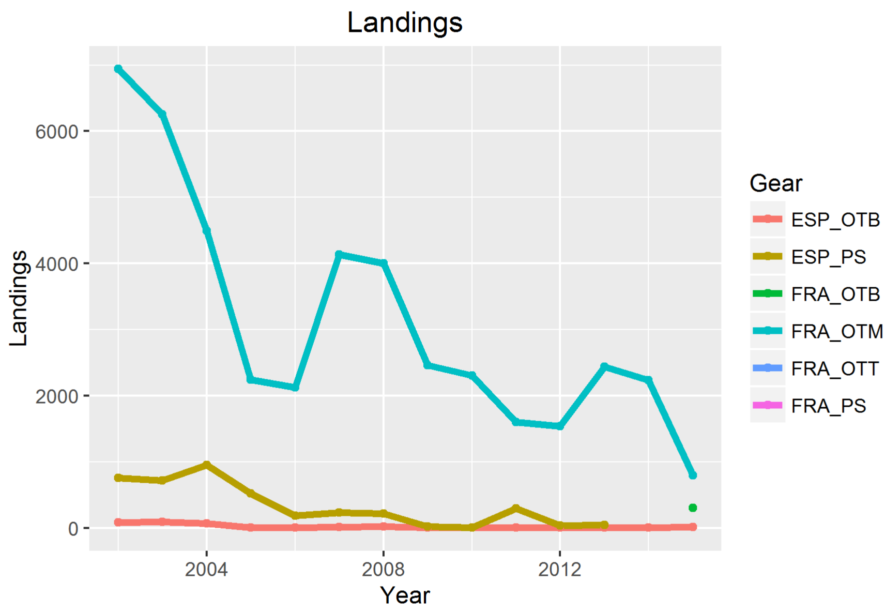


Figure 6.4.2.2. European Anchovy in GSA 7. Landings data in tonnes by fishing gear.

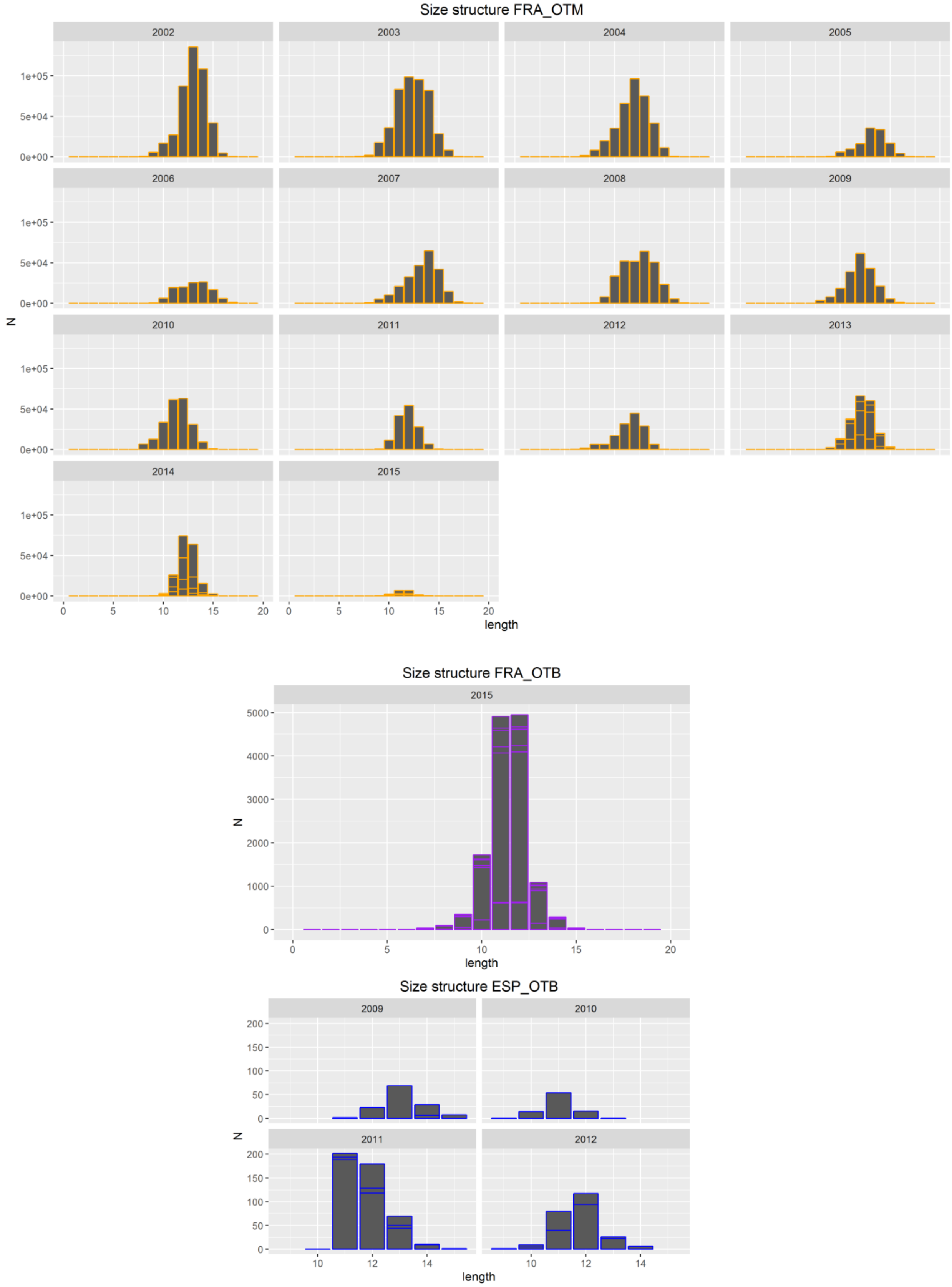


Figure 6.4.2.3. European Anchovy in GSA 7. Size structure of the landings data by fishing gear.

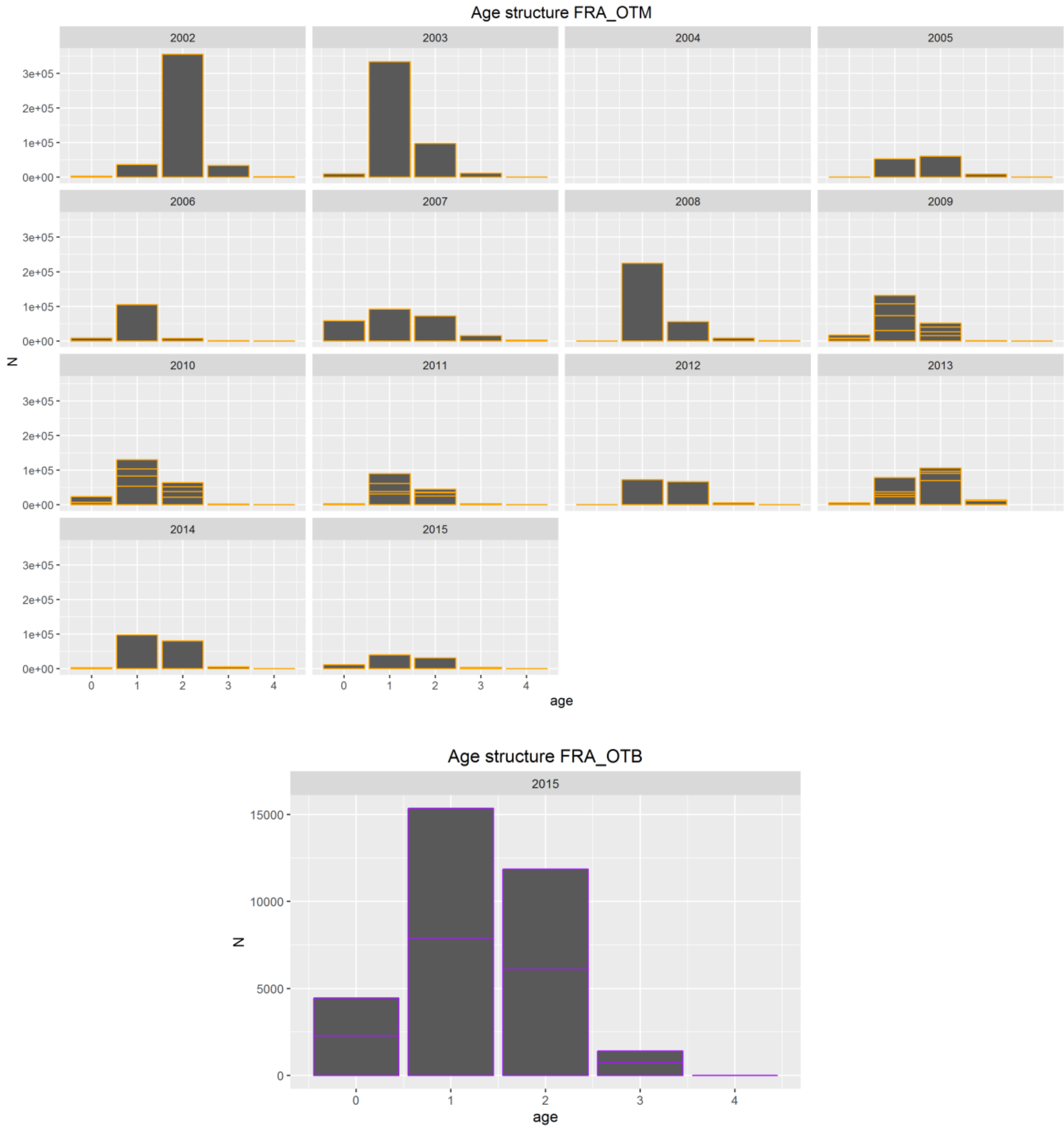


Figure 6.4.2.4. European Anchovy in GSA 7. Age structure of the landings data by fishing gear.

No landings have been reported for Spanish purse seines in 2014-2015, for French bottom trawls in 2002-2014, for French purse seines for all year and for French twin trawl for all years.

Size structure of the landings is missing for all the years for the Spanish purse seines and for 2002-2008 and 2013-2015 for the Spanish bottom trawls.

Age structure of the landings is missing for all the years of the Spanish gears and for 2004 for the French mid-water trawls.

An additional source of data is the reconstructed time series of Landings of anchovy in GSA 7 performed by IFRMER and kindly provided by C. Saraux. The time series is the longest available in the Mediterranean as it starts in 1860 and ends in 2014 and puts the historical exploitation of this stock in the right temporal context. The last part of the series is overlapped with the DCF time series and some discrepancies are evident while the overall pattern is similar (Figure 6.4.2.5).

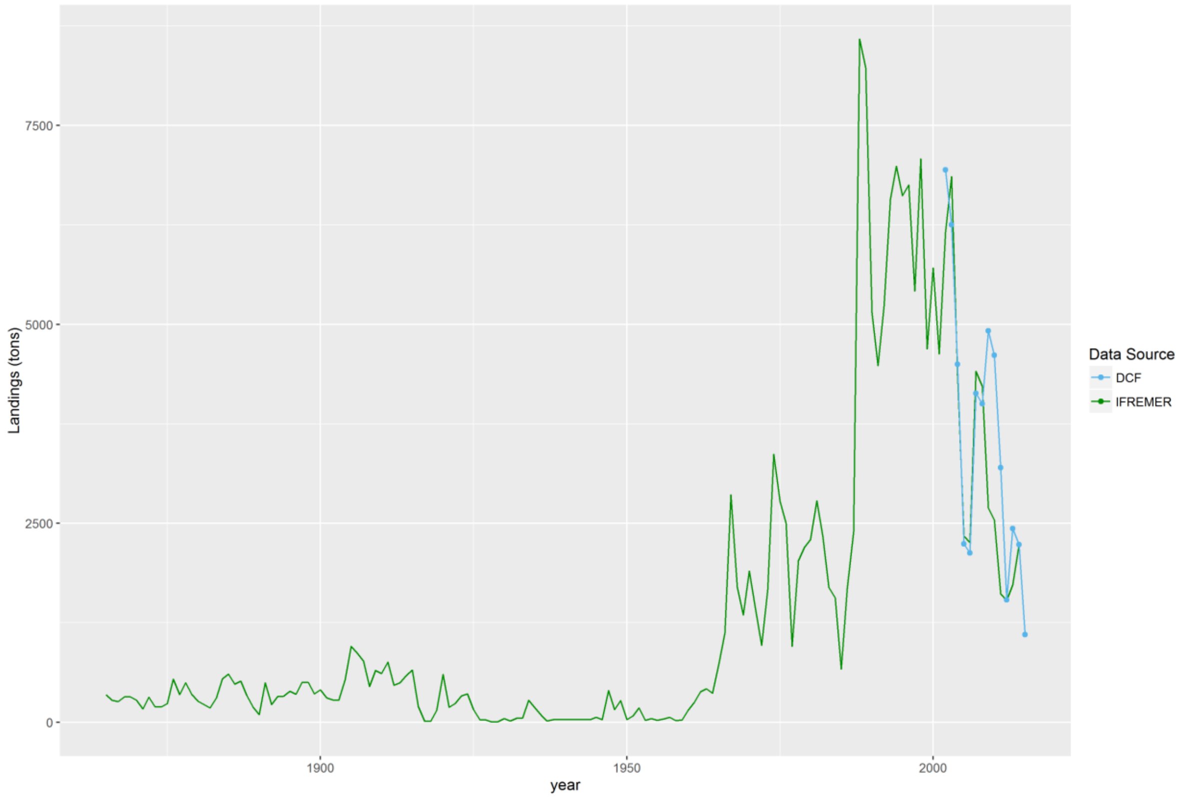


Figure 6.4.2.5 European Anchovy in GSA 7. Historical landings according to the reconstruction performed by IFREMER and compared with DCF.

Discards

Discards data were reported to STECF EWG 16-13 through the DCF. Discards for GSA 7 were present for all the years except for 2002 and 2004. They were negligible or considered unreliable thus they were not included in the stock assessment. Discards data are presented in the following tables and figures.

Table 6.4.2.2. European Anchovy in GSA 7. Discards in tonnes by year and fishing gear.

Year	ESP_OTB	ESP_PS	FRA_OTB	FRA_OTM	Total
2002	-	-	-	-	-
2003	-	-	1.57	-	1.57
2004	-	-	-	-	-
2005	0	-	0.49	-	0.49
2006	-	-	1.97	-	1.97
2007	-	-	0.42	0.28	0.7
2008	0.01	-	-	0.23	0.24
2009	0	-	-	-	0
2010	0	0	-	-	0
2011	15.66	-	-	-	15.66
2012	45	-	-	-	45
2013	1.4	-	-	-	1.4
2014	3.53	-	-	0	3.53
2015	0	-	0	0	0

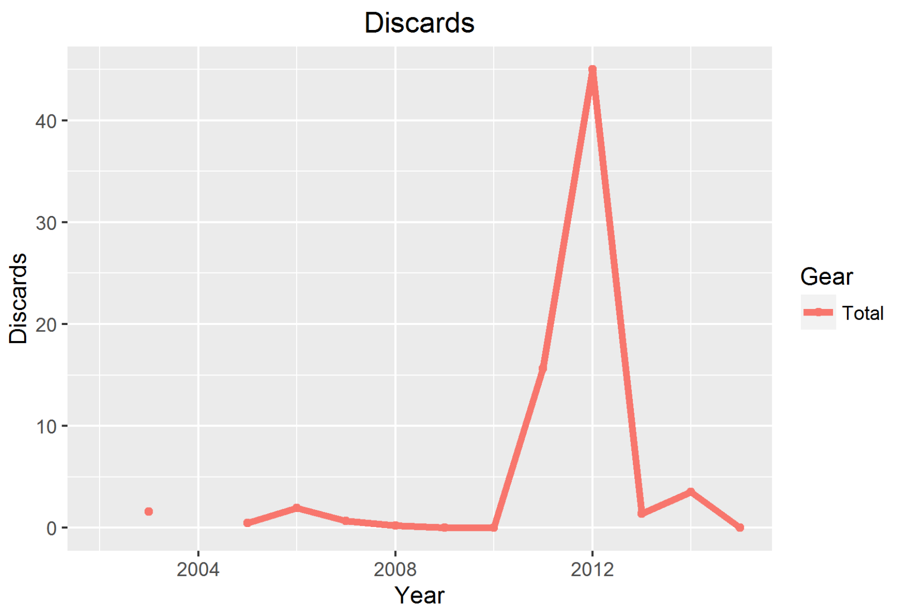


Figure 6.4.2.6. European Anchovy in GSA 7. Discards data in tonnes.

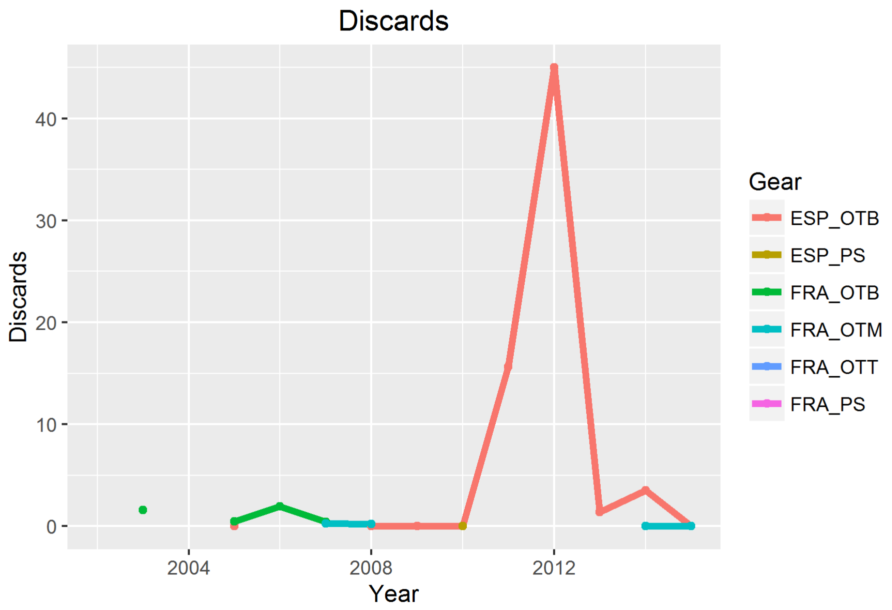
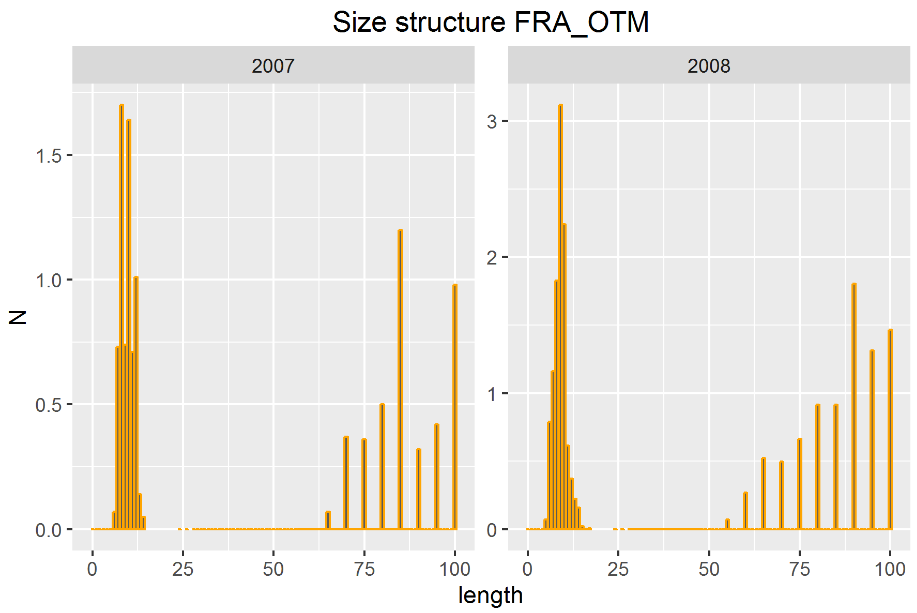


Figure 6.4.2.7. European Anchovy in GSA 7. Discards data in tonnes by fishing gear.



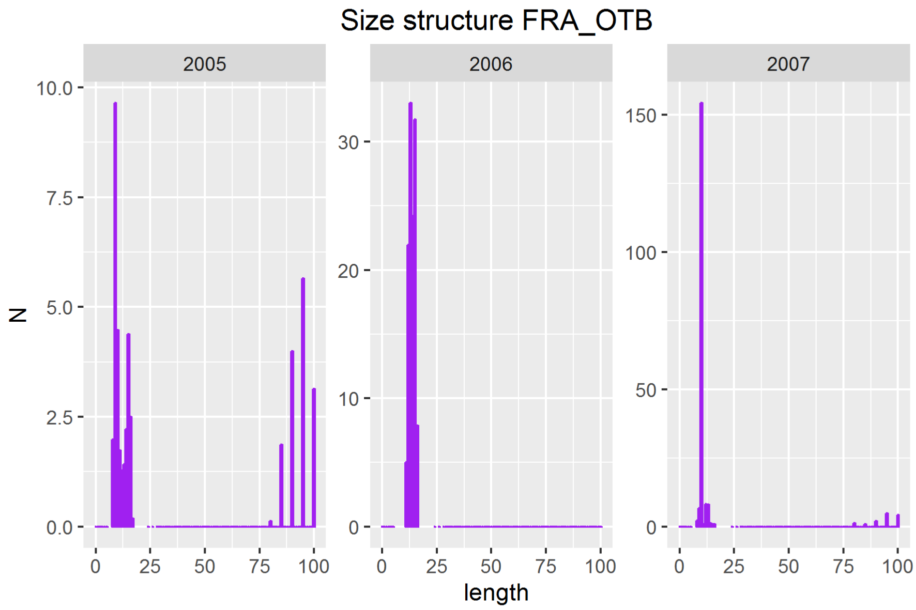


Figure 6.4.2.8. European Anchovy in GSA 7. Size structure of the discards data by fishing gear.

No discards have been reported for Spanish purse seines except for 2010, for Spanish bottom trawls except for 2005, 2008-2015, for French mid-water trawls except for 2007-2008, 2014-2015, for French bottom trawls except for 2003, 2005-2007, for French purse seines for all year and for French twin trawl for all years.

Size structure of the discards is missing for all the years for all the Spanish gears and for all the years except for 2007-2008 for the French mid-water trawls and for all the years except for 2005-207 for the French bottom trawls.

The size structure of the discards presents obvious mistakes showing individual lengths bigger than 50 cm.

Age structure of the discards is missing for all the years and gears.

6.4.3. Fishing effort data

Fishing effort data were reported to STECF EWG 16-13 through DCF. Fishing effort for GSA 7 was present for all the years except for 2002 and 2003. Fishing effort data are presented in the following tables and figures.

Table 6.4.3.1. European Anchovy in GSA 7. Fishing effort in GT*Days at sea by year and fishing gear.

Year	ESP_OTB	ESP_PS	FRA_OTB	FRA_OTM	FRA_OTT	FRA_PS	Total
2004	322841.0	33436.4	-	-	-	-	356277.4
2005	308926.1	23558.7	-	-	-	-	332484.8
2006	308266.3	10879.0	-	-	-	-	319145.3
2007	316487.7	13247.1	-	-	-	-	329734.8
2008	322027.2	8173.6	-	-	-	-	330200.8
2009	313450.4	4068.5	-	-	-	-	317518.9
2010	275498.4	108.8	-	-	-	-	275607.2
2011	310191.5	7457.2	-	-	-	-	317648.6
2012	268788.5	652.1	-	-	-	-	269440.7
2013	248107.0	3418.1	-	-	-	-	251525.0
2014	268089.5	-	-	-	-	-	268089.5
2015	276489.9	33.1	949262.2	55063.3	78788.5	105784.5	1465421.5

Table 6.4.3.2. European Anchovy in GSA 7. Fishing effort in Days at sea by year and fishing gear.

Year	ESP_OTB	ESP_PS	FRA_OTB	FRA_OTM	FRA_OTT	FRA_PS	Total
2004	3714.0	755.0	-	-	-	-	4469.0
2005	3626.0	515.0	-	-	-	-	4141.0
2006	3550.0	247.0	-	-	-	-	3797.0
2007	3553.0	293.0	-	-	-	-	3846.0
2008	3694.0	184.0	-	-	-	-	3878.0
2009	3008.0	94.0	-	-	-	-	3102.0
2010	3097.0	4.0	-	-	-	-	3101.0
2011	3486.0	167.0	-	-	-	-	3653.0
2012	2966.0	15.0	-	-	-	-	2981.0
2013	2791.0	52.0	-	-	-	-	2843.0
2014	2966.0	-	-	-	-	-	2966.0

2015	3064.0	2.0	9939.3	386.4	736.2	883.4	15011.3

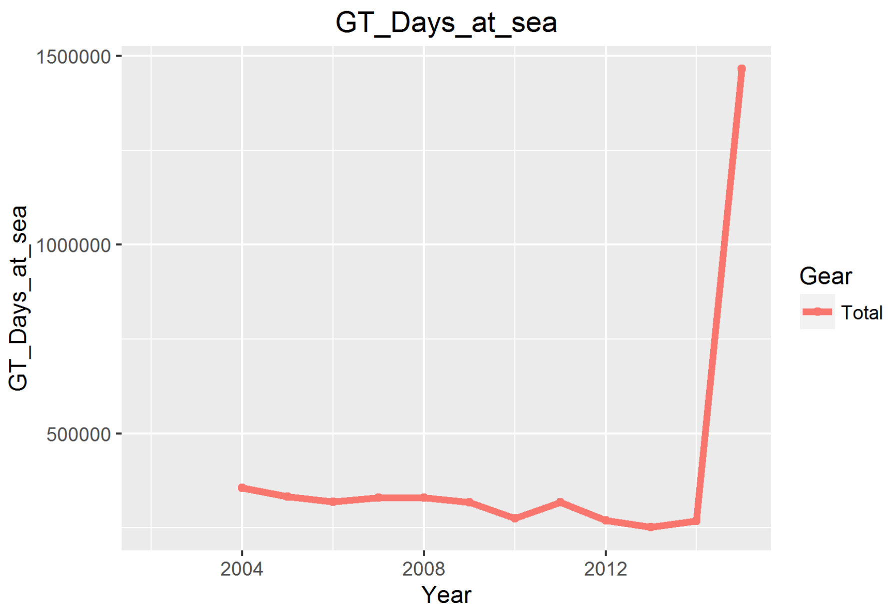


Figure 6.4.3.1. European Anchovy in GSA 7. Fishing effort data in GT*Days at sea.

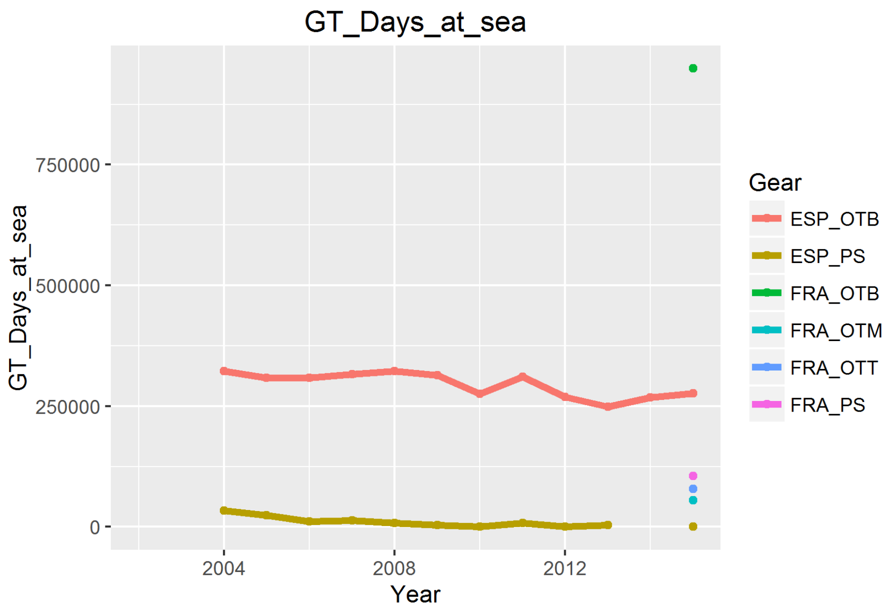


Figure 6.4.3.2. European Anchovy in GSA 7. Fishing effort data in GT*Days at sea by fishing gear.

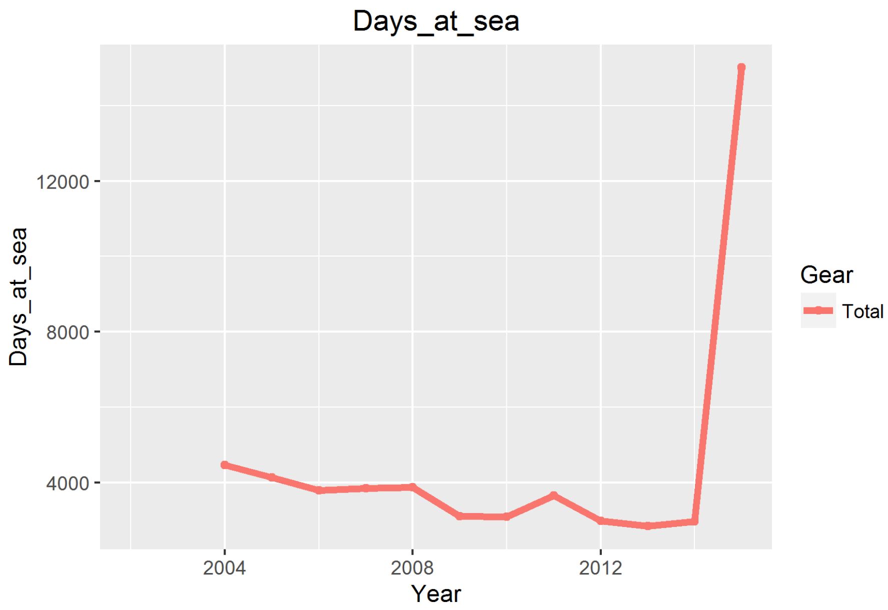


Figure 6.4.3.3. European Anchovy in GSA 7. Fishing effort data in Days at sea.

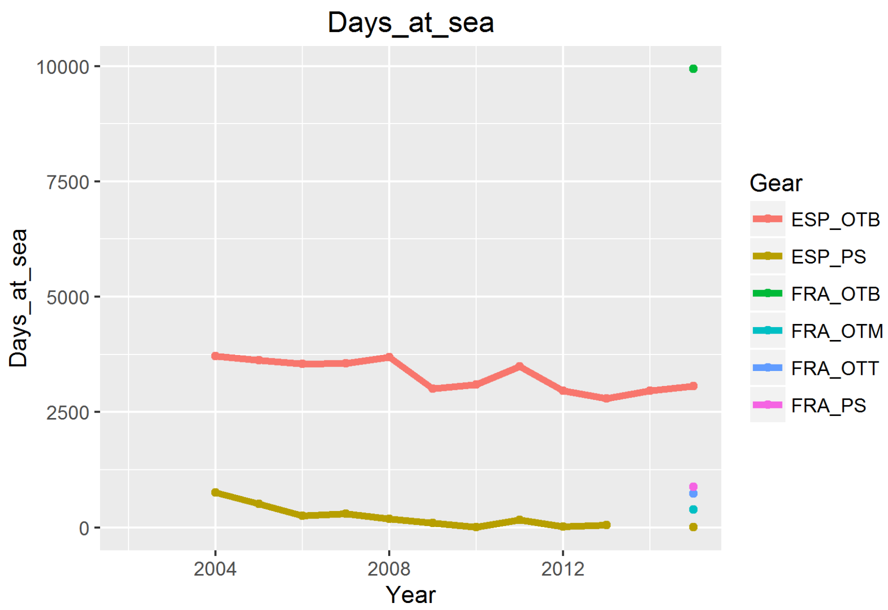


Figure 6.4.3.4. European Anchovy in GSA 7. Fishing effort data in Days at sea by fishing gear.

No Fishing effort has been reported for Spanish purse seines for 2014. France reported fishing effort just for 2015.

6.4.4. Survey Indices of abundance and biomass by year and size/age

Survey #1 (PELMED)

The scientific survey (PELMED) used is an acoustic and trawl-survey that has been conducted every July since 1993. It follows the Mediterranean Acoustic Survey (MEDIAS) protocol.

Methods

Sampling was performed along 9 parallel and regularly spaced transects (inter-transect distance = 12 nautical miles, see map below). Acoustic data were obtained by means of echo sounders (Simrad ER60) and recorded at constant speed of 8 $nm.h^{-1}$. The size of the elementary distance sampling unit (EDSU) is 1 nautical mile. Discrimination between species was done both by echo trace classification and trawls output (Simmons & MacLennan 2005). Indeed, each time a fish trace was observed for at least 2 nm on the echogram, the boat turned around to conduct a ≥30 min-trawl at 4 $nm.h^{-1}$ in order to evaluate the proportion of each species (by random sampling of the catch and sorting before counting and weighing per species). While all frequencies were visualized during sampling and helped deciding when to conduct a trawl, only the energies from the 38kHz channel were used to estimate fish biomass. Acoustic data were preliminary treated with Movies + software in order to perform bottom corrections and to attribute to each echo trace one of the 5 different echo types previously defined. Acoustic data analyses (stock estimation, length-weight relationships, etc.) were later performed using R scripts.

Geographical distribution

A recent study on spatial distribution of small pelagics in the Gulf has been published (Saraux et al. 2014). Below are the maps for Anchovy from this publication.

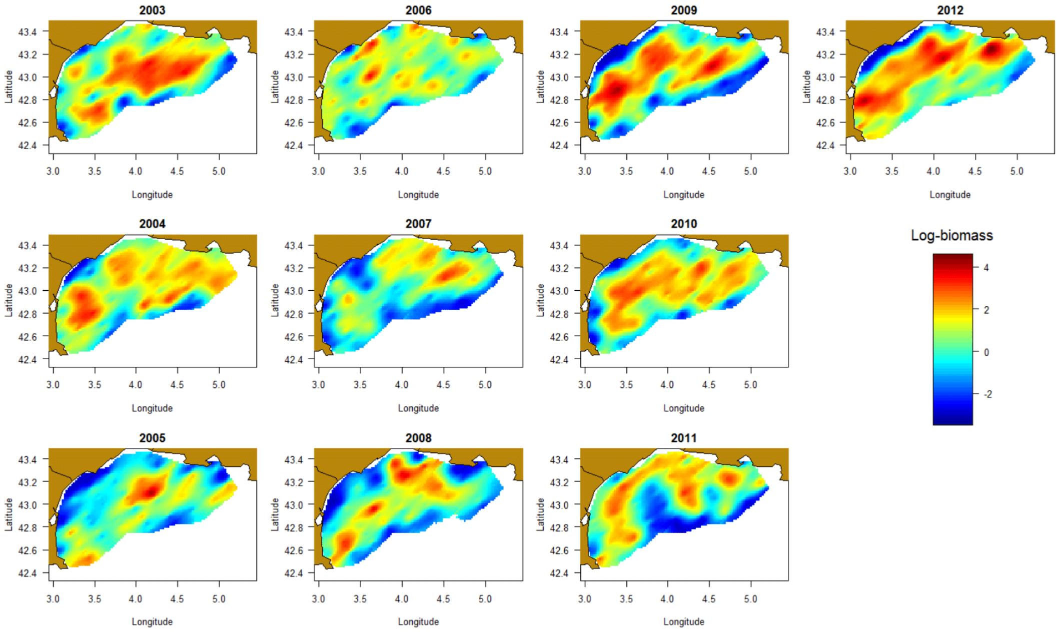


Figure 6.4.4.1. European Anchovy in GSA 7. Spatial distribution of anchovies from acoustic survey (from Saraux et al. 2014).

Trends in abundance and biomass

Abundance and biomass indexes were reported to STECF EWG 16-13 through DCF. European Anchovy time series of abundance and biomass indices from PELMED surveys are shown and described in the following figures.

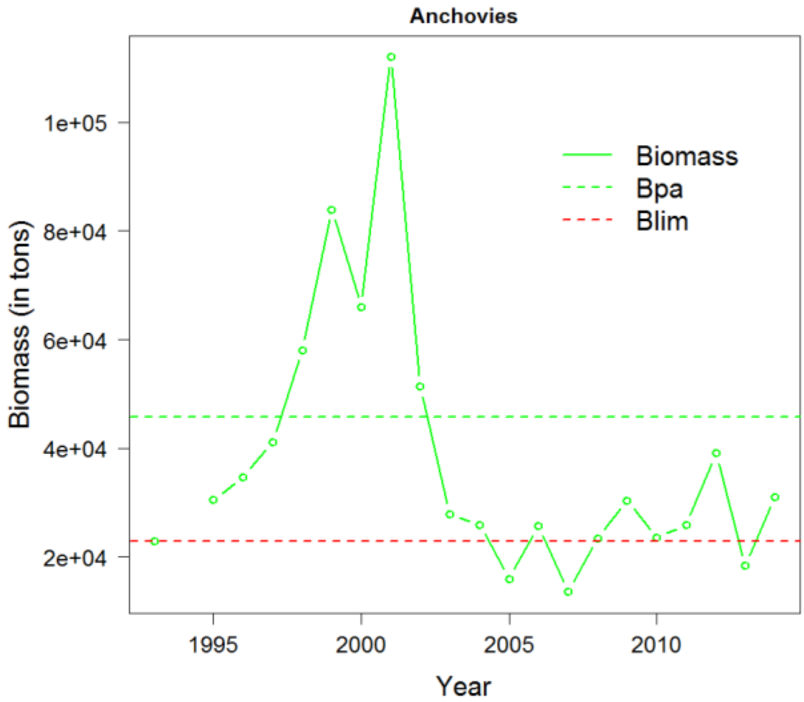


Figure 6.4.4.2. European Anchovy in GSA 7. Historical trends of biomass index estimated by direct acoustic method from PELMED survey (from the GFCM 2015 assessment).

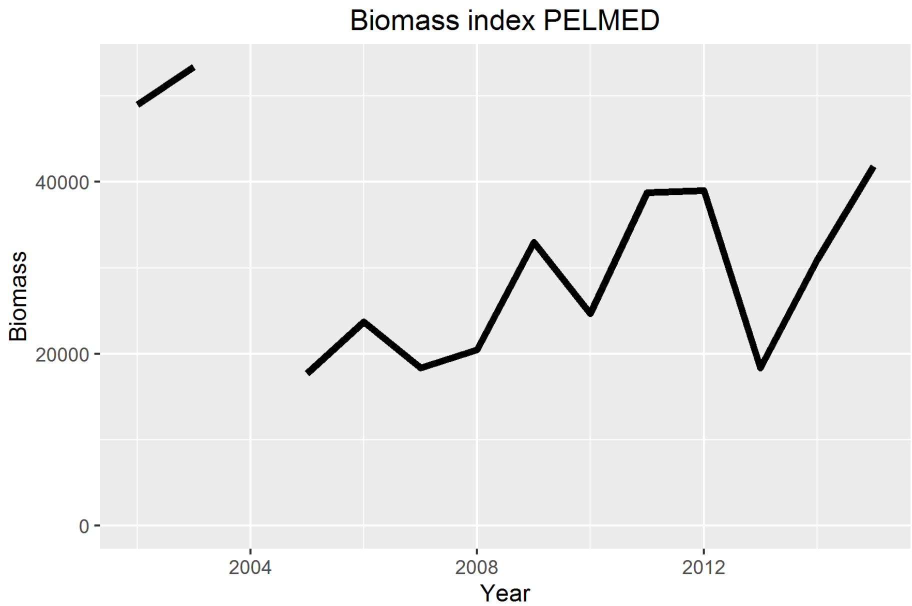


Figure 6.4.4.3. European Anchovy in GSA 7. Biomass index estimated by direct acoustic method from PELMED survey.

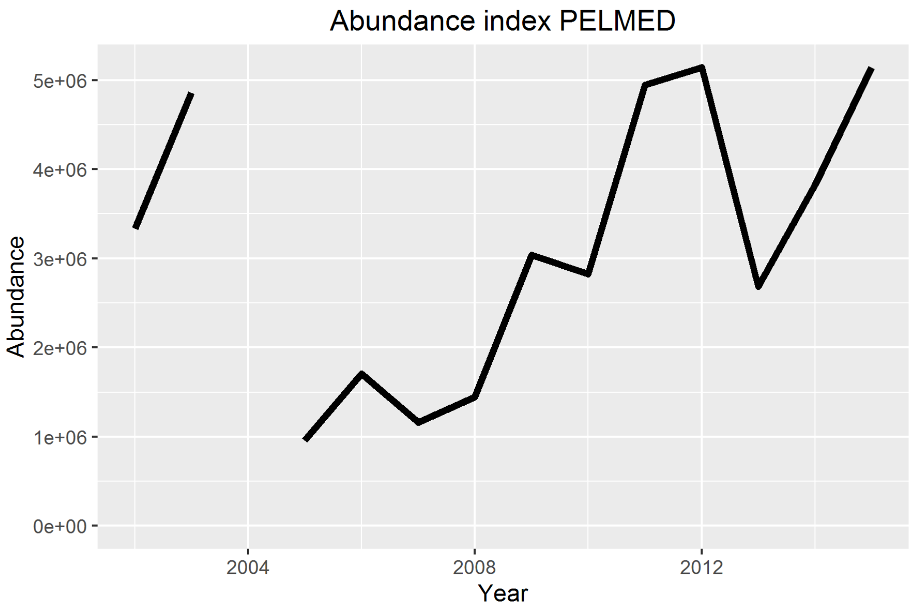


Figure 6.4.4.4. European Anchovy in GSA 7. Abundance index estimated by direct acoustic method from PELMED survey.

No data on biomass or abundance coming from PELMED survey have been reported for 2004 and before 2002. By comparing the biomass index reported through the DCF and the biomass index presented in GFCM in 2015 it is possible to notice some inconsistencies in the values of the time series especially at the beginning of the time series and in 2011.

In the last two years both the biomass and abundance index show an increasing trend.

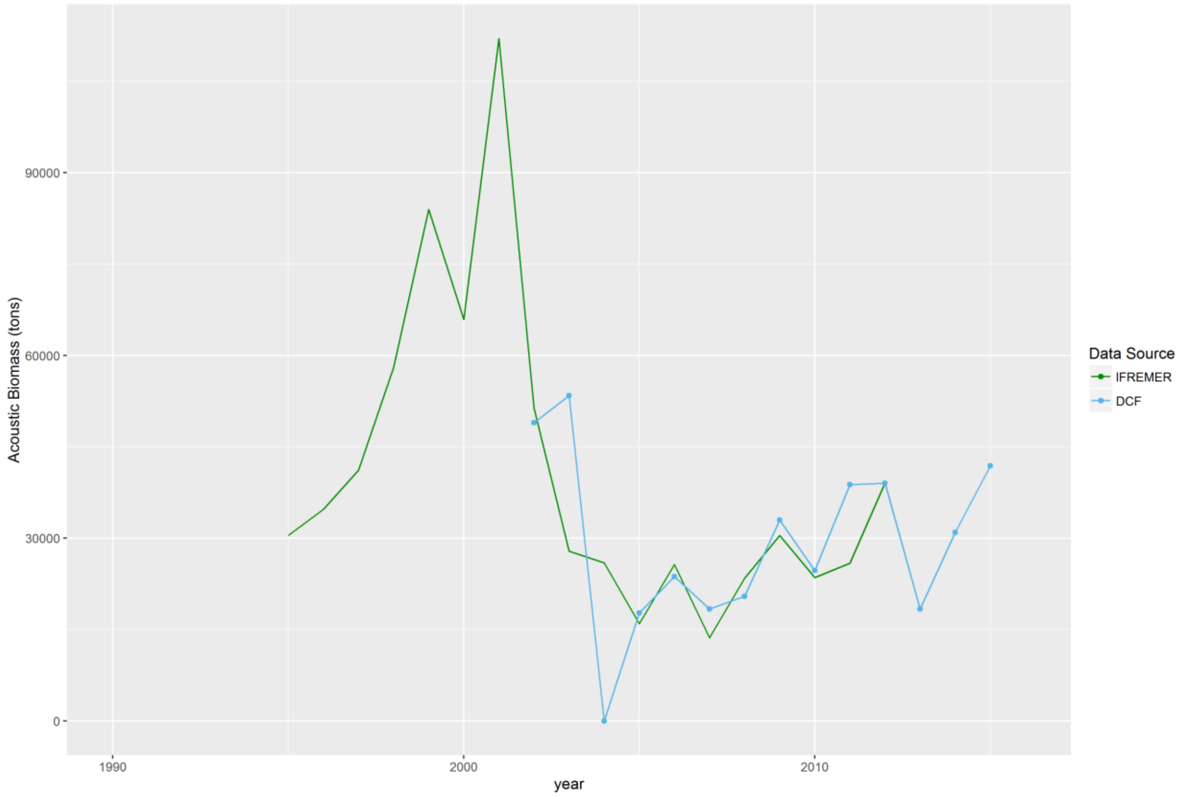


Figure 6.4.4.5. European Anchovy in GSA 7. Acoustic biomass index from DCF and IFREMER, used in the 2015 GFCM assessment.

Trends in abundance and biomass by length or age

Abundance and biomass indexes were reported to STECF EWG 16-13 through DCF. European Anchovy time series of abundance and biomass indices from PELMED surveys are shown and described in the following figures.

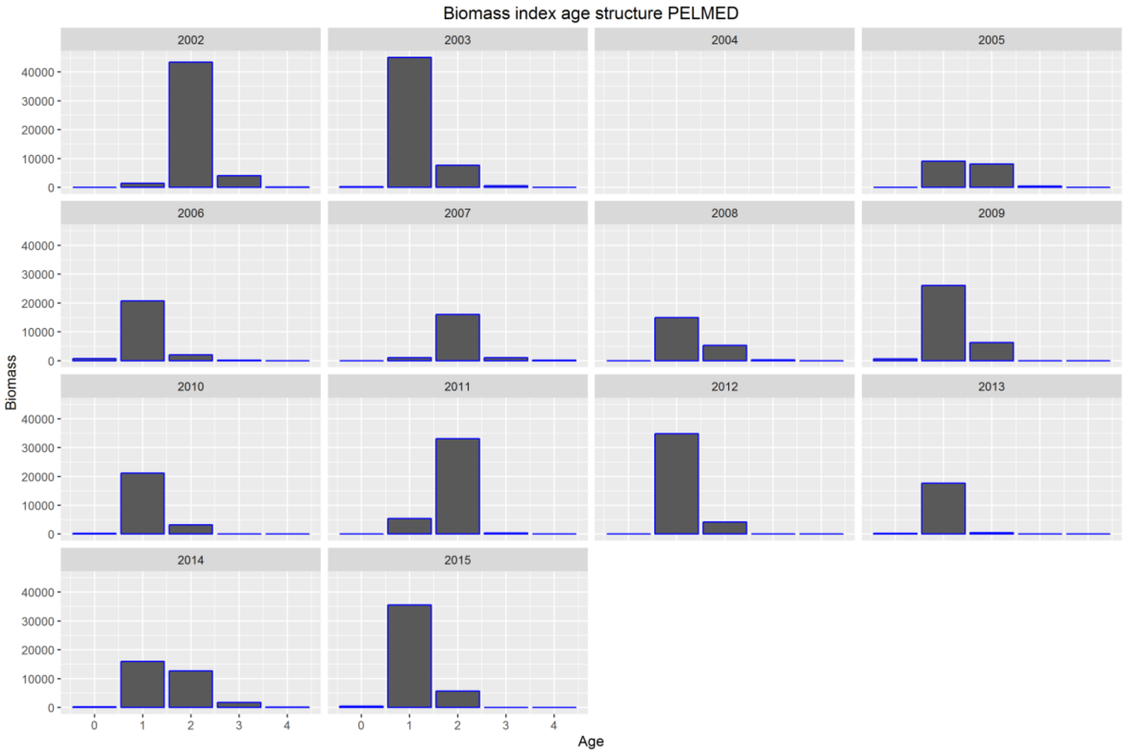


Figure 6.4.4.6. European Anchovy in GSA 7. Age structure of the Biomass index estimated by direct acoustic method from PELMED survey.

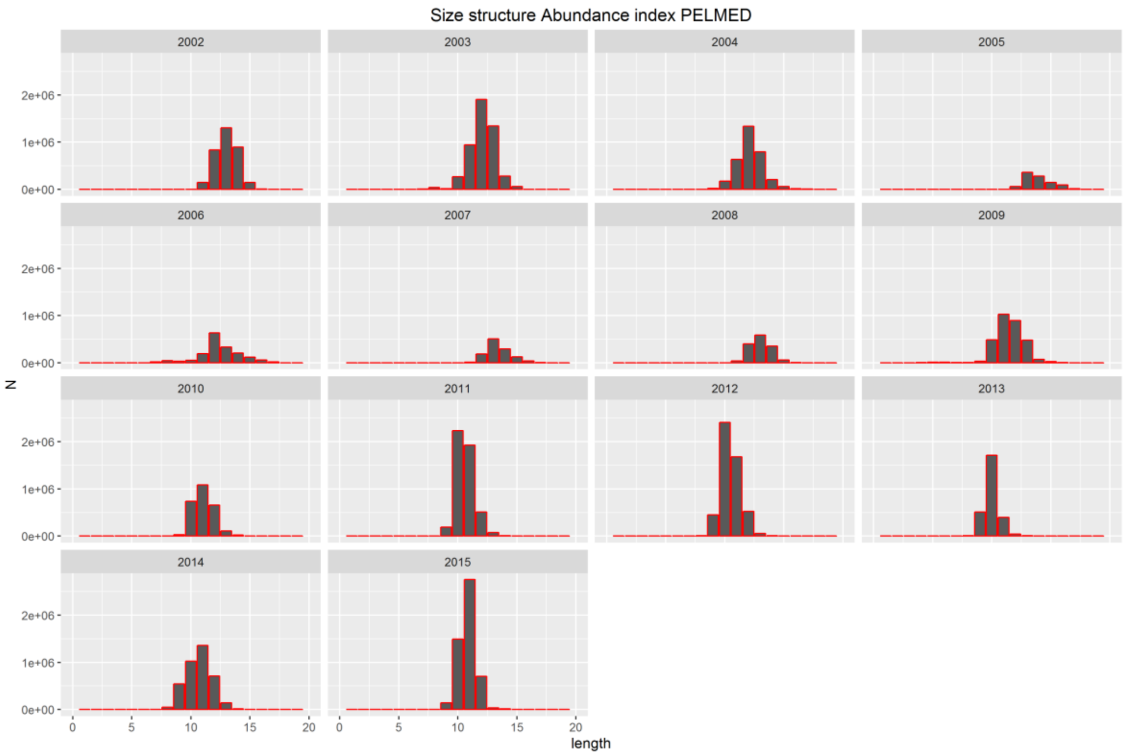


Figure 6.4.4.7. European Anchovy in GSA 7. Size structure of the Abundance index estimated by direct acoustic method from PELMED survey.

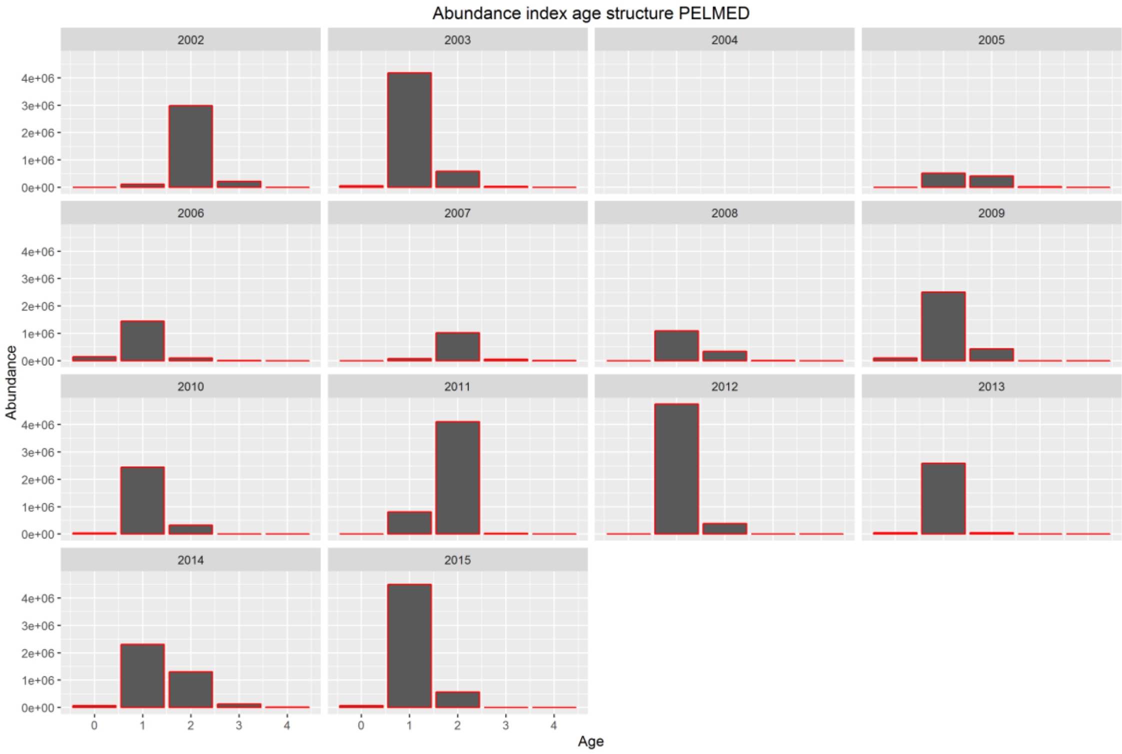


Figure 6.4.4.8. European Anchovy in GSA 7. Age structure of the Abundance index estimated by direct acoustic method from PELMED survey.

No data on size or age structure of biomass or abundance coming from PELMED survey have been reported for 2004 and before 2002. No data on size structure of the biomass coming from PELMED was reported.

6.4. DATA GATHERING OF SARDINE IN GSA 7

6.4.1. Stock Identity and Biology

GSA 7 corresponds to the entire Gulf of Lions. However, the Gulf of Lions may not correspond to a single stock unit. Hydrological exchanges between the Gulf of Lions and the Catalan Sea for instance are well known, which might affect larval transport and then recruitment of juvenile sardine in both areas. Similarly, part of the young recruited in the Gulf of Lions (GSA 07) sardine population may come from larval transport from spawners of the Ligurian Sea (GSA 09). Yet, it should be noted that the spatial distribution of sardine in GSA 06 shows concentrations mostly in the Southern area, so that a large spatial gap would exist between Gulf of Lions and GSA 6 sardine distribution. This does not exclude exchanges between the two of course but reduces the possibility of a continuous population. However, due to a lack of specific information about the stock structure of the sardine population in the western Mediterranean, this stock was assumed to be confined within the GSA 07 boundaries in this assessment.

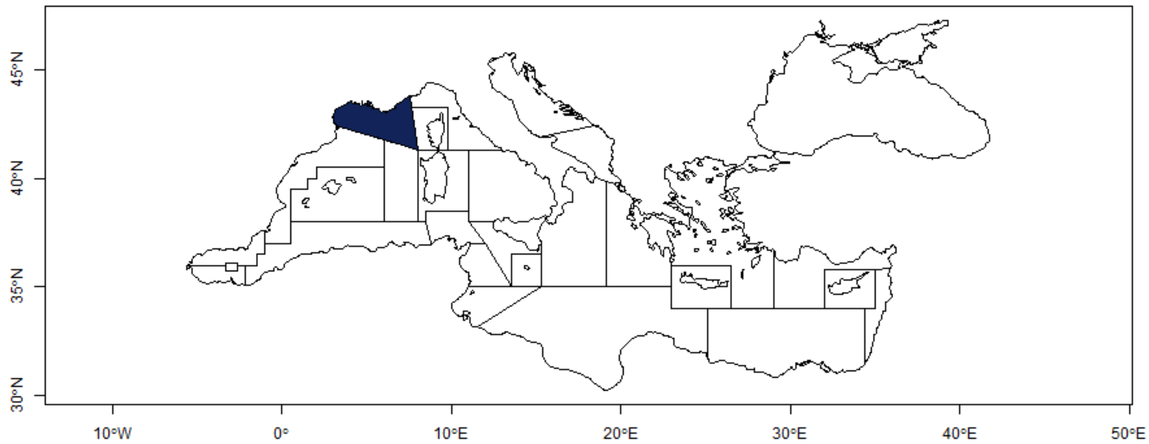


Figure 6.4.1.1. Geographical location of GSA 7.

Growth

The species can reach the size of 25 cm TL, with a relatively short life cycle (8-12 years), although in the Mediterranean seems more plausible to a maximum age of 8 years (Sinovčić, 2000). This species has a very fast initial growth, reaching sexual maturity at the end of the first year of life (Sinovčić, 1984).

Growth parameters were estimated using data collected within the Data Collection Framework (DCF).

The method applied was the von Bertalanffy equation fit to the age and growth data estimated using otoliths and using nonlinear estimation with minimum least squares. Different sets of parameters reported in the DCF database and estimated for the stock of GSA 07 are showed in Table 6.4.1.1.

Table 6.4.1.1. Sardine in GSA 7. Growth parameters of the von Bertalanffy equation.

country	Period	sex	L_{inf}	k	t_0
FRA	2004-2005	Female	17.7	0.53	-1.52
FRA	2006-2008	Female	18.6	0.745	-0.73
FRA	2009-2015	Female	35.1	0.079	-4.17
FRA	2004-2005	Male	16.9	0.642	-1.34
FRA	2006-2008	Male	16.6	1.518	0.02
FRA	2009-2015	Male	27.8	0.105	-4.26

Maturity

Sardine is a batch-spawner: females emit groups of pelagic eggs asynchronously, with different ovulations during the breeding season (autumn-winter) (Ganias et al., 2004). In the Mediterranean the breeding season is between October and April (Muzinić, 1954; 1984, Morello and Arneri 2009). Reproduction occurs both in the open sea and close to shoreline, producing 50000-60000 eggs with a diameter of 1.5 mm. The larval and post larval forms are present in the period between January and March close to the coast. The hatching of eggs depends strongly on the temperature. In the peak of the breeding season each female lays from 11337 to 12667 eggs (Sinovčić, 1983).

The sexual maturity ogive by size for sardine in GSA 07 (DCF data) is reported in Fig 6.4.1.2.1.. The size at first maturity is around 9.5 cm TL and 10.5 cm TL for males and females, respectively.

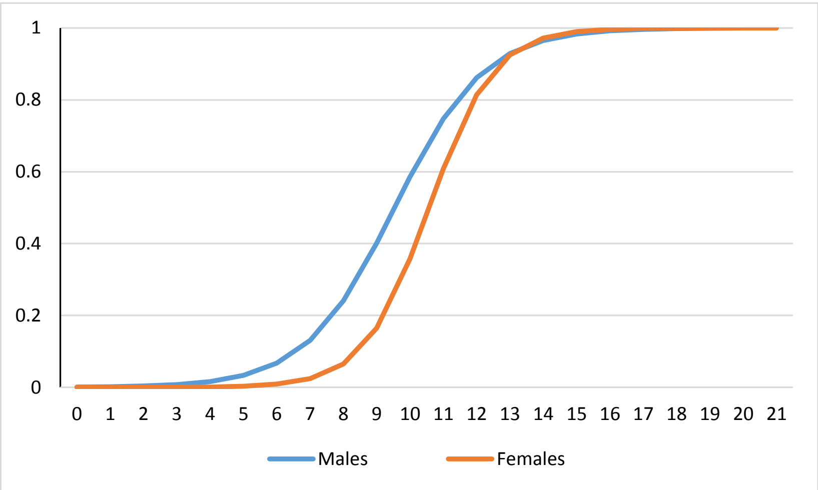


Figure 6.4.1.2. Sardine in GSA 7. Sexual maturity ogive by sex.

Ecology

In the Mediterranean Sea, juveniles and adults mostly feed during daylight (Conway *et al*., 1994; Dulčić, 1999; Munuera-Fernández and González- Quirós, 2006). In the Adriatic Sea, the peak of feeding activity takes place in the afternoon, coinciding with the vertical ascent of zooplankton (Andreu, 1969; Vučetić, 1964). At dusk, shoals of sardines move to the sea bottom where they remain during the night to avoid predation (Zwolinski *et al*., 2007). Unlike other clupeids, which feed by filtering water indiscriminately and holding the food within their gills, sardines select their preys individually (Gramitto, 2001)?

Sardine is a gregarious fish, which forms schools of considerable size, mono and multispecific. Aggregation begins at the stage of postlarva, since larval sardines are still rather scattered. The typical schooling behaviour of the species is known as 'gregariousness per size', as it involves the aggregation of different species of similar size in the same school. Sardine is a euryhaline and eurytherm species, which tolerates variations in salinity between 27 and 41 psu and temperature from 10 to 20 °C (Bini, 1968-70).

Natural mortality

Natural mortality was estimated using Gislason (2010). The input parameters used were L_{inf} = 18.6 cm, k = 0.64, t_0 = -1.125. The natural mortality vector by age is reported in Tab. 6.4.1.4.1.

Table 6.4.1.1. Sardine in GSA 7. Vector of natural mortality by age.

Age	M
0	1.40
1	0.97
2	0.82
3	0.75
4	0.72

6.4.2. Catch data

General description of the fisheries

Traditionally, in GSA 7 sardine was exploited by pelagic otter trawling used by French vessels (OTM_SPF). Due to its low economic value, however, sardine does not represent the main target species for this fleet, while anchovy (*Engraulis encrasicolus*) is the most important species exploited by this fishery.

The drastic reduction of anchovy catches observed in the last years has determined an evident reduction of the fishing effort exerted by the pelagic trawlers. At present, fishing pressure is very low, landings of sardine being lower than 1000 tons. The absence of large specimens of sardine observed in the last years contributed to effort reduction. 14 trawlers have landed more than 1 ton during the year. Yet, only one of these 14 trawlers seems to fish small pelagic fish all along the year (though anchovy is its main target), the 13 others alternate with demersal species as well and sardine appears mostly as by-catch for them. The landings of the purse seines are also very seasonal, one season offshore Marseille from January to May and one season of Port-Vendres in July-August. This activity is very opportunistic and none of these boats are focusing on sardine all throughout the year, the landings per boat vary between 1 and 100 t.

In GSA 7 operate also Spanish vessels using bottom otter trawling and purse seine; sardine represents a by-catch for them.

Landings

The annual total landing of sardine observed from 1993 to 2013 is reported in Fig. 6.4.2.2.1. Although a constant decrement was observed until 2003, the landing increased reaching a peak in 2007. The landed biomass dropped since 2008, collapsing to the minimum values of the data series.

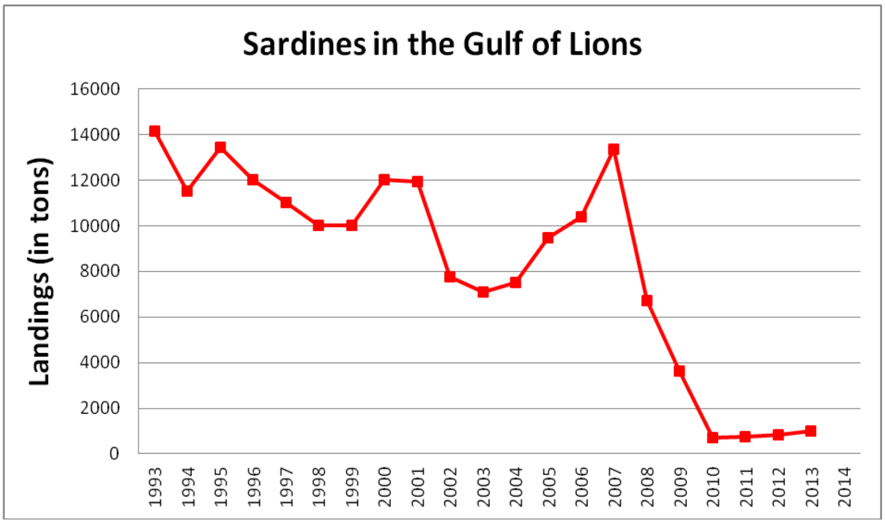


Figure 6.4.2.1. Sardine in GSA 7. Landings from 1993 to 2013 (Source: EWG 14-19).

In Figure 6.4.2.2 and table 6.4.2.1 the trend of the annual total landing from DCF for the French and Spanish fleets operating in the GSA 7 is reported. The data, split by gear, show as pelagic trawling contributed in very high values until 2007; then the catches almost collapsed and the main gear landing sardine, mainly as bycatch, was purse seine used by the Spanish fleet. The negative trend of the last years is confirmed in 2014 and 2015.

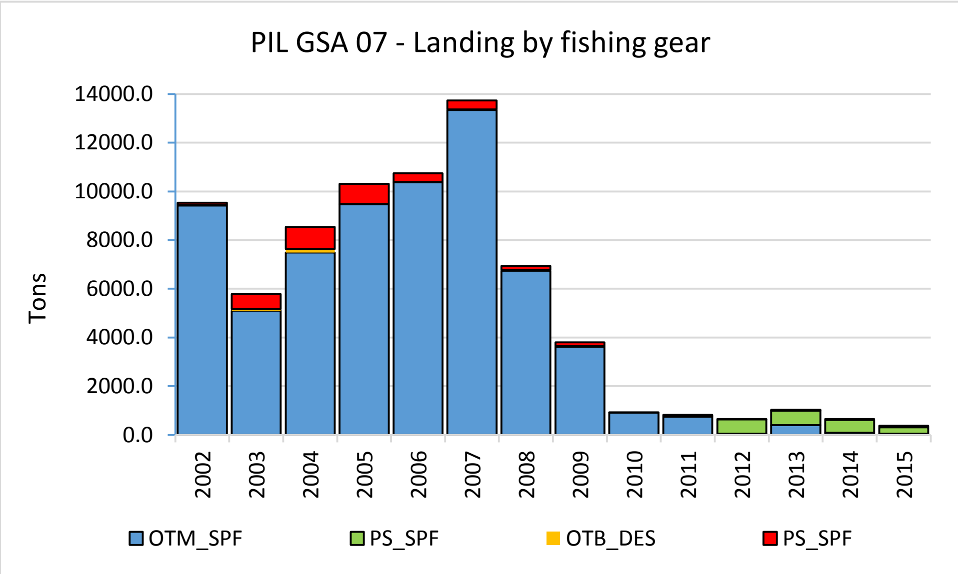


Figure 6.4.2.2. Sardine in GSA 7. Landings from 2002 to 2015 (Source: DCF database).

Table 6.4.2.1. Sardine in GSA 7. Landings from 2002 to 2015 (Source: DCF database).

Contry	Gear	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
FRA	OTM_SPF	9416.4	5095.2	7493.4	9472.2	10381.1	13339.6	6740.5	3620.3	906.8	748.4	46.0	406.2	82.5	53.4
FRA	PS_SPF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	589.4	582.8	535.0	262.8
FRA	OTB_DES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.6	26.0
ESP	OTB_DES	31.2	63.5	141.9	9.4	8.2	26.3	32.3	17.7	5.1	3.6	1.6	0.7	0.7	0.2
ESP	PS_SPF	86.9	629.3	905.2	824.0	347.3	373.4	161.5	159.8	7.6	67.2	5.2	46.7	14.6	31.1
FRA+ESP	Total landing	9534.5	5788.0	8540.5	10305.5	10736.6	13739.3	6934.2	3797.8	919.5	819.3	642.2	1036.3	647.3	373.4

The size structure composition of the landing is available for 4 of the 5 fleets fishing for sardine in GSA 7 (Fig. 6.4.2.4-7); no information is available for Spanish purse seine. Length distributions of Spanish bottom trawling are missing for the periods 2002-2008 and 2013-2015.

Concerning the main fleet targeting the species, pelagic trawling (OTM_SPF), the size distributions are available for the entire period (2002-2015) with the only exception of 2011 (Fig. 6.4.2.4). Histograms are not evident in 2012, 2014 and 2015 due to the very low landings. For the period 2002-2009 the modal class is around 15-16 cm TL. In the following period, the most abundant size class is 13 cm TL. This demonstrates that, not only the landing collapsed in the last years but also the specimens are smaller than those landed before 2010.

Distributions by age for pelagic trawling are not available in the DCF database for the years 2004, 2005 and 2011 (Fig. 6.4.2.8). Age 2 is the main age class exploited by this gear.

Data by age are available for French bottom trawling (Fig. 6.4.2.9) and French purse seiners (Fig. 6.4.2.10). Also for these gears, the age class more abundant in the landing is age 2. No data by age for the Spanish fleets are available in the DCF database.

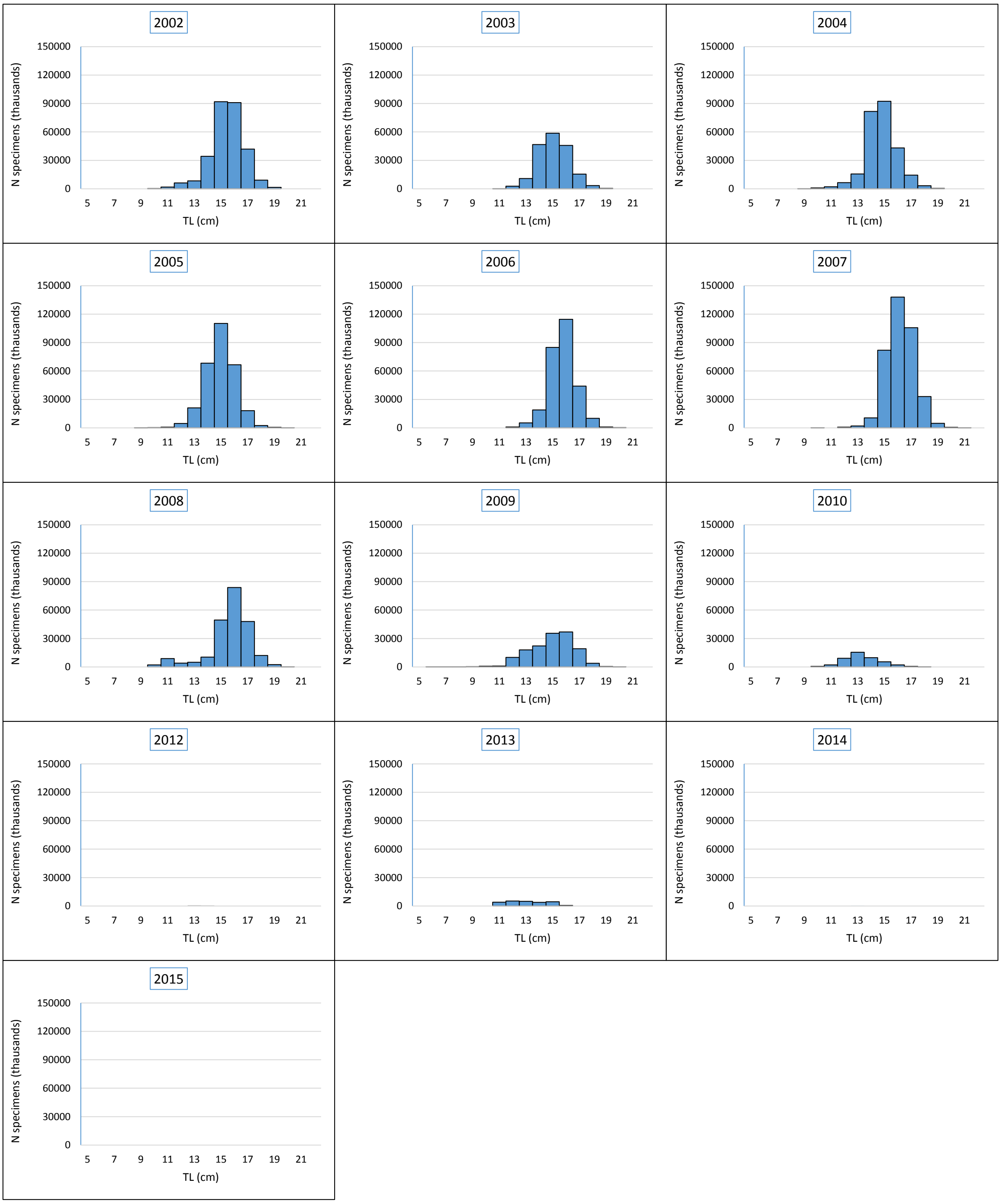


Figure 6.4.2.4. Sardine in GSA 7. Size structure of the pelagic trawl landing (OTM_SPF) for the French fleet (Source: DCF database).

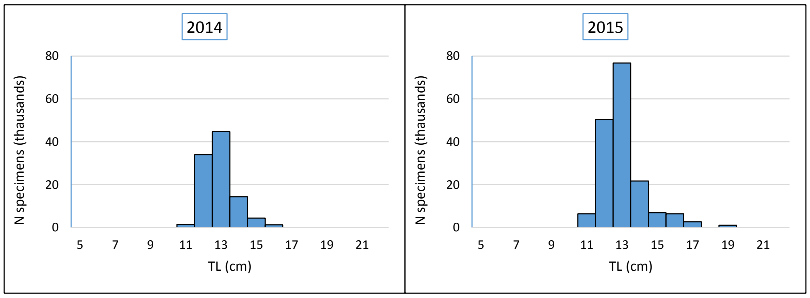


Figure 6.4.2.5. Sardine in GSA 7. Size structure of the bottom trawl landing (OTB_DES) for the French fleet (Source: DCF database).

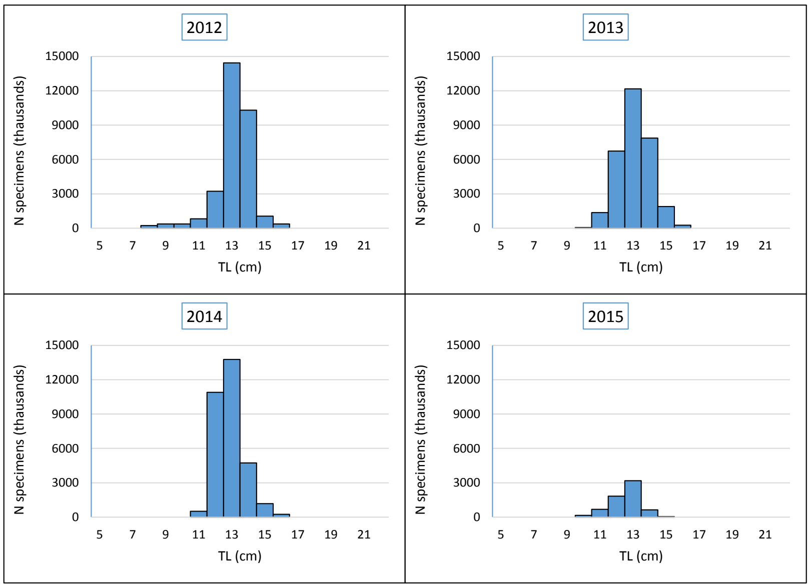


Figure 6.4.2.6. Sardine in GSA 7. Size structure of the purse seine landing (PS_SPF) for the French fleet (Source: DCF database).

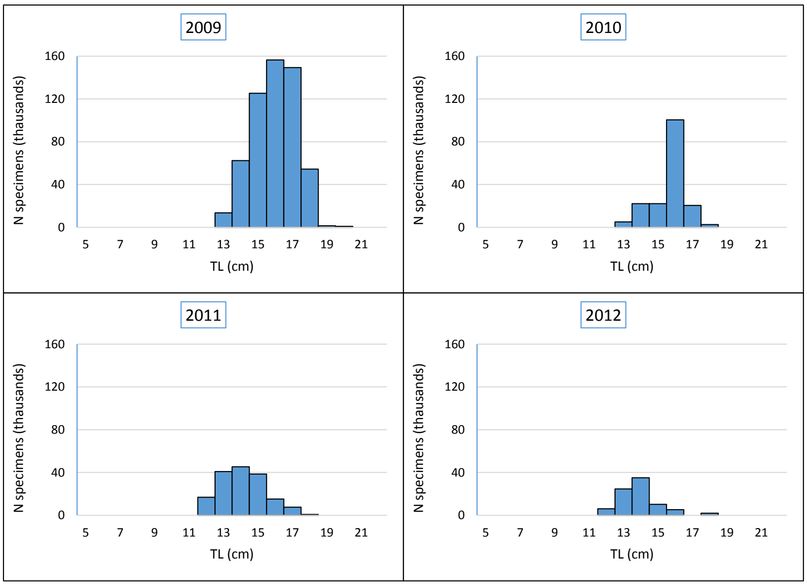


Figure 6.4.2.7. Sardine in GSA 7. Size structure of the bottom trawl landing (OTB_DES) for the Spanish fleet (Source: DCF database).

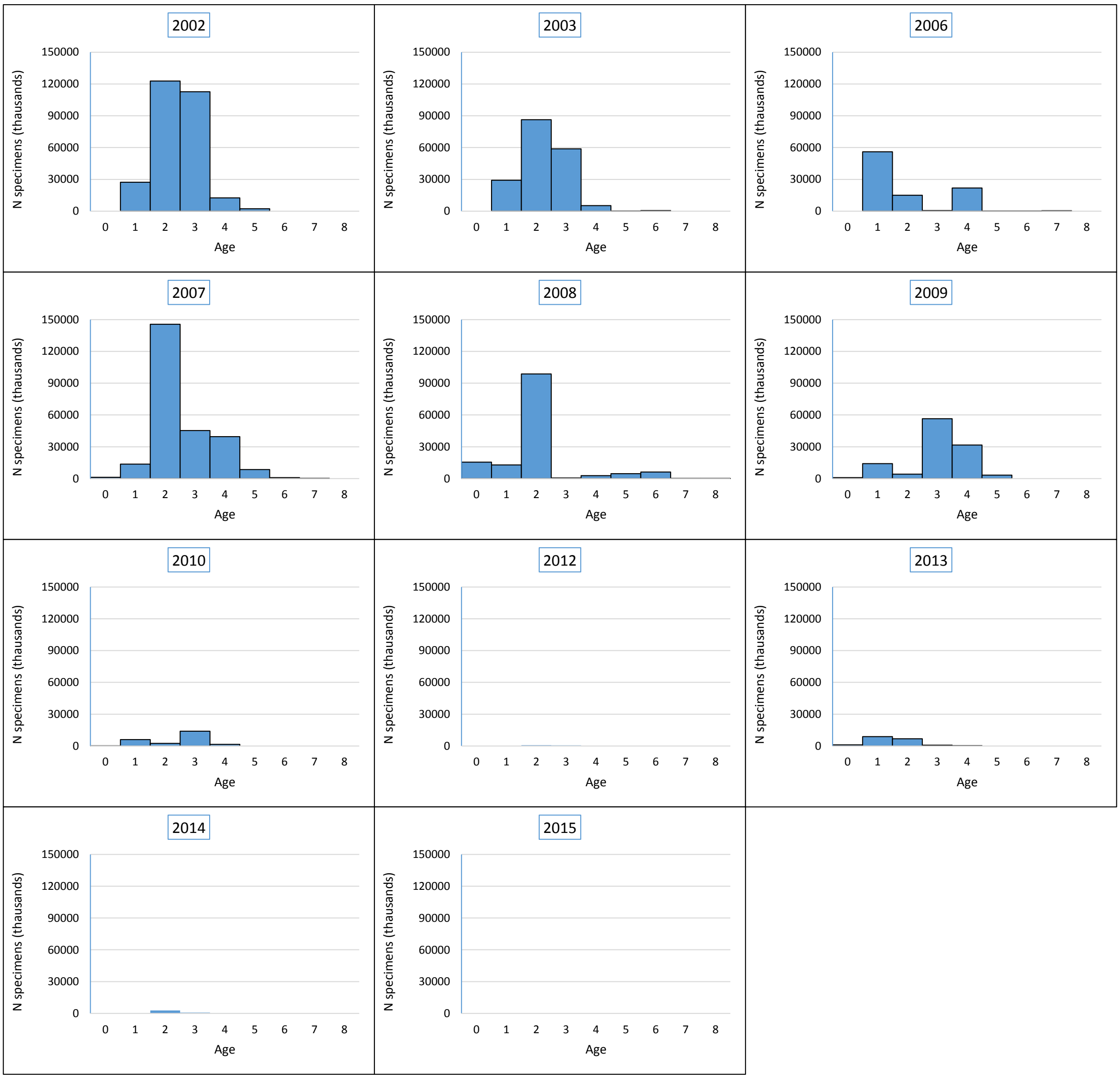


Figure 6.4.2.2.8. Sardine in GSA 7. Age structure of the pelagic trawl landing (OTM_SPF) for the French fleet (Source: DCF database).

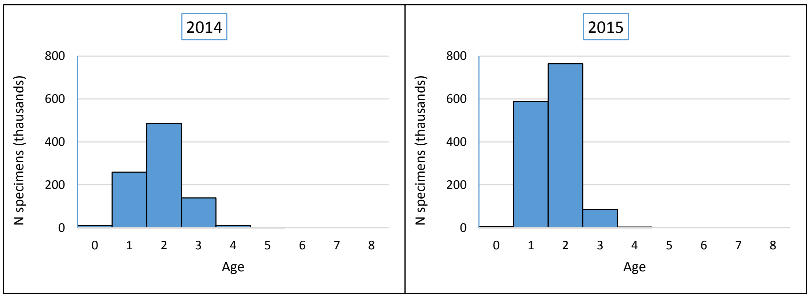


Figure. 6.4.2.2.9. Sardine in GSA 7. Age structure of the bottom trawl landing (OTB_DES) for the French fleet (Source: DCF database).

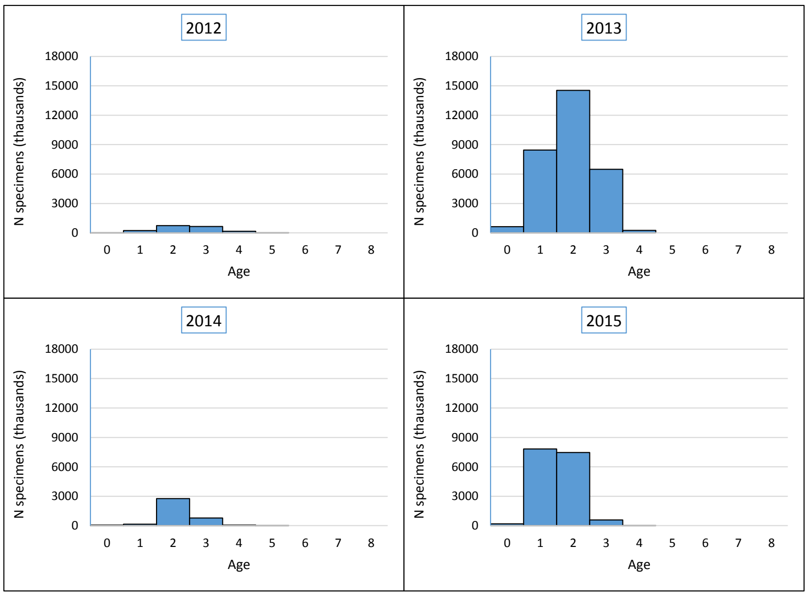


Figure 6.4.2.2.10. Sardine in GSA 7. Age structure of the purse seine landing (PS_SPF) for the French fleet (Source: DCF database).

An additional source of data is the reconstructed time series of Landings of sardine in GSA 7 performed by IFRMER and kindly provided by C. Saraux. The time series is the longest available in the Mediterranean as it starts in 1860 and ends in 2014 and puts the historical exploitation of this stock in the right temporal context. The last part of the series is overlapped with the DCF time series and some discrepancies are evident while the overall pattern is similar (Fig. 6.4.2.2.11).

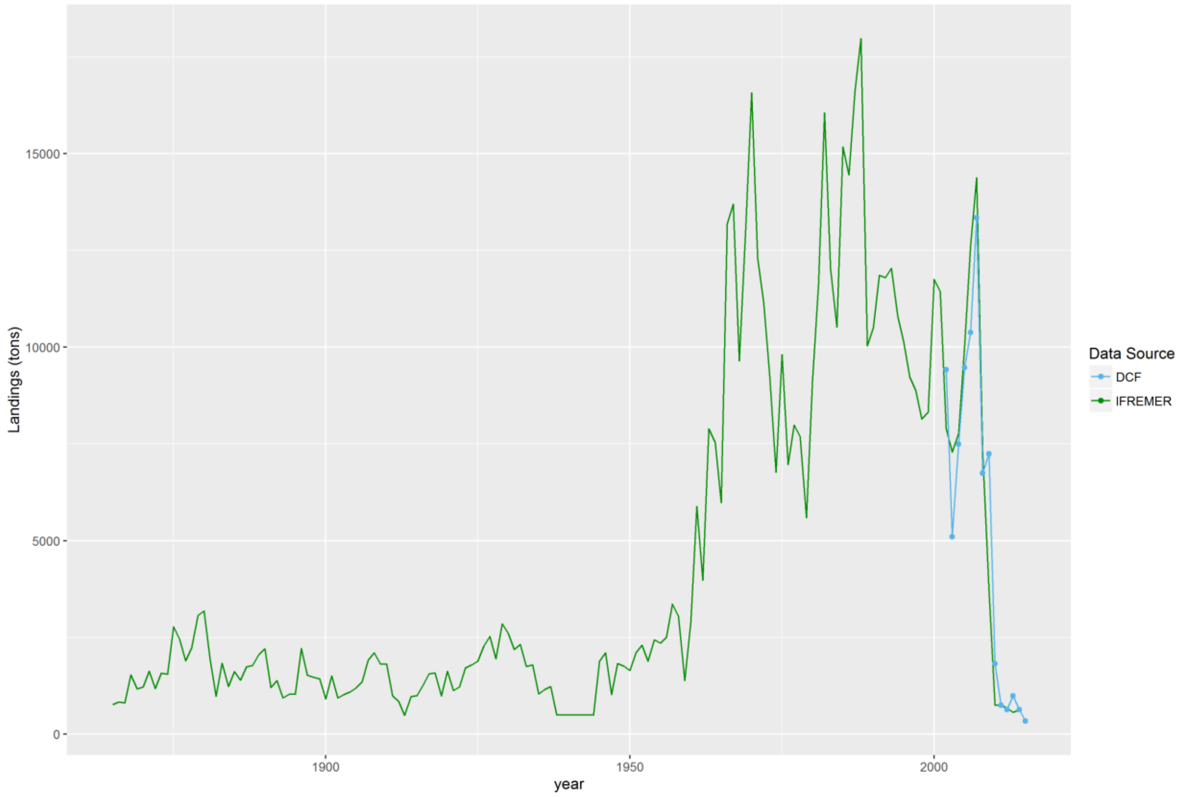


Figure 6.4.2.11. Sardine in GSA 7. Landings according to the IFREMER reconstruction and DCF data.

Discards

In general, discard of sardine in GSA 07 is negligible, being below 10 tons per year (Fig. 6.4.2.12 and Tab. 6.4.2.2). Only in 2014, a huge amount of discard from French pelagic trawlers (320 tons) and French bottom trawlers (56 tons) is reported in the DCF database.

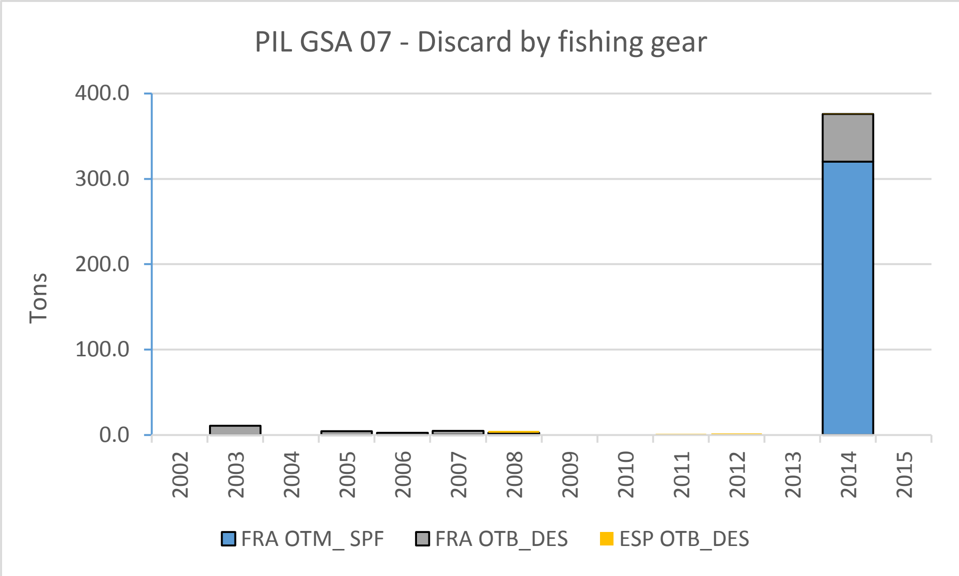


Figure 6.4.2.12. Sardine in GSA 7. Discards from 2002 to 2015 (Source: DCF database).

Table 6.4.2.2. Sardine in GSA 7. Discards from 2002 to 2015 (Source: DCF database).

Contry	Gear	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
FRA	OTB_DES	0.0	10.9	0.0	4.4	2.7	4.6	1.8	0.0	0.0	0.0	0.0	0.0	56.0	0.0
FRA	OTM_ SPF	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.0	0.0	0.0	0.0	0.0	320.0	0.0
ESP	OTB_DES	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	1.3	1.7	0.0	0.2	0.0
FRA+ESP	Total discard	0.0	10.9	0.0	4.4	2.7	4.7	4.9	0.0	0.0	1.3	1.7	0.0	376.2	0.0

Size frequency distributions of discard are available for both French pelagic and bottom trawling fleets (Fig. 6.4.2.13-14). The modal class of the discarded fraction in pelagic trawling is 11 cm TL, while in bottom trawling it ranges between 13 and 15 cm TL. Discard data by age are missing in the DCF database.

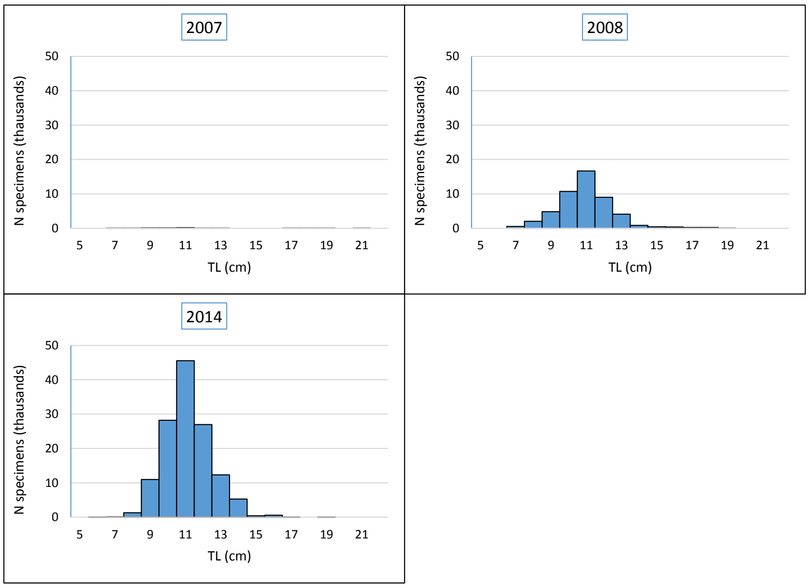


Figure. 6.4.2.13. Sardine in GSA 7. Size structure of the pelagic trawl discard (OTM_SPF) for the French fleet (Source: DCF database).

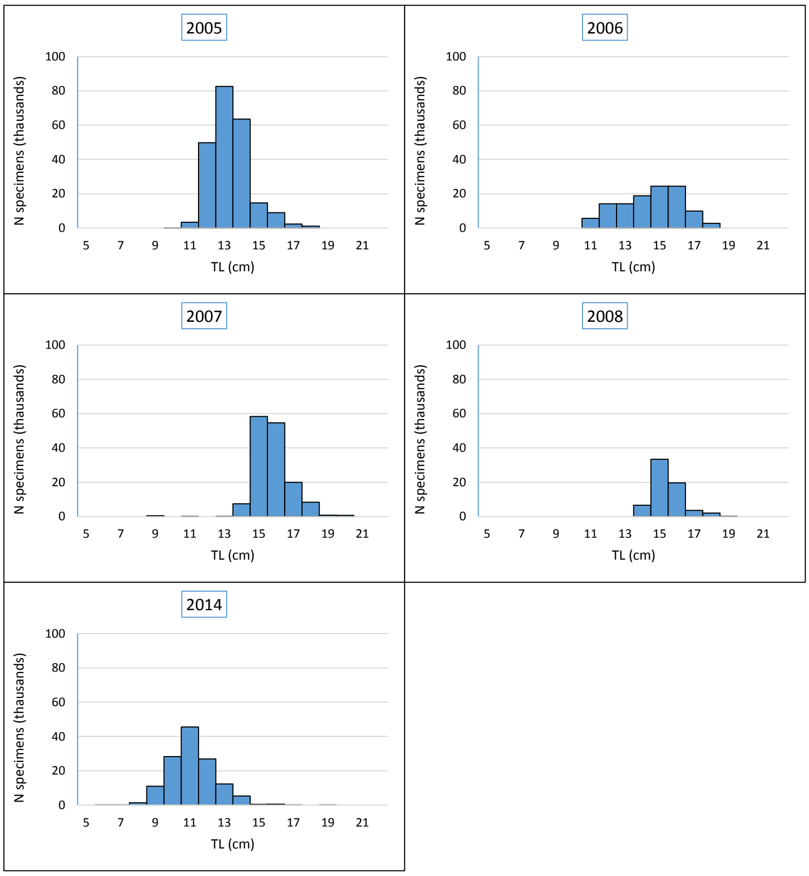


Figure 6.4.2.14. Sardine in GSA 7. Size structure of the bottom trawl discard (OTB_DES) for the French fleet (Source: DCF database).

6.4.3. Fishing effort data.

DCF database available for the EWG 16-13 does not contain data on fishing effort exerted by the French fleets fishing for sardine in GSA 07 with the only exception of 2015. A continuous data series is available for Spanish bottom trawling and purse seiners but those fleets have a very opportunistic sardine fishing behaviour and their effective effort on the species is complicated to measure.

Concerning French pelagic trawling, generic information is available from EWG 14-19 for data before 2014. The authors reported that fishing effort has strongly decreased, due to a decrease in sardine average size. The number of pelagic trawlers (OTM) decreased and only 1 was focusing on small pelagics all year round. Most other OTM alternate between bottom trawling and pelagic trawling.

Table 6.4.3.1. Sardine in GSA 7. Fishing effort expressed in GT*days. (Source: DCF database).

Country	Gear	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ESP	OTB_DES	322841	308926	308266	316488	322027	313450	275498	310191	268789	248107	268090	276490
	PS_SPF	33436	23559	10879	13247	8174	4069	109	7457	652	3418	0	33
	Total	356277	332485	319145	329735	330201	317519	275607	317649	269441	251525	268090	276523
FRA	OTT_SPF	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	78789
	OTB_DES	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	949262
	OTM_SPF	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	55063
	PS_SPF	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	105784
	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1188898
Total	All gears	356277	332485	319145	329735	330201	317519	275607	317649	269441	251525	268090	1465421

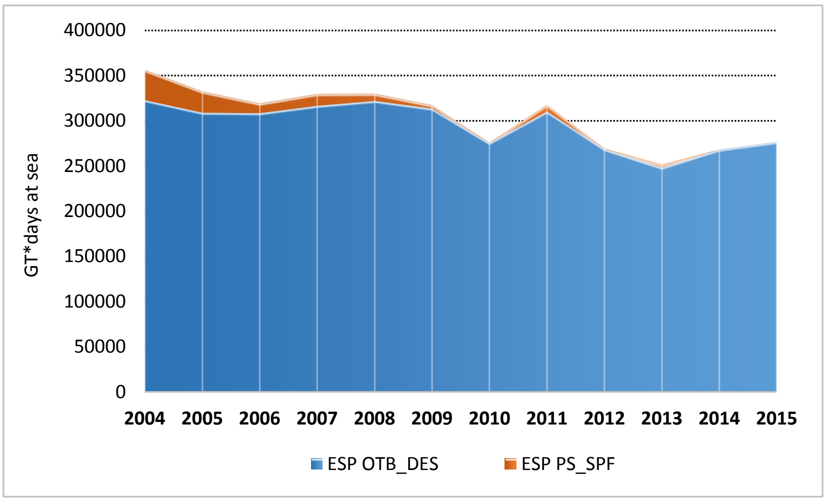


Figure 6.4.3.1. Sardine in GSA 7. Fishing effort expressed in GT*days at sea for the Spanish fleets. (Source: DCF database).

Table 6.4.3.2. Sardine in GSA 7. Fishing effort expressed in days at sea. (Source: DCF database).

Country	Gear	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	OTB_DES	3714	3626	3550	3553	3694	3008	3097	3486	2966	2791	2966	3064
ESP	PS_SPF	755	515	247	293	184	94	4	167	15	52	0	2
	Total	4469	4141	3797	3846	3878	3102	3101	3653	2981	2843	2966	3066
	OTT_SPF	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	736
	OTB_DES	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9939
FRA	OTM_SPF	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	386
	PS_SPF	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	883
	Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	11945
Total	All gears	4469	4141	3797	3846	3878	3102	3101	3653	2981	2843	2966	15011

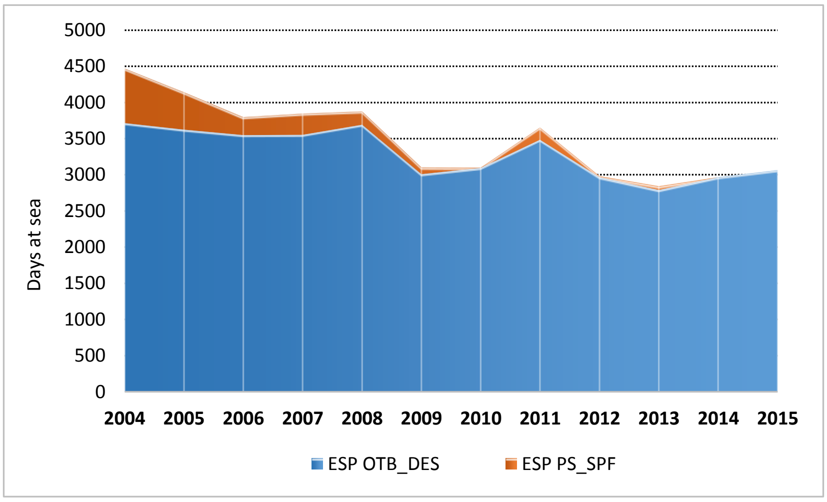


Figure 6.4.3.2. Sardine in GSA 7. Fishing effort expressed in days at sea for the Spanish fleets. (Source: DCF database).

6.4.4. Survey Indices of abundance and biomass by year and size/age

Survey #1 (PELMED)

The scientific survey (PELMED) used is an acoustic and trawl-survey that has been conducted every July since 1993. It follows the Mediterranean Acoustic Survey (MEDIAS) protocol.

Methods

Sampling was performed along 9 parallel and regularly spaced transects (inter-transect distance = 12 nautical miles, see map below). Acoustic data were obtained by means of echo sounders (Simrad ER60) and recorded at constant speed of 8 $nm.h^{-1}$. The size of the elementary distance sampling unit (EDSU) is 1 nautical mile. Discrimination between species was done both by echo trace classification and trawls output (Simmons & MacLennan 2005). Indeed, each time a fish trace was observed for at least 2 nm on the echogram, the boat turned around to conduct a ≥30 min-trawl at 4 $nm.h^{-1}$ in order to evaluate the proportion of each species (by random sampling of the catch and sorting before counting and weighing per species). While all frequencies were visualized during sampling and helped deciding when to conduct a trawl, only the energies from the 38kHz channel were used to estimate fish biomass. Acoustic data were preliminary treated with Movies + software in order to perform bottom corrections and to attribute to each echo trace one of the 5 different echo types previously defined. Acoustic data analyses (stock estimation, length-weight relationships, etc.) were later performed using R scripts.

Geographical distribution

A recent study on spatial distribution of small pelagics in the Gulf has been published (Saraux *et al.*, 2014). Below are the maps for sardine from this publication.

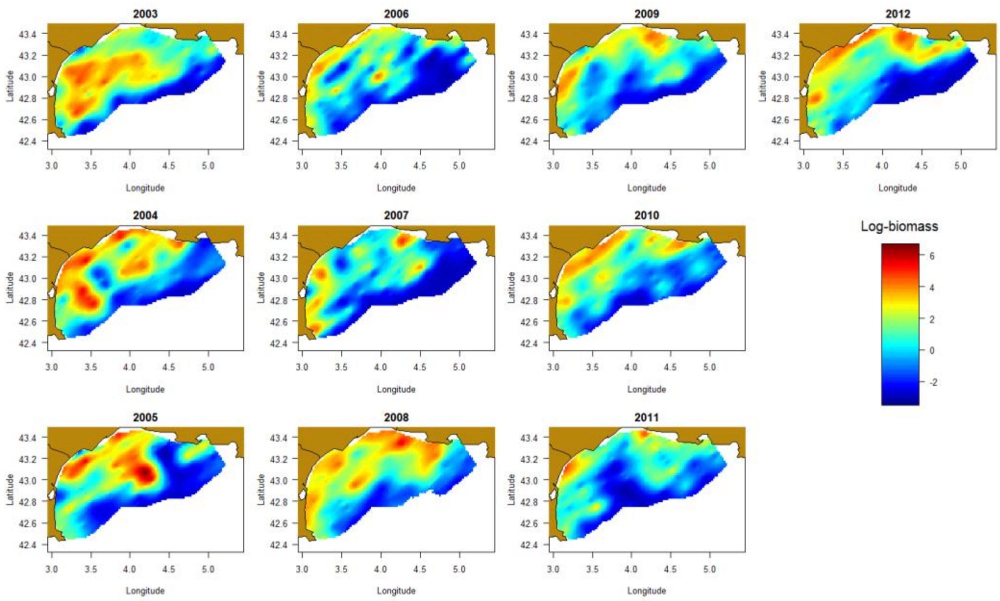


Figure 6.4.4.1. Sardine in GSA 7. Spatial distribution of sardine from acoustic survey (from Saraux *et al.*, 2014).

Trends in abundance and biomass

The annual biomass index of sardine from 1993 to 2013 (Fig. 6.4.4.2) has been published in EWG 14-19. The index shows an increasing trend with an evident peak in 2005; then the values are comparable to the initial period of the series.

The data available in the DCF are reported in Table 6.4.4.1 and in Fig. 6.4.4.3. The series concerns the period 2006-2016; no information is available for the years 2002-2005.

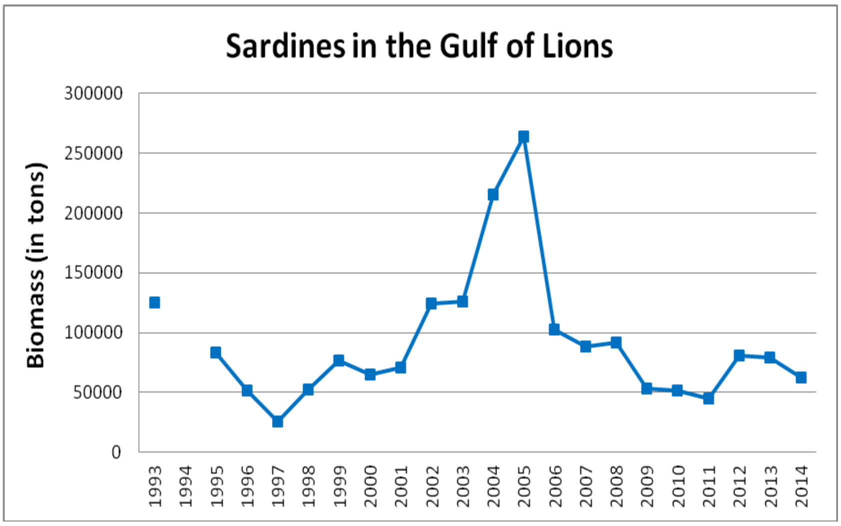


Figure 6.4.4.2. Sardine in GSA 7. Biomass index estimated by direct acoustic method from PELMED survey (Source: EWG 14-19).

Table 6.4.4.1. Sardine in GSA 7. Abundance and biomass indices estimated by direct acoustic method from PELMED survey (Source: DCF database).

Year	Total biomass	Total abundance
2002	NA	5829556
2003	NA	2652008
2004	NA	7503415
2005	NA	11317732
2006	92814	2815792
2007	59230	1758883
2008	80462	8737709
2009	58888	7361805
2010	38114	5794331
2011	28449	3634175
2012	80592	9370836
2013	79181	7927861
2014	62458	5612181
2015	67140	7098184

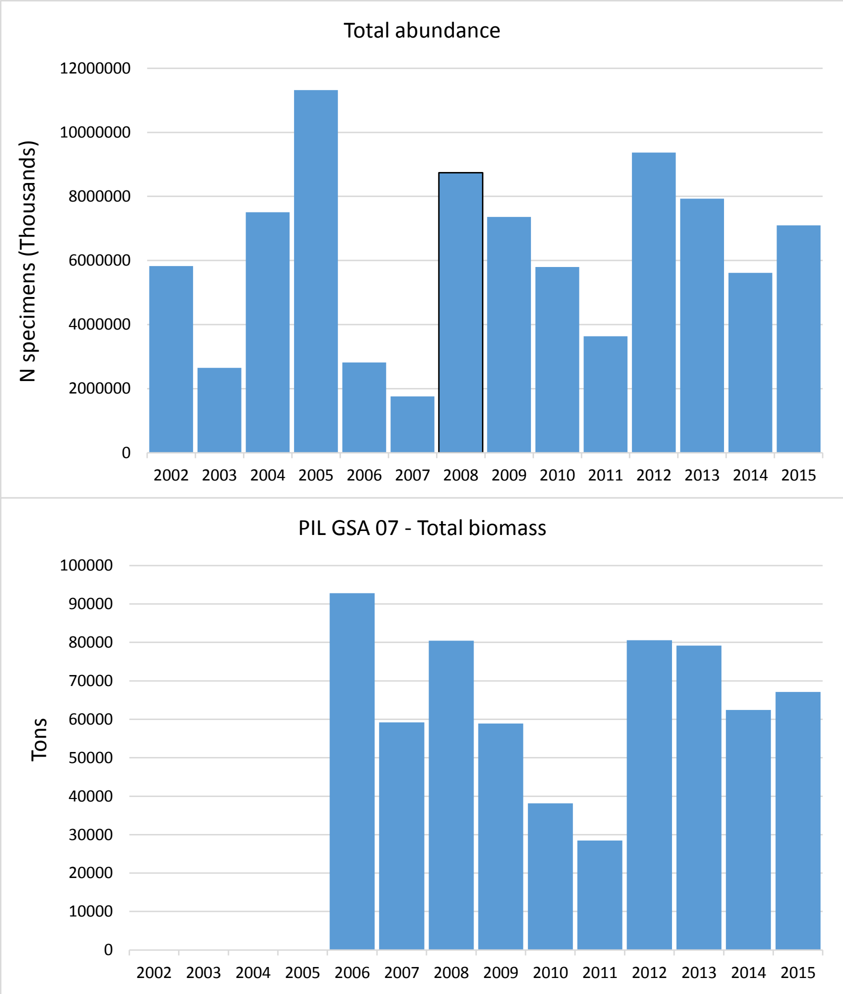


Figure 6.4.4.3. Sardine in GSA 7. Abundance and biomass indices estimated by direct acoustic method from PELMED survey (Source: DCF database).

Trends in abundance and biomass by length or age

Abundance indexes by size and age are displayed in Fig. 6.4.4.4 and 6.4.4.5, respectively. The size index is characterised by two modal components, the first one at 9-10 cm TL and the second one at 15-16 cm TL. This shape of the distribution is particularly evident in the first years of the data series (from 2002 to 2010). Then, the second component disappears from the distributions that are composed almost exclusively by small specimens.

The abundance index by age shows very high values of class 0 in 2008, 2009, 2010 and 2012. In the remaining years, the age class 1 is also important.

Biomass index by age is displayed in Fig. 6.4.4.6. No data on biomass index by size coming from PELMED was reported.

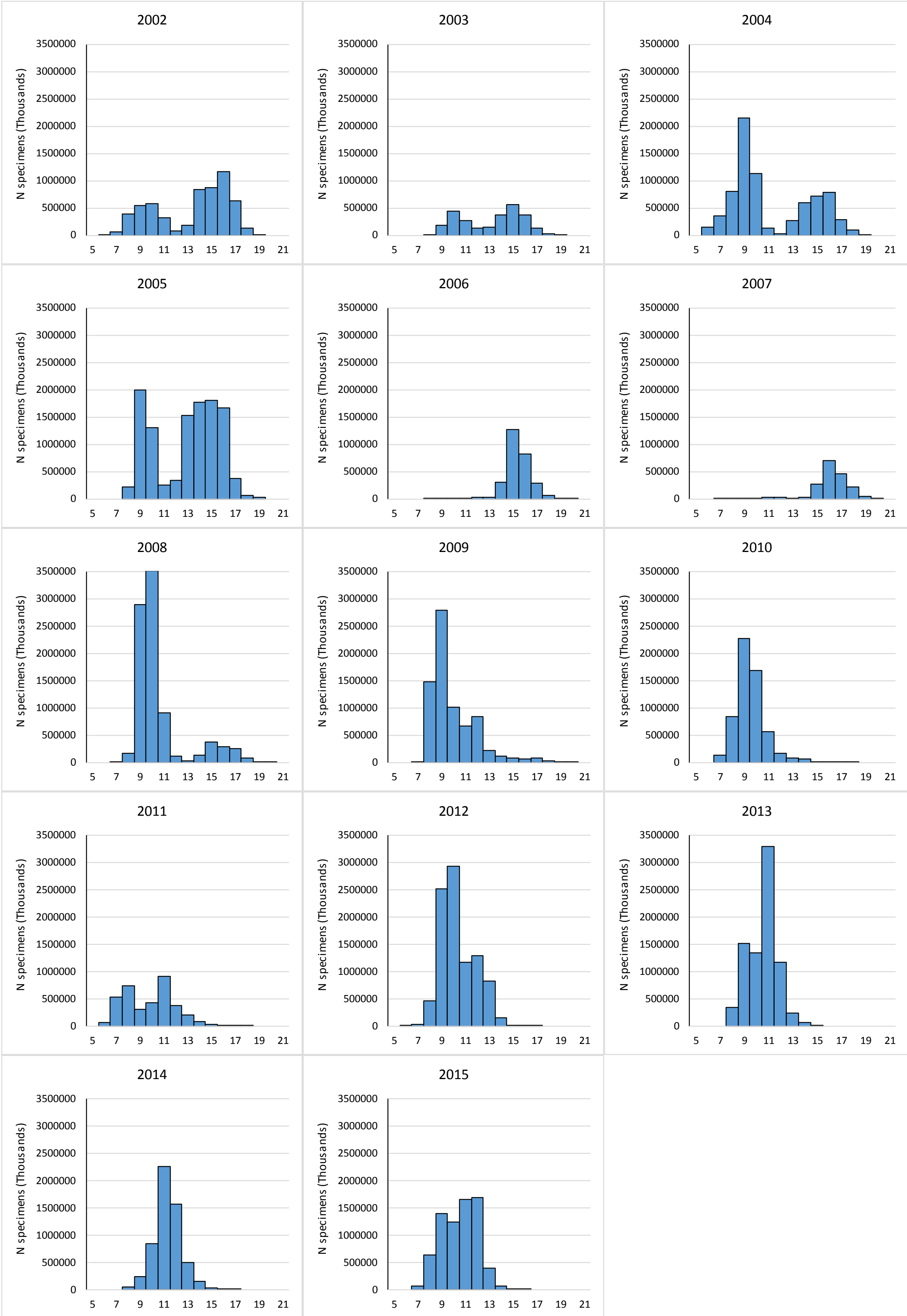


Figure 6.4.4.4. Sardine in GSA 7. Length structure of the abundance index estimated by direct acoustic method from PELMED survey.

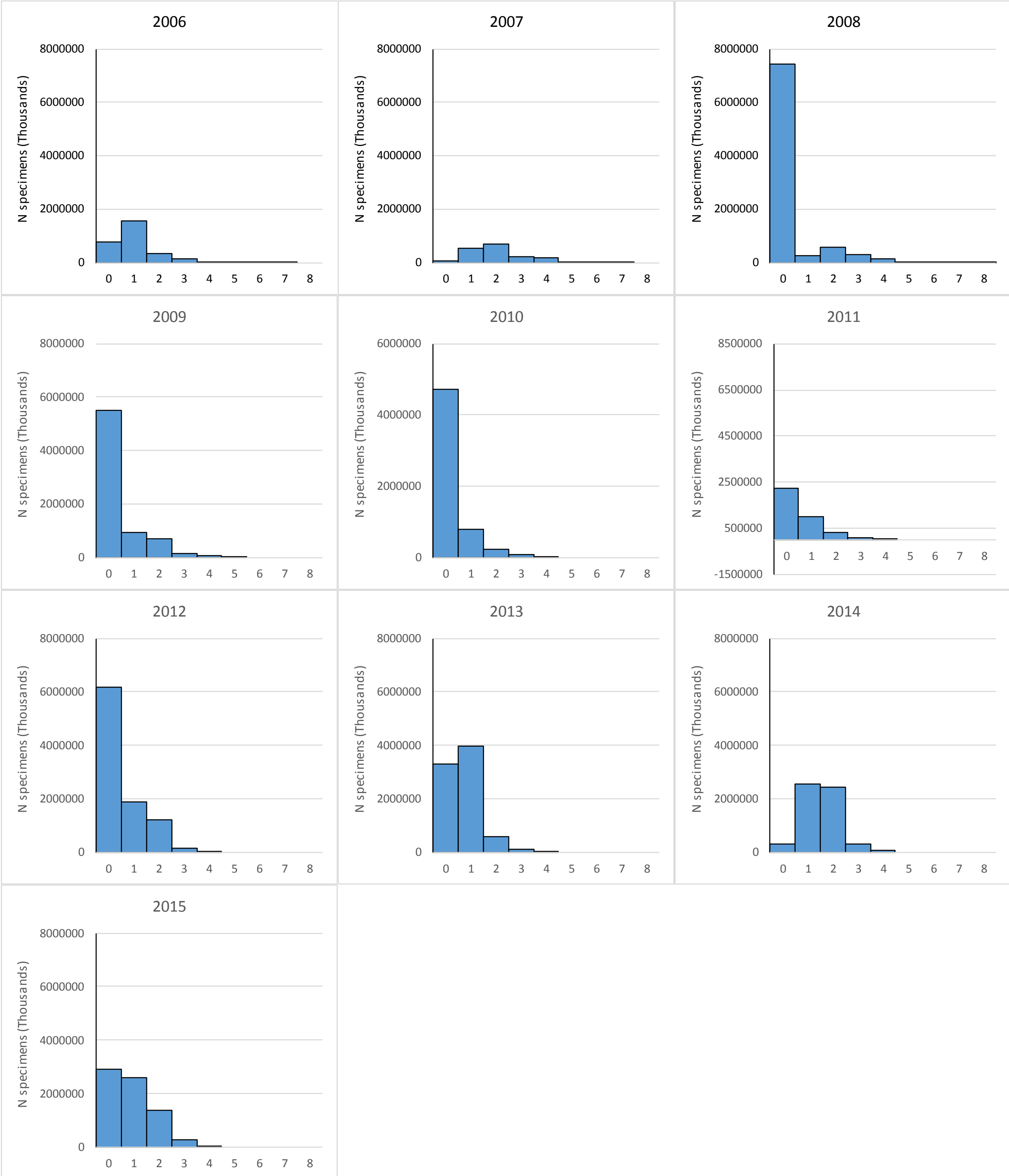


Figure 6.4.4.5. Sardine in GSA 7. Age structure of the abundance index estimated by direct acoustic method from PELMED survey.

Figure 6.4.4.6. Sardine in GSA 7. Age structure of the biomass index estimated by direct acoustic method from PELMED survey.

6.5 DATA GATHERING OF ANCHOVY IN GSA 17-18

6.5.1 Stock Identity and Biology

Many studies have been carried out regarding the presence of a unique stock or the presence of different sub populations of anchovy in the Adriatic Sea (GSA 17 and GSA 18). This has several implications for the management, i.e. differences in the growth features between subpopulations imply the necessity of *ad hoc* strategies in the management. The hypothesis of two distinct populations claims the evidence of morphometric differences between northern and southern Adriatic anchovy, such as colour and length, and some variability in their genetic structure (Bembo *et al*., 1996). Nevertheless, many authors warn against the use of morphological data in studies on population structure (Tudela, 1999) and, a recent study from Magoulas *et al.* (2006), revealed the presence of two different clades in the Mediterranean, one of those is characterized by a high frequency in the Adriatic Sea (higher than 85%) with a low nucleotide diversity (around 1%). Therefore, in this year assessment, and according to the fact that a lot of vessels registered in GSA 18 fish in GSA 17, it was decided to merge the two GSAs and thus carry out an assessment for anchovy in GSA 17-18.

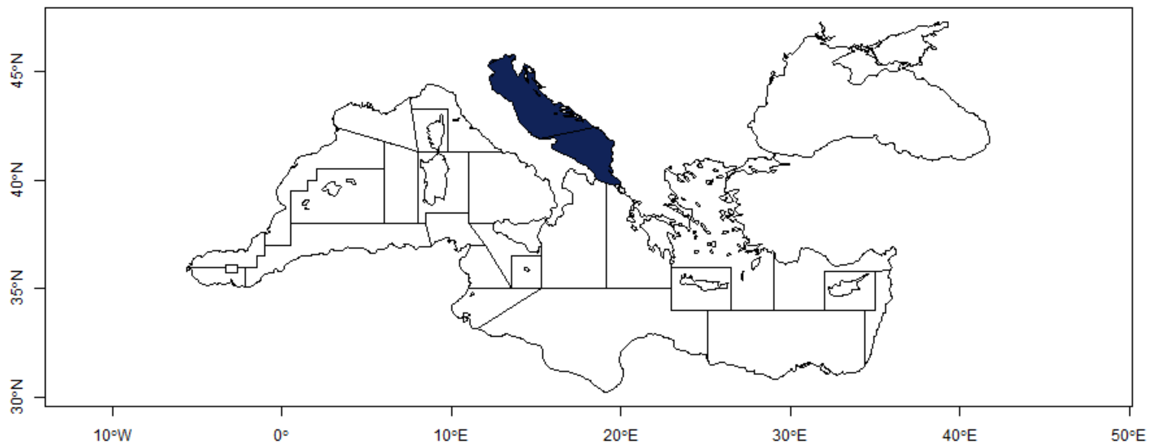


Figure 6.5.1.1. Geographical location of GSAs 17-18.

Growth

A revision of the historical dataset for anchovy in the Adriatic Sea has been carried out in 2015: the main changes concern the use of one ALK to split the length frequency distribution of eastern side into numbers at age and the use of calendar year data, instead of using the split year assumption. The same data were used in this assessment also.

The growth parameters were not re-estimated during this meeting, but the same parameters as in previous GFCM 2015 stock assessment were used (Table 6.5.1.1). The growth parameters used during the EWG 16-13 were:

Table 6.5.1.1. European Anchovy in GSAs 17-18. Von Bertalanffy growth and length-weight parameters used.

	Growth parameters			Length-weight	
	L_{inf}	k	t_0	a	b
Sex Combined	19.4	0.57	-0.5	0.0032	3.2339

Maturity

Table 6.5.1.2. European Anchovy in GSAs 17-18. Proportion of mature specimens at age.

Period	Age	0	1	2	3	4
1975-2015	**Prop. Matures**	0.5	1.00	1.00	1.00	1.00

Natural mortality

Table 6.5.1.3. European Anchovy in GSAs 17-18. Natural mortality vector by age from Gislason et al. (2010).

Period	Age	0	1	2	3	4
1975-2015	**M**	2.36	1.10	0.81	0.69	0.64

6.5.2. Catch data

General description of Fisheries

Anchovy is commercially very important in the Adriatic Sea: it is targeted by pelagic trawlers (Italy) and purse seiners (Italy, Croatia, Slovenia). The number of vessels targeting this species is around 400. Most of the Italian boats whose port of registry is located in GSA 18 actually fish and land in GSA 17.

In Montenegro most of the catches are originated from small-scale beach seine fisheries and from the fishery with small purse seiners in coastal waters (< 70 m depth); currently, the three existing large purse seiners as well as the pelagic trawler are currently not active due to market constrains and lack of skilled fishers (UNEP-MAP-RAC/SPA. 2014): the catches therefore are really low (FAO Official Fisheries Statistics 2016) but no information on the real magnitude and length structure of the catches are available. Such as for Montenegro, almost no information are available for Albania, nevertheless from the FAO Official Fisheries Statistics (2016) it appears that also Albanian catches are small.

Management regulations applicable in 2015

A multi–annual management plan for small pelagic fisheries in the Adriatic Sea has been established by the General Fisheries Commission for the Mediterranean (GFCM) in 2012. Besides, Italy has been enforcing for years a general regulation concerning the fishing gears and since 1988 a suspension (about one month) of fishing activity of pelagic trawlers in summer. A closure period is observed from 15th December to 15th January from the Croatian purse seiners. A closure period of 60 days (August and September) and a closure period of 42 days were endorsed respectively in 2011-2012 and in 2013 by the Italian fleet.

Landings

Concerning GSA17, landings and catch at age data from 2004 were available through the DCF database for Italy and Slovenia. For Croatia, data from 2009 to 2015 were available through the Croatian experts, since Croatia is participating to the Data Collection Program starting from 2013. Concerning GSA 18, data were available through the DCF program starting in 2005. Updated data set from the last GFCM stock assessment were used as input data in this assessment.

Data prior to DCF were reconstructed as follows and used in the last assessment carried out by GFCM WGSASP in 2015:

- 1975-1994: total landings for maritime compartment from the Italian National Institute of Statistics (ISTAT). The data were available until 1999, but in the last 5 years of data the landings showed an unreliable pattern, with high peaks. A similar behaviour was evident also for the landings of another small pelagic, i.e. sardine, and it was therefore ascribed to some sampling issues (e.g. changing in the sampling methodology). For this reason the data from 1995 to 1999 were not included.
- 1995-2004: an average proportion of catches in GSA 18 over the catches in GSA 17 was estimated from the total landings available from the sampling program

from 2006 to 2013 (i.e. GSA18/GSA17 = 34.4%). This ratio was used to derive an estimate of GSA 18 landings from GSA 17 for the period 1995-2004.

- 2005-2015: DCF database.

The reconstructed landings are presented in Figure 6.5.5.3.1. To account for the landings of Albania and Montenegro the FAO Official Fisheries Statistics (2016) were used: the average amount from 2004 to 2013 is about 20 t, therefore the values are included in the plot below together with GSA 18 estimates.

Overall, observing the catch trend a collapse of anchovy catch in 1987 is evident. From 1988 the trend is increasing reaching the maximum of the entire time series in 2007 with 75,511 tons. From 2007 the catches are decreasing again.

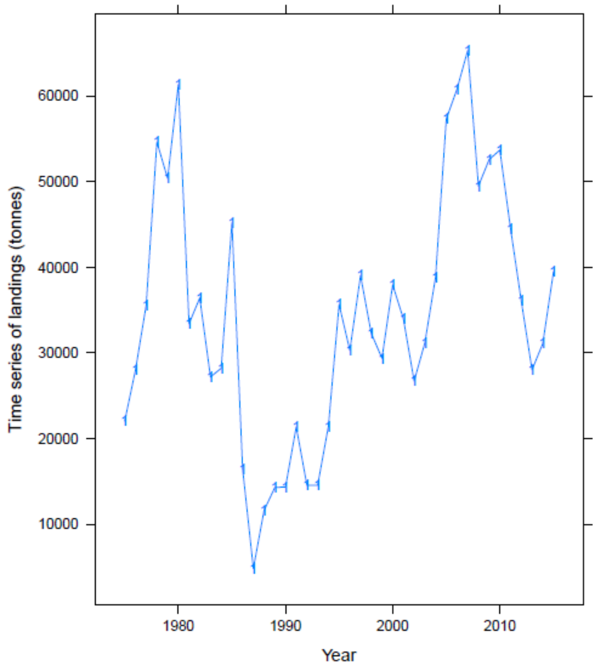


Figure 6.5.2.1. European Anchovy in GSAs 17-18. Total landings (in tons) by GSA from 1975 to 2015 (reconstructed landings (1975-2014).

The following table shows the annual landings (t).

Table 6.5.2.1. European Anchovy in GSAs 17-18. Total landings (tons) of anchovy by year.

Year	Landings (t)	Year	Landings (t)
1975	22049	**1996**	30304
1976	28001	**1997**	39040
1977	35565	**1998**	32294
1978	54624	**1999**	29383
1979	50378	**2000**	37952
1980	61323	**2001**	33984
1981	33422	**2002**	26721
1982	36425	**2003**	31172
1983	27201	**2004**	38859
1984	28211	**2005**	57301
1985	45198	**2006**	60803
1986	16446	**2007**	65317
1987	4848	**2008**	49486
1988	11624	**2009**	52578
1989	14287	**2010**	53689
1990	14363	**2011**	44487
1991	21371	**2012**	36045
1992	14557	**2013**	28043
1993	14562	**2014**	31085
1994	21424	**2015**	39449
1995	35665		

The mean weight at age (kg) of the catches is shown in Fig. 6.5.2.2.

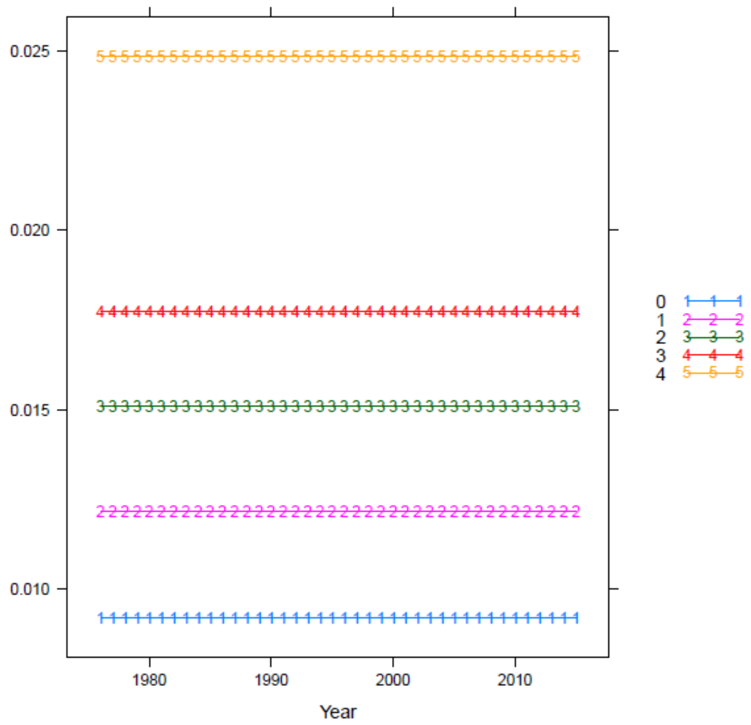


Figure 6.5.2.2. European Anchovy in GSAs 17-18. Mean weight at age (kg) of the catch at age.

Discards

Discards were not included in the assessment.

6.5.3. Fishing effort data

The number of vessels from Italy, Croatia and Slovenia targeting this species is around 400. In Montenegro most of the catches are originated from small-scale beach seine fisheries and from the fishery with small purse seiners in coastal waters (< 70 m depth); currently, the three existing large purse seiners as well as the pelagic trawler are currently not active due to market constrains and lack of skilled fishers (UNEP-MAP-RAC/SPA. 2014): the catches therefore are really low (FAO Official Fisheries Statistics 2016) but no information on the real magnitude and length structure of the catches are available. Such as for Montenegro, almost no information are available for Albania, nevertheless from the FAO database it appears that also Albanian catches are small.

6.5.4. Survey Indices of abundance and biomass by year and size/age

Methods

MEDIAS

In the western part of Adriatic Sea the acoustic survey was carried out since 1976 in the Northern Adriatic (2/3 of the area) and since 1987 also in the Mid Adriatic (1/3 of the area) and in the MEDIAS framework since 2009. In the GSA 18, acoustic survey was carried out from 2009. The eastern part was covered by Croatian national pelagic monitoring program PELMON until 2012 and later on through DCF. Fish biomass in a part of eastern survey area not covered with acoustic sampling in 2011-2012 was estimated as corresponding average percentage of biomass during 2009-2015. The survey methods for MEDIAS are given in the MEDIAS handbook (MEDIAS, March 2015).

The data from all surveys in western and eastern GSA 17 and western GSA 18 have been used as one single independent tuning index in the form of numbers-at-age from 2009 to 2015.

Acoustic sampling transects and the total area covered in GSA 17 is shown in Figure 6.5.4.1.

Figure 6.5.4.1. European Anchovy in GSAs 17-18. Acoustic transects for the western echo survey (white tracks) and the eastern echo survey (pink tracks) for the GSA 17 and GSA 18.

Trends in abundance & biomass

Biomass estimates from the acoustic surveys for the entire Adriatic Sea show the highest abundance in 2010 and then a decrease reaching in 2015 the value of 289331 tons. The contribution of the eastern survey in the last three years of data is much lower respect to previous years, while the average contribution of the GSA 18 survey is more or less stable.

Pooled total biomass in tons from eastern (GSA 17) and western (GSA 17 and GSA 18) echo survey (2004-2015) is given in Table 6.5.4.1 and it is shown in Figure 6.5.4.2.

Table 6.5.4.1. European Anchovy in GSAs 17-18. Total biomass (tons) estimated by the acoustic surveys.

	GSA17-East	**GSA17-West**	**GSA18**	**TOT**
2009	122170	364470	104022	590662
2010	166325	479341	50692	696358
2011	46472	441520	33997	521989
2012	11639	528324	72785	612748
2013	39711	373461	61596	474768
2014	27868	262461	83624	373953
2015	23907	232261	33164	289331

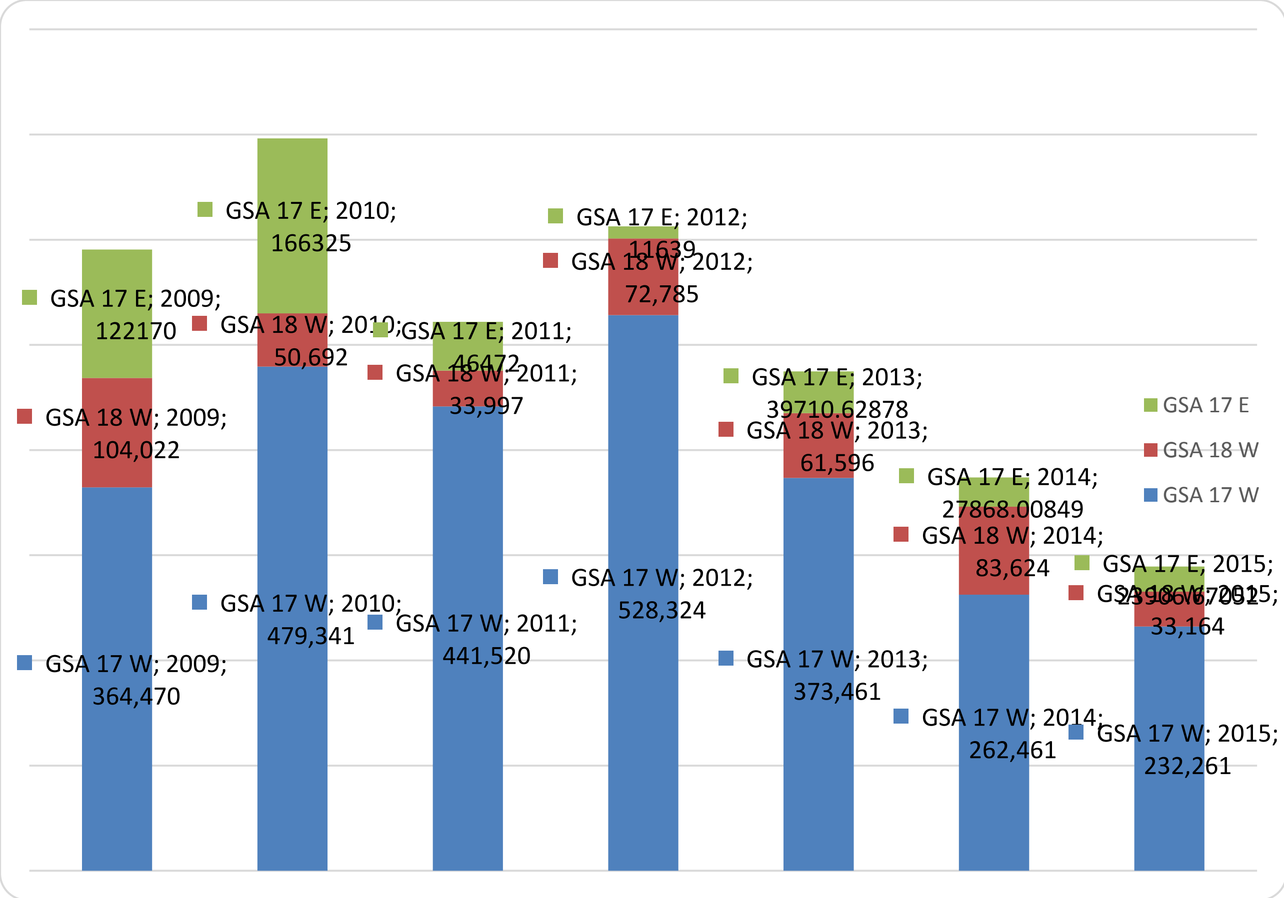


Figure 6.5.4.2. European Anchovy in GSAs 17-18. Total biomass (tons) estimated by the acoustic surveys.

Data exploration of the tuning data is showed in the figures below (Figure 6.5.4.3). The data showed a generally good internal consistency.

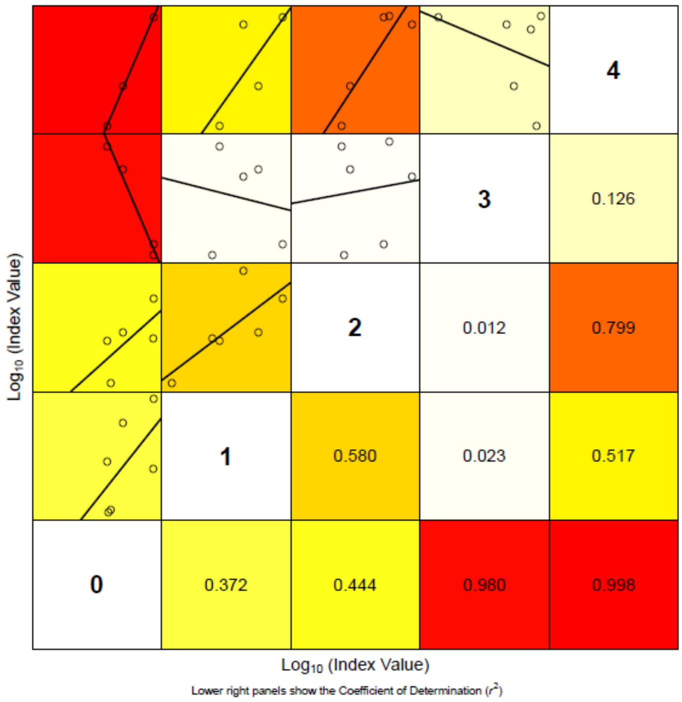


Figure 6.5.4.3. European Anchovy in GSAs 17-18. Internal consistency between ages for the acoustic survey.

The trend in numbers at age for the three surveys is shown in Figure 6.5.4.4.

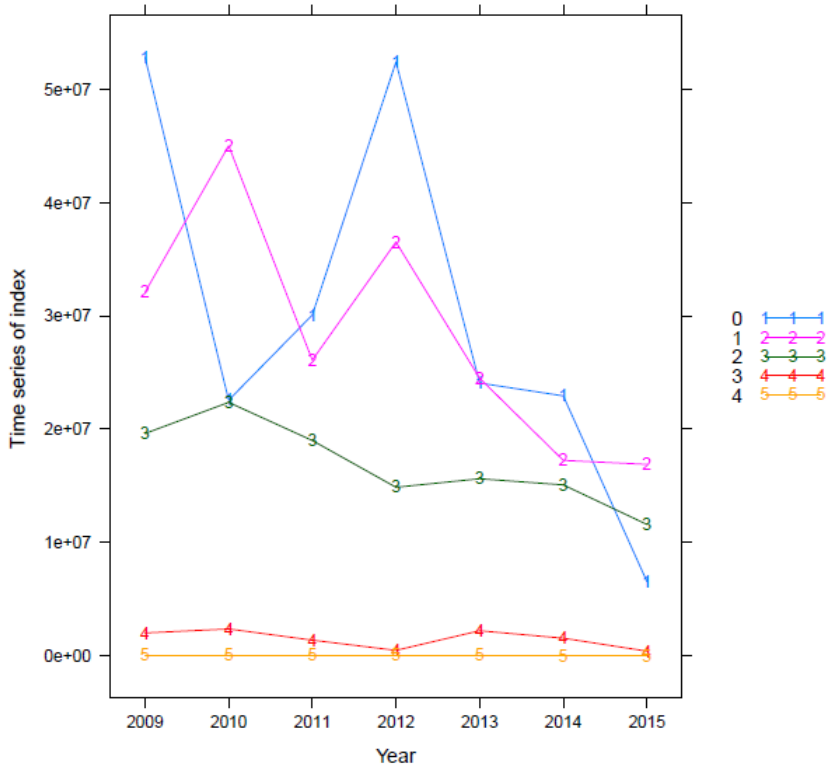


Figure 6.5.4.4. European Anchovy in GSAs 17-18. Trend in numbers at age for the acoustic survey in GSAs 17-18.

6.6. DATA GATHERING OF SARDINE IN GSA 17-18

6.6.1. Stock Identity and Biology

Although there is some evidence of differences on a series of morphometric, meristic, serological and ecological characteristics, the lack of genetic heterogeneity in the Adriatic stock has been demonstrated through allozymic and mitochondrial DNA (mtDNA) surveys (Carvalho *et al.*, 1994) and through sequence variation analysis of a 307-bp cytochrome b gene (Tinti *et al*., 2002). Also, Ruggeri *et al*. (2013) supports the hypothesis of one stock on the basis of microsatellites DNA, even if suggests that some of the genetic homogeneity observed could be apparent and the identification of a subtle structuring in sardine population could be limited by technical difficulties and by the incomplete knowledge of molecular mechanisms. Therefore, in this year assessment, and according to the fact that a lot of vessels registered in GSA 18 fish sardines in GSA 17, it was decided to merge the two GSAs.

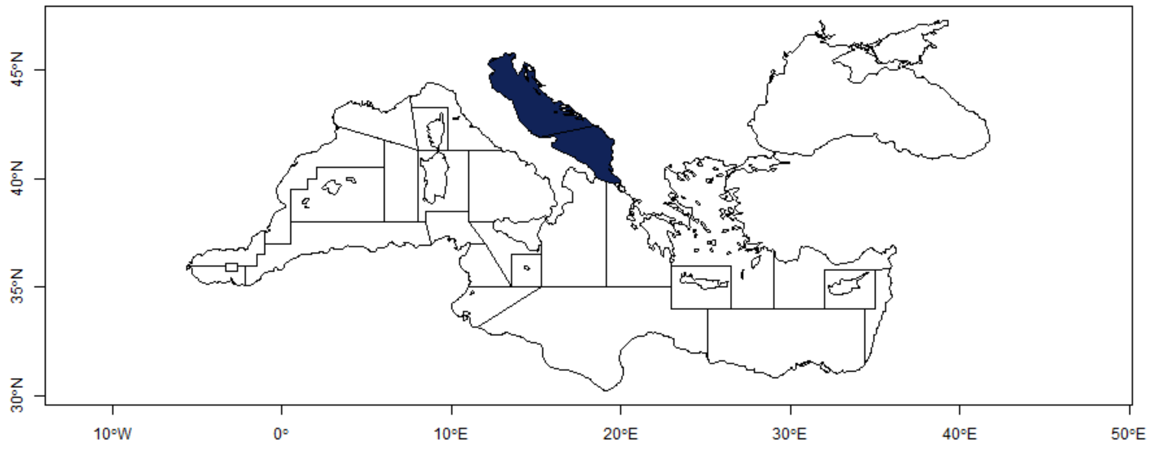


Figure 6.6.1.1. Geographical location of GSAs 17 - 18

Growth

On April 2015, AdriaMED project organised a workshop on otolith reading to harmonise and agree on common criteria of age assignment for sardine in the Adriatic Sea. The results of the workshop are available in AdriaMed (2015). As a result, considering the difference between the new procedure and the previous reading, it was decide to use the new ALK agreed from 2014 to estimate new growth parameters (and re-estimate consequently new values of natural mortality M), and to calculate the numbers at age given the length frequency distribution of both catch and survey data for the whole data series.

The growth parameters were not re-estimated during this meeting, but the same parameters as in previous GFCM 2015 stock assessment were used (Table 6.6.2.1). Age-length and age-weight keys were produced using otolith readings made in accordance with guidelines from AdriaMed workshop (Split, April, 2015). The growth parameters used during the EWG 16-13 were:

Table 6.6.1.1. Sardine in GSAs 17-18. Von Bertalanffy growth and length-weight parameters used.

	Growth parameters			Length-weight	
	L_{inf}	k	t_0	a	b
Sex Combined	19.8	0.38	-1.785	0.0058	3.119

Maturity

Table 6.6.1.2. Sardine in GSAs 17-18. Proportion of mature specimens at age.

Period	Age	0	1	2	3	4
1975-2015	Prop. Matures	0.5	1.00	1.00	1.00	1.00

Natural mortality

Table 6.6.1.3. Sardine in GSAs 17-18. Natural mortality vector by age from Gislason et al. (2010).

Period	Age	0	1	2	3	4
1975-2015	M	1.06	0.83	0.69	0.61	0.48

6.6.2. Catch data

General description of Fisheries

Sardine is a commercially very important species in the Adriatic Sea: it is targeted mainly by pelagic trawlers (Italy) and purse seiners (Croatia, Slovenia, Italy). The number of vessels targeting adult sardine is around 400. Most of the Italian boats whose port of registry is located in GSA 18 actually fish and land in GSA 17. In Montenegro most of the catches are originated from small-scale beach seine fisheries from the fishery with small purse seiners in coastal waters (< 70 m depth); currently, the three existing large purse seiners as well as the pelagic trawler are currently not active due to market constrains and lack of skilled fishers (UNEP-MAP-RAC/SPA. 2014): the catches therefore are likely to be rather low (FAO-Statistic Database) but no information on the real magnitude and on length structure of the catches are available. Such as for Montenegro, almost no information are available for Albania, nevertheless from the FAO database it appears that also Albanian catches are small .

In addition to fisheries targeting adult population of sardine, there was also a so called "bianchetto fishery" targeting juvenile specimens. According to the information from EU-FP6 SARDONE Project, the bianchetto fishery is carried out along most of the Italian coast with gears differing from area to area. In the past, this fishery was authorised by the EC and legislated by a series of National Ministerial Decrees until 2010, but nowadays it is closed. Manfredonia (south-western Adriatic; Fig. 1) has, by far, the highest number of authorised boats in Italy, accounting for an average 33% of all licences released. Here, contrarily to other areas where sardine fry is fished by means of seines, the fishery is a trawl fishery which makes use of a net with 2 cod-ends, the innermost one with larger mesh sizes (15 mm stretch) and the outermost with very fine meshes (5 mm stretch) (Ungaro et al., 1994).

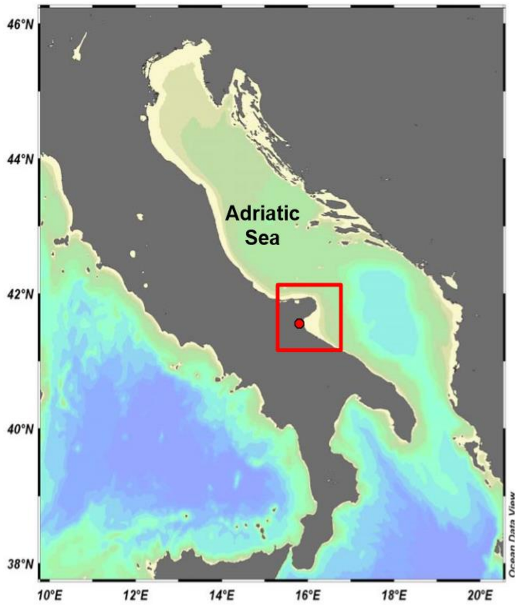


Figure 6.6.2.1. Sardine in GSAs 17-18. Map of the Adriatic Sea: the Gulf of Manfredonia is enclosed within the red box (source: SARDONE Project). *Ref: Ungaro, N., Casavola, N., Marano, G. and Rizzi, E. 1994. "Bianchetto" and "Rossetto" fry fisheries in the Manfredonia Gulf: effort exerted and catch composition. Oebalia, 10: 99-106.*

Management regulations applicable in 2015

A multi–annual management plan for small pelagic fisheries in the Adriatic Sea has been established by the General Fisheries Commission for the Mediterranean (GFCM) in 2012. Besides, Italy has been enforcing for years a general regulation concerning the fishing gears and since 1988 a suspension (about one month) of fishing activity of pelagic trawlers in summer. A closure period is observed from 15th December to 15th January from the Croatian purse seiners. A temporal fishing closure period of around 50 is observed by the Italian fleet.

Landings

Concerning GSA 17, landings and catch at age data from 2004 were available through the DCF database for Italy and Slovenia. For Croatia, data from 2004 to 2012 were available through the Croatian experts, since Croatia is participating to the Data Collection Program starting in 2013. Data sets from last GFCM assessment were updated and used as a basis in this assessment.

Concerning GSA 18, the data were available through the DCF program starting in 2005; before that, the data were reconstructed as follows:

- 1975-1994: total landings for maritime compartment from the Italian National Institute of Statistic. The data were available until 1999, but in the last 5 years of data, the landings showed an unreliable pattern, with high peaks. A similar behaviour was evident also for the landings of another small pelagic, i.e. anchovy, and it was therefore ascribed to some sampling issues (e.g. changing in the sampling methodology). For this reason the data from 1995 to 1999 were not included.
- 1995-2004: an average proportion of catches in GSA 18 over the catches in GSA 17 was estimated from the total landings available from the sampling program from 2006 to 2013 (i.e. GSA 18/GSA 17 = 12.3%). This ratio was used to derive an estimate of GSA 18 landings from GSA 17 for the period 1995-2004.
- In 2010 data were also not available for sardine, therefore the same procedure applied for the years from 1995 to 2004 was used.

The reconstructed landings are presented in Figure 6.6.5.3.1. To account for the landings of Albania and Montenegro, the FAO Official Fisheries Statistics (version 2016) were used.

The catches started to decrease in the late eighties reaching a minimum in 2006 with 20,475 tons. In the last 8 years the Croatian catches grew high, therefore catches reached a maximum in 2014 with about 82,539 tons (about 80% of the overall catches are from Croatia).

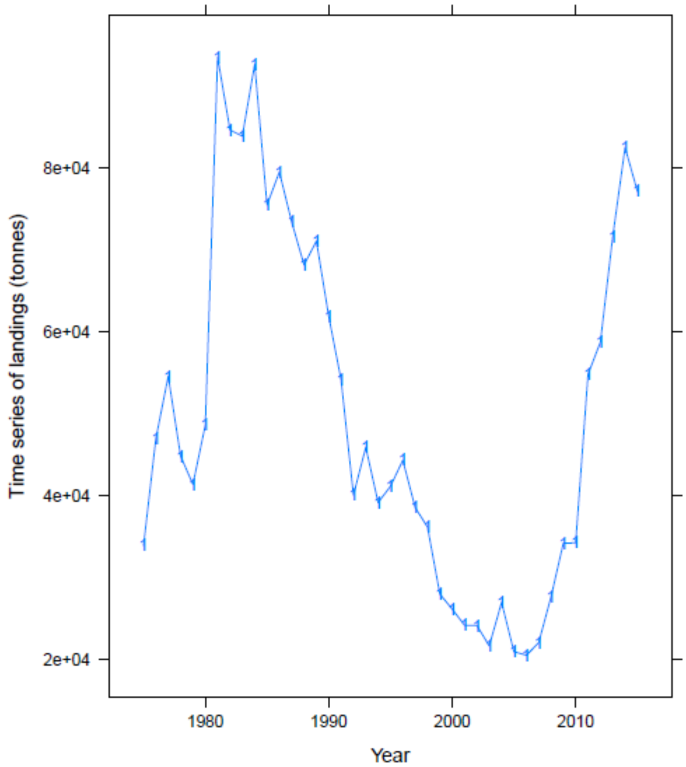


Figure 6.6.2.2. Sardine in GSAs 17-18. Total reconstructed landings (in tons) by GSA from 1975 to 2015.

The following table shows the annual landings (t) of sardine in GSAs 17-18.

Table 6.6.2.1. Sardine in GSAs 17-18. Total landings (tons) by year for the entire GSA 17-18.

Year	Landings (t)	Year	Landings (t)
1975	33887	1996	44310
1976	46985	1997	38522
1977	54576	1998	36139
1978	44820	1999	27949
1979	41362	2000	26107
1980	48593	2001	24138
1981	93559	2002	24101
1982	84688	2003	21620

1983	**83927**	**2004**	**26930**
1984	**92724**	**2005**	**20907**
1985	**75521**	**2006**	**20475**
1986	**79547**	**2007**	**21984**
1987	**73428**	**2008**	**27584**
1988	**68191**	**2009**	**34164**
1989	**71098**	**2010**	**34214**
1990	**61882**	**2011**	**54816**
1991	**54138**	**2012**	**58733**
1992	**40050**	**2013**	**71643**
1993	**45885**	**2014**	**82539**
1994	**39143**	**2015**	**77182**
1995	**41129**		

The mean weight-at-age of catches is shown in Table 6.6.2.2. The mean weight-at-age vector was estimated averaging the data provided in the DCF data call 2016.

Table 6.6.2.2. Sardine in GSAs 17-18. Mean weight-at-age vector in the catches for the entire time series (1975-2015).

Period	**Age**	**0**	**1**	**2**	**3**	**4**
1975-2015	**Mean Weight (kg)**	**0.016**	**0.020**	**0.025**	**0.032**	**0.039**

Discards

Discards were not included in the assessment, as considered negligible (on the overall discards are around 8% for the Italian fleet in GSA 17 in the period 2011-2013, and 3% for the Slovenian fleet in GSA 17 in the period 2005-2013).

6.6.3. Fishing effort data

The number of vessels from Italy, Croatia and Slovenia targeting this species is around 400. In Montenegro most of the catches are originated from small-scale beach seine fisheries and from the fishery with small purse seiners in coastal waters (< 70 m depth); currently, the three existing large purse seiners as well as the pelagic trawler are currently not active due to market constrains and lack of skilled fishers (UNEP-MAP-RAC/SPA. 2014): the catches therefore are really low (FAO-Statistic Database) but no information on the real magnitude and on length structure of the catches are available. Such as for Montenegro, almost no information are available for Albania, nevertheless from the FAO database it appears that also Albanian catches are small.

6.6.4. Survey Indices of abundance and biomass by year and size/age

MEDIAS

In the western part of Adriatic Sea the acoustic survey was carried out since 1976 in the Northern Adriatic (2/3 of the area) and since 1987 also in the Mid Adriatic (1/3 of the area), and in the MEDIAS framework since 2009. In the GSA 18, acoustic survey was carried out from 2009. The eastern part was covered by Croatian national pelagic monitoring program PELMON until 2012 and later on through DCF. Fish biomass in a part of eastern survey area not covered with acoustic sampling in 2011-2012 was estimated as its average percentage of biomass during 2009-2015. The survey methods for MEDIAS are given in the MEDIAS handbook (MEDIAS, March 2015).

The data from all surveys in GSA 17 and GSA 18 have been used as one single independent tuning index in the form of numbers-at-age from 2009 to 2015.

A revised 2014 ALK, following the guidelines of AdriaMed workshop (Split, April 2015) have been used to split the number at length into numbers at age for the 2009 to 2015 in the western part of GSA 17 and GSA 18. ALKs (2013-2015) from survey on the eastern part of GSA 17 were obtained on the basis of age readings following the same guidelines of before mentioned AdriaMed workshop.

Acoustic sampling transects and the total area covered in GSA 17 is shown in Figure 6.6.4.1.

Figure 6.6.4.1. Acoustic transects for the western echo survey (white tracks) and the eastern echo survey (pink tracks) for the GSA 17 and GSA 18.

Trends in abundance & biomass

Biomass estimates from the acoustic surveys in the period 2009-2015 for the entire Adriatic Sea indicate the highest biomass in 2011 and the lowest biomass in 2012. A decrease can be noticed in the last 3 years, mostly due to decrease of sardine biomass in the western part of the Adriatic sea, while its abundance in the eastern part is stable.

Total biomasses of sardine in tons from eastern part of GSA 17 and western part of GSAs 17 and 18 estimated by acoustic surveys in the period 2009-2015 are given in Table 6.6.4.1 and are shown in Figure 6.6.4.2.

Table 6.6.4.1. Sardine in GSAs 17-18. Total biomass (tons) estimated by the acoustic surveys.

	GSA17-East	GSA17-West	GSA18-West	TOT
2009	**231809**	**137313**	**39409**	**408531**
2010	**125031**	**132838**	**27461**	**285330**
2011	**79372**	**401099**	**73361**	**553832**
2012	**89329**	**133745**	**27271**	**250345**
2013	**104225**	**326444**	**101428**	**532097**
2014	**113089**	**298937**	**63179**	**475204**
2015	**114002**	**275434**	**6885**	**396322**

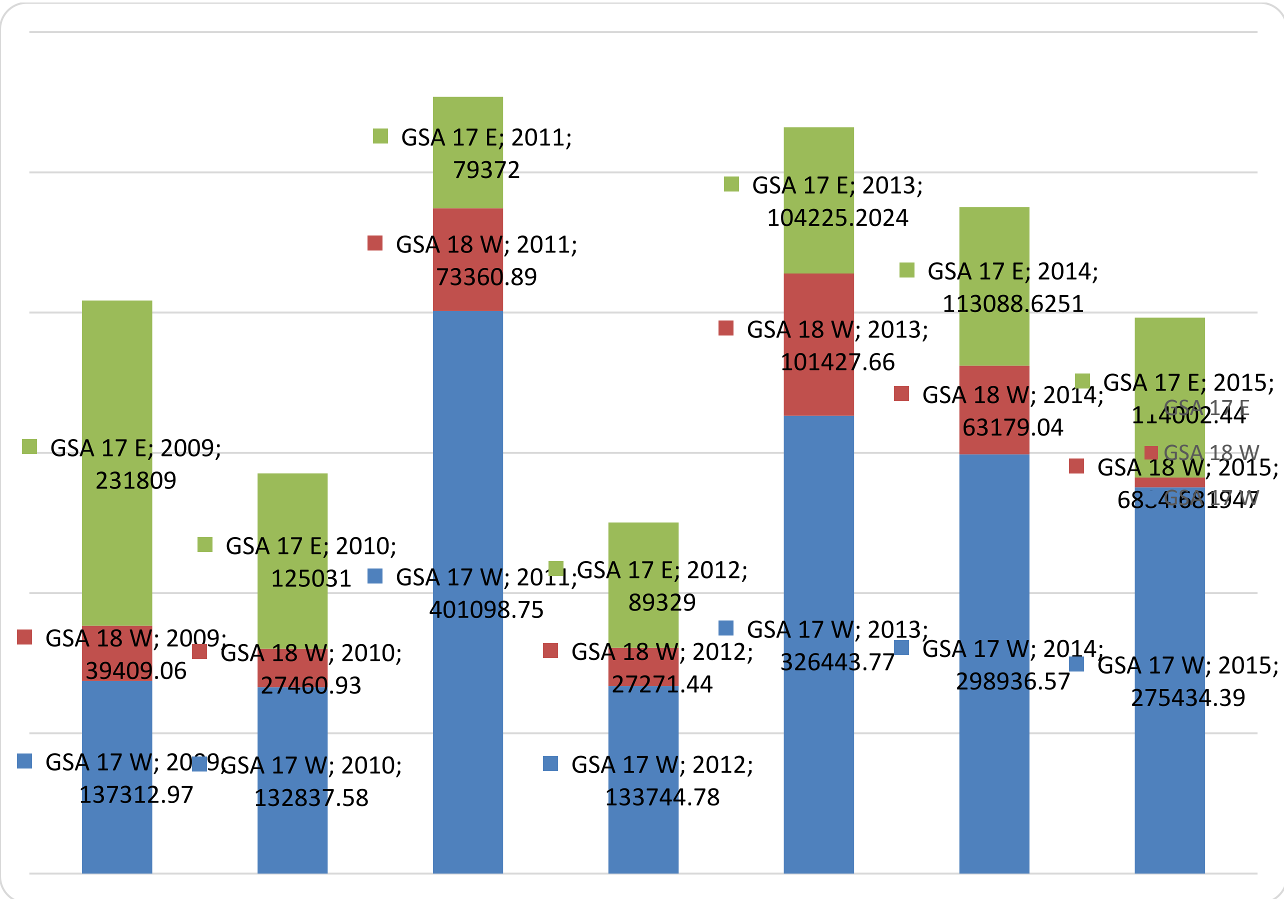


Figure 6.6.4.2. Sardine in GSAs 17-18. Total biomass (tons) estimated by the acoustic surveys (2009-2015).

Data exploration of the tuning data is showed in the figures below (Figure 6.6.4.3). Even though the data showed a general lack of internal consistencies, they were used to tune the assessment.

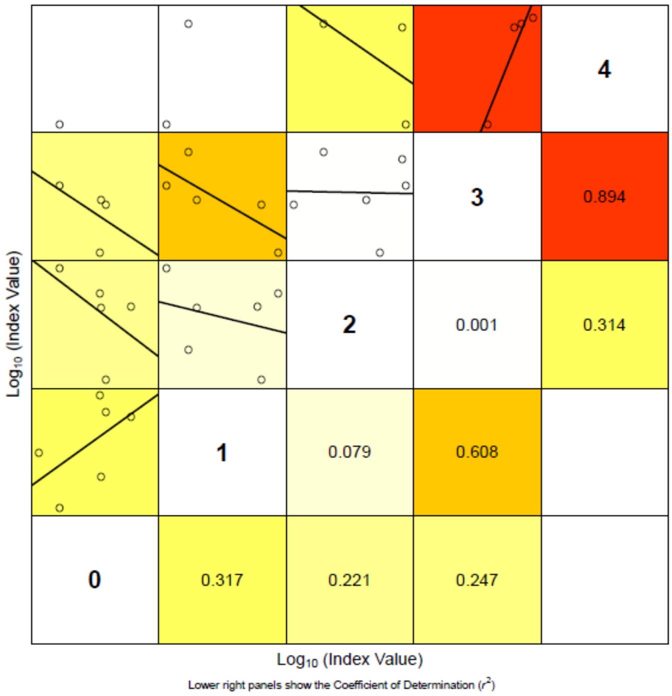


Figure 6.6.4.3. Sardine in GSAs 17-18. Internal consistency between ages for the tuning fleet (combined surveys in western and eastern GSA 17, and western GSA 18).

The trend in numbers-at-age for the combined acoustic surveys used as tuning fleet in the assessment is shown in Figure 6.6.4.4.

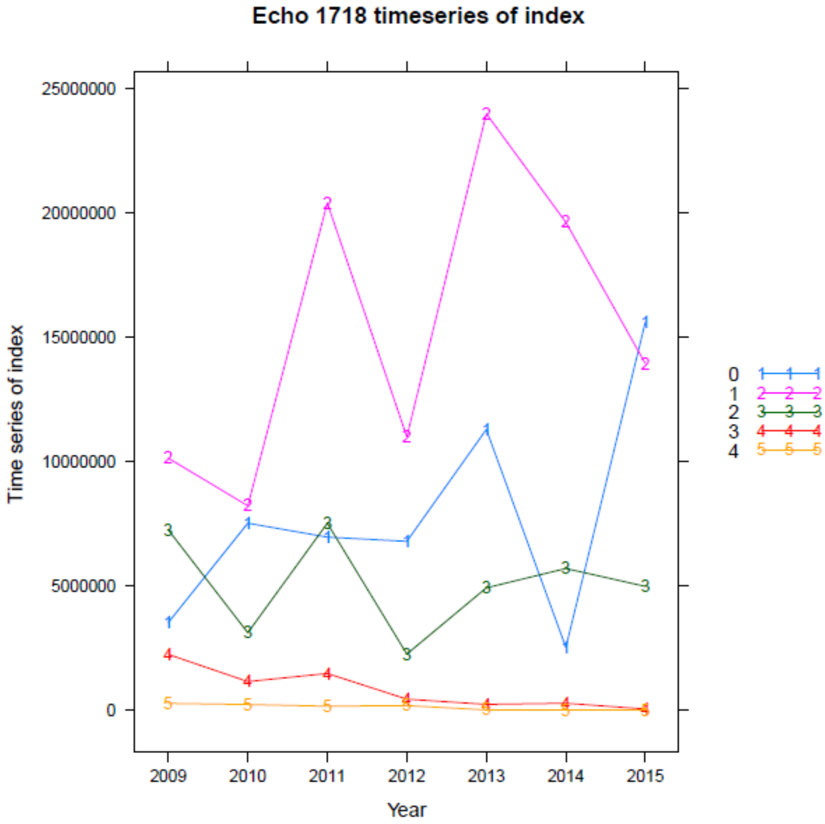


Figure 6.6.4.4. Sardine in GSAs 17-18. Trend in numbers at age for the tuning fleet (combined surveys in western and eastern GSA 17, and western GSA 18).

6.7. DATA GATHERING IN ATLANTIC HORSE MACKEREL IN GSAs 1,5,6,7

6.7.1. Stock Identity and Biology

According to the main outcomes of the EU StockMed project carried out in MAREA framework, HOM in the GSAs 1, 5, 6, 7 seems to belong to a single stock unit. STECF EWG 16-13 was asked to assess the state of Atlantic horse mackerel in the whole area.

The area, hereafter named region 1 (GSAs 1, 5, 6,7), include 2 countries (ESP; FRA). It covers a surface of about 71775 km2 in the depth range between 10-800 m (Figure 6.7.1.1).

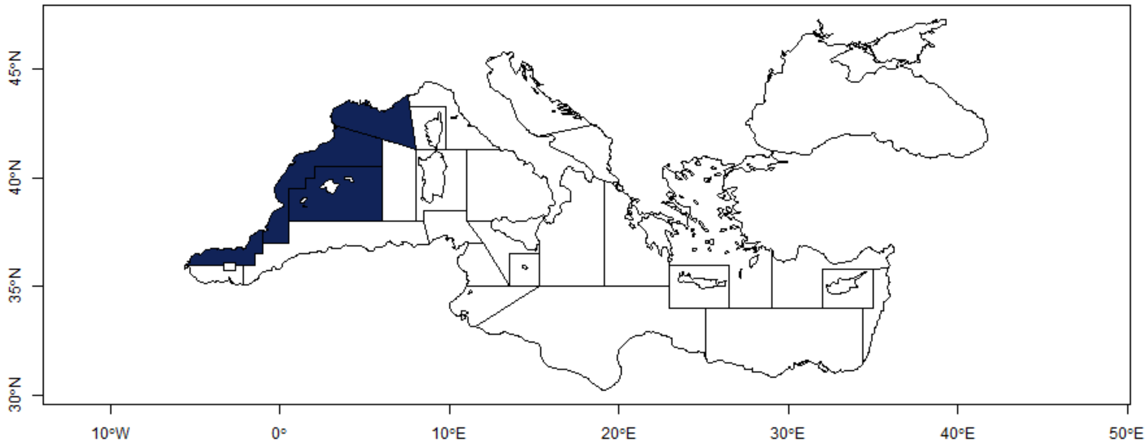


Figure 6.7.1.1. Geographical location of GSAs 1,5,6,7

Of the three species of horse mackerel living in Mediterranean (*T. trachurus*, *T. mediterraneaus* and *T. picturatus*), *Trachurus trachurus* can be distinguish by the accessory lateral line along the whole back which is provided with very large bone scutes. However sometimes, particularly in juveniles, the identification of the species is not easy.

It is a gregarious bentho-pelagic species whit a broad geographical distribution which cover the whole Mediterranean, Black Sea included (Bini, 1968; Relini and Lanteri, 2010), the Atlantic Ocean from Iceland to Senegal and the Canary Islands, Madeira and Cape Verde (Abaunza et al., 2008), and the western coasts of the Pacific Ocean (Karaiskou et al., 2003).

Adults of *T. trachurus* form large shoals in deep waters and medium-deep waters and is frequently found at a depth between 10 and 500 m. Juveniles swim in small shoals, under floating objects or megaplancton (such as *Rhizostoma pulmo* or *Cotylorhiza tubercolata*), and tend to concentrate within 100-150 m depth (Nannini et al., 1997; Matarrese et al., 1998).

The Horse Mackerel species can reach a maximum size of 60 cm TL, although in the Mediterranean Sea, specimens caught with trawl or seine do not exceed 30 cm TL, while those caught with bottom longline can reach up to 50 cm TL (Relini et al., 1999).

As concern feeding HOM change feeding habits with age, shifting from zooplanktivorous (feeds mainly on planktonic crustaceans) to ichthyophagous (youth stages of other fishes, and also adult stages of anchovies and sardine) with rising age (ICES 2013 southern horse mackerel stock annex).

Landings in Region 1 are mostly covered by Spanish data only from GFCM 1, and the available time-series is long (2002-2015 by quarter) although not all gears are represented in the whole time-series.

Growth

Growth parameters have been derived from the dataset of biological parameter (gp.csv) as reported in the last data call (Table 6.7.1.4) for the GSA1.

Table 6.7.1.4. Atlantic Horse Mackerel. Growth parameters.

Stock Identification	L_inf	k	t0	L-W: a	L-W: b	Source
Region 1	45	0.1044	-1.901	0.0099	2.9853	ESP GSA1

Maturity

Maturity ogives were taken from DCF data. L50 is reported at 17-20 cm TL corresponding to a 0-1 age class.

Table 6.7.1.5. Atlantic Horse Mackerel. Proportion of mature fish by age.

Age	0	1	2	3	4	5	6	7	8	9	10
Maturity	0.04	0.24	0.76	0.97	1	1	1	1	1	1	1

Natural mortality

For the natural mortality EWG16-13 refers to the ICES WGHANSA (2013) for the southern horse mackerel stock (Table 6.7.1.6).

Table 6.7.1.6. Atlantic Horse Mackerel. Natural mortality, as used by ICES WGHANSA for the southern horse mackerel stock.

Age	0	1	2	3	4	5	6	7	8	9	10
M	0.9	0.6	0.4	0.3	0.2	0.15	0.15	0.15	0.15	0.15	0.15

6.7.2. Catch data

The time series of annual data on landings and discards was available for 2002-2015 for most of the gears as reported in table 6.7.2.1.

Table 6.7.2.1. Atlantic Horse Mackerel in GSAs 1,5,6,7. Continuous time-series per and gear.

Stock Identification	GSA	Gear	Landings series	Discards series
Region 1	1	GNS	2002-2015	
		GTR	2002-2015	
		LHP	2013-2015	
		LLS	2011-2015	
		OTB	2002-2015	
		PS	2002-2015	

Landings

As reported on the DCF data call total landings (tonnes) area available since 2002 and almost equally divided by 2 gears (OTB and PS) in the first 10 years (2002-2012), while in the last 3 years are mostly by the OTB (Figure 6.7.2.1, Tables 6.7.2.2 and 6.7.2.3).

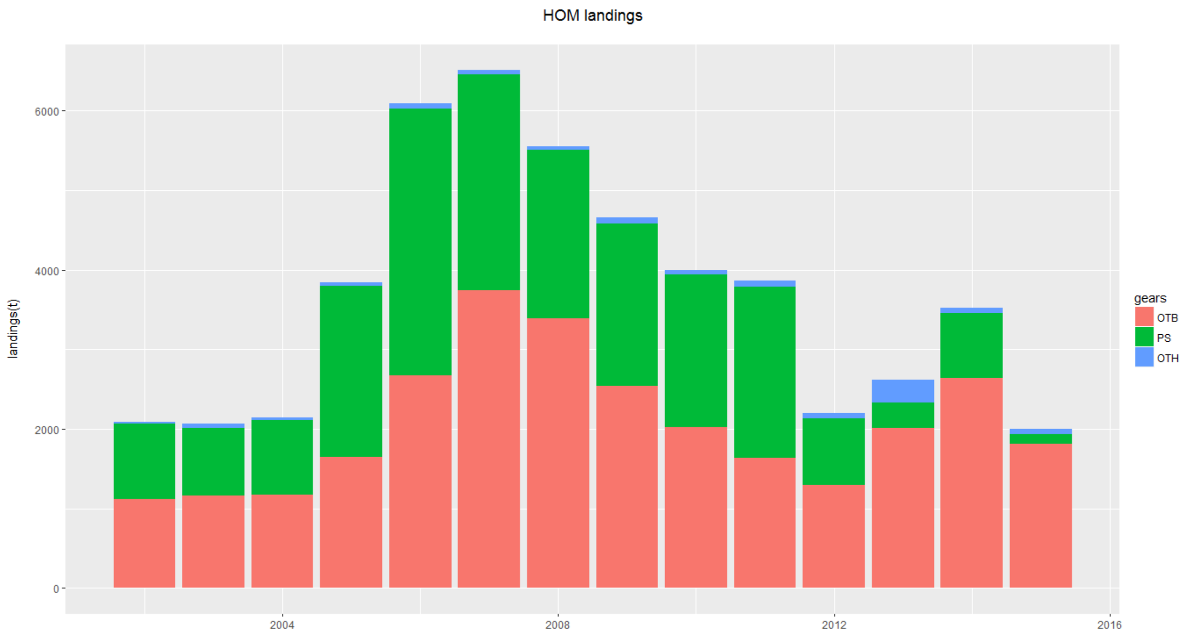


Figure 6.7.2.1. Atlantic Horse Mackerel in GSAs 1,5,6,7. Total landings by year and main fishing gear in the region 1 (GSAs 1, 5, 6, 7).

Table 6.7.2.2 Atlantic Horse Mackerel in GSAS 1,5,6,7. Year trend on total landings and percent contribution by main gear in the region 1 (GSAs 1, 5, 6, 7).

Year	OTB	PS	OTH	**Total**	%OTB	%PS	%OTH
2002	1118	947	21	**2086**	53.6	45.4	1.0
2003	1161	845	62	**2068**	56.1	40.9	3.0

2004	1167	937	38	**2142**	54.5	43.8	1.8
2005	1802	2272	124	**4198**	42.9	54.1	3.0
2006	4317	4447	527	**9291**	46.5	47.9	5.7
2007	5425	3476	543	**9444**	57.4	36.8	5.7
2008	4412	2680	493	**7585**	58.2	35.3	6.5
2009	3681	2707	603	**6990**	52.7	38.7	8.6
2010	3168	2453	597	**6217**	51.0	39.5	9.6
2011	3233	3029	616	**6878**	47.0	44.0	9.0
2012	2647	1351	448	**4446**	59.5	30.4	10.1
2013	3442	622	618	**4682**	73.5	13.3	13.2
2014	3846	990	385	**5221**	73.7	19.0	7.4
2015	3003	272	397	**3672**	81.8	7.4	10.8

Table 6.7.2.3. Atlantic Horse Mackerel in GSAS 1,5,6,7. Total landings by year and gear in the region 1 (GSAs 1, 5, 6, 7).

Year	-1	FPO	GND	GNS	GTR	LHP	LLD	LLS	OTB	OTM	PS	PTM	SB	SV	TBB
2002	0	0	0	11	11	0	0	0	1118	0	947	0	0	0	0
2003	0	0	0	46	16	0	0	0	1161	0	845	0	0	0	0
2004	0	0	0	27	10	0	0	0	1167	0	937	0	0	0	0
2005	0	0	0	100	24	0	0	0	1802	0	2272	0	0	0	0
2006	11	0	68	144	289	0	0	14	4317	0	4447	2	0	0	0
2007	29	0	60	138	293	0	0	22	5425	0	3476	0	0	0	0
2008	18	0	36	135	280	0	3	22	4412	0	2680	0	0	0	0
2009	4	0	65	157	330	0	0	46	3681	0	2707	0	0	0	0
2010	11	0	26	148	370	0	0	41	3168	0	2453	0	0	0	0
2011	2	0	7	194	341	0	2	46	3233	3	3029	18	0	0	3
2012	1	0	0	144	187	0	3	27	2647	84	1351	0	1	1	0
2013	0	0	0	460	111	1	0	45	3442	0	622	0	1	1	0
2014	0	0	0	200	50	0	0	135	3846	0	990	0	0	0	0
2015	1	0	0	181	124	0	0	85	3003	5	272	0	0	0	0

Landings at length were available from 2003 and reported by main fishing gear (Table 6.7.2.4, Fig. 6.7.2.2). No great differences in landings by OTB and PS are detected.

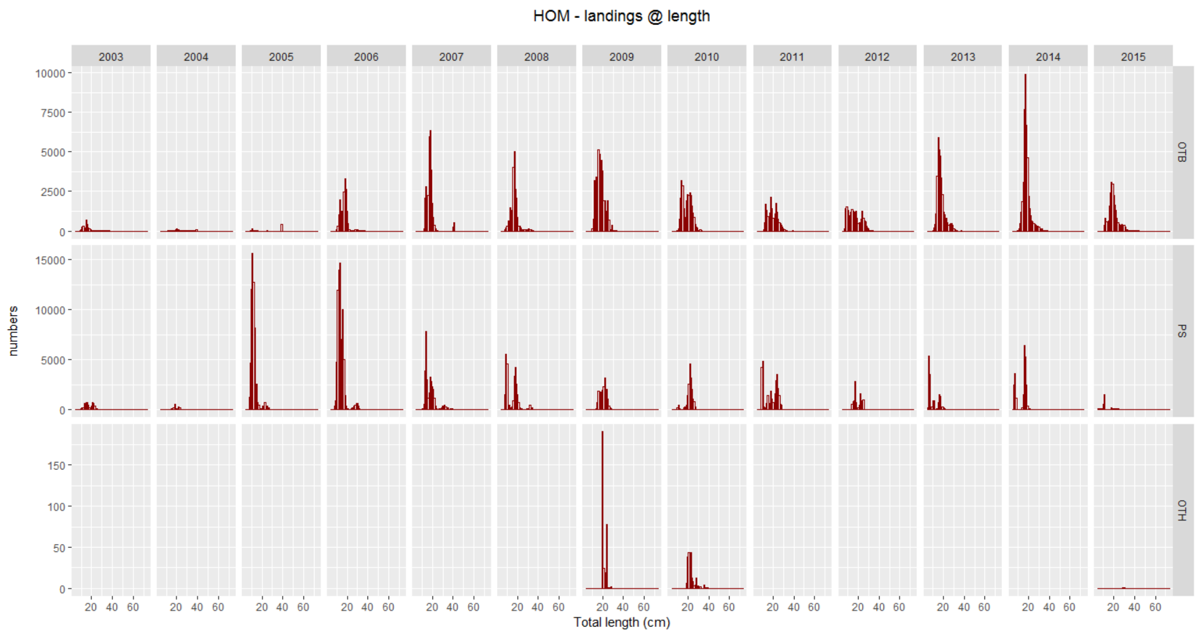


Figure 6.7.2.2. Atlantic Horse Mackerel in GASs 1,5,6,7. Length at age distribution by year and main fishing gear in the region 1.

Table 6.7.2.4. Atlantic Horse Mackerel in GASs 1,5,6,7. Landings at length by year and main gear in the region 1.

gear	Len	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OTB	7	0	0	0	0.1	0	0	0	0	0	164.7	0	0	0
OTB	8	0.6	0	2.1	0	1.1	85.4	0	5.7	0	1441.3	0	0	0
OTB	9	13.8	0.2	11.5	0.7	0	218.4	0	1.9	0	1523.7	0	6.9	0
OTB	10	73.6	2.9	32.4	69.2	0	314.3	142.1	9.1	2.6	1307.3	37.7	5.4	0
OTB	11	255.8	4.4	125.2	319.8	0	623	752.5	146.7	83.4	953.3	184.1	165.1	367.9
OTB	12	308.9	7.2	54.7	1025.6	148.1	568.8	3169.9	731.8	517.2	933.6	434.8	465.1	808.2
OTB	13	114.5	14.1	47.6	1991.2	2093	1472.2	2334.7	2076.9	1700.8	1220.8	1106.2	1215.5	580.7
OTB	14	199	13.8	35	1229.6	2814.2	1090.5	3422.3	3171.8	1305.1	1388.3	3460.7	1834	497.7
OTB	15	683.2	16.1	17.2	454.6	1890.8	1290.5	2703.7	2861	927.4	1272.3	5900.8	3107.6	662
OTB	16	444.9	22.9	10.4	1231.2	2275.1	3996.5	5108.9	1438.7	829.6	1144.8	5152.3	7665.7	1574.1
OTB	17	190.4	23.7	5.5	2447.5	5939.1	5036.4	4872.2	838.9	1140.1	1212.3	4757.9	9885.1	2403.2
OTB	18	134.4	37.8	2.8	3301	6357.7	2643.4	3964.5	873.8	2158.3	1271.3	3381.4	6680.1	3098.4
OTB	19	68.8	81.7	5	2629.3	3832.4	2079.1	4437.6	1892.4	1416.3	801.8	2305.4	4633.2	2977.4
OTB	20	28.3	121.6	0.2	1276.2	1740.1	847.4	3815.9	2279.4	831.8	486.9	1192.6	2198.1	2253.3
OTB	21	34.8	105.5	0.2	454.6	874.2	302	1912.4	2242.1	642	553.3	1024	1408.1	1647.5
OTB	22	26	74.7	1.7	98.8	361.8	334.1	1895.9	2434.3	1074.5	457.3	747.8	961	1280.5
OTB	23	43.3	34.6	4.3	34.9	121.9	186.9	1226.3	2251.7	1776	762	820.1	648.7	820.9
OTB	24	39.8	22.5	5.7	34.6	48.5	87.4	1079.2	1593.6	1220.4	1260	560	570.7	546.5
OTB	25	30.5	10.3	24.6	28.5	33.5	53.3	1920.7	1155.2	777.2	830.6	377.5	475	406.2
OTB	26	19.4	29	4.3	37.1	2	81.2	692.1	838.9	549.9	664.2	417.3	441.9	369.6

gear	Len	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OTB	27	27.9	36.3	4.4	37.6	2.9	97	88.9	446.7	489.9	582.6	472.7	376.9	362.8
OTB	28	21.5	36.2	3.2	78.4	1.7	40.6	37	252.4	384.4	314.6	458.9	312.3	442.5
OTB	29	43.6	38.9	4.6	48.8	2	111.7	371.1	175.1	263.9	218.2	390.6	309.6	356.1
OTB	30	25.8	34.9	1.4	81.2	3.2	103.1	14.4	43.5	138.7	131.8	164.8	240.3	361.2
OTB	31	19.2	30.5	2.2	47.2	5.8	146.8	1.5	53.7	80	47	83.9	153.4	261.5
OTB	32	32.3	13.6	1.9	24.4	3.5	76.2	14.9	89.3	34.1	38.5	54.3	84.5	110.3
OTB	33	19.8	7.4	0.7	24.4	0.9	65	8.3	10.5	29.4	26.3	16.7	133.4	62.4
OTB	34	20.7	6.8	0.4	12.6	1.5	32.3	1.6	5	5.4	8.1	3.1	27.4	27.7
OTB	35	19.8	12.8	0	11.4	0.5	17.2	0	5.7	2.2	2.1	1.1	19.3	16
OTB	36	9.9	19.6	0.4	20.9	0	0.6	0	2.5	3.4	1.1	1.4	16.4	5
OTB	37	9.9	16.2	0.6	10.3	0	0	1.8	3.2	0	1.2	7.1	12.5	9.6
OTB	38	4.9	6.1	1	3.2	0.4	0.6	0	1.2	0	0	0	9.6	17
OTB	39	0	71.4	411.1	1.7	0	0	0	0.6	8.1	0	0.2	0	16.1
OTB	40	0	2.6	0	0.8	258.8	0	0	1.2	0	0	0.6	0	13.2
OTB	41	0	1.2	0	1.7	516.7	0	0	0.3	0	0	0	0	8.9
OTB	42	0	0	0	0.9	0	0	0	0.3	0	0	0	0	8.5
OTB	43	0	0	0	0.1	0	0	0	0	0	0	0	0	53.6
OTB	44	0	0	0	0.5	0	0	0	0	0	0	0	0	12
OTB	45	0	0	0	0	0	0	0	0	0	0	0	0	1.9
OTB	46	0	0	0	0	0	0	0	0	0	0	0	0	0.2
OTB	47	0	0	0	0	0	0	0	0	0	0	0	0	1.8
OTB	48	0	0	0	0	0	0	0	0	0	0	0	0	0.2
OTB	49	0	0	0	0	0	0	0	0	0	0	0	0	4.5
OTB	50	0	0	0	0	0	0	0	0	0	0	0	0	0.1
OTB	51	0	0	0	0	0	0	0	0	0	0	0	0	2.4
OTB	53	0	0	0	0	0	0	0	0	0	0	0	0	3.2
OTB	54	0	0	0	0	0	0	0	0	0	0	0	0	0.1
OTB	73	0	0	0	0	0	0	0	0	0	0	0	0	1.7
PS	5	0	0	0	0	0	0	0	0	0	0	177.7	0	121.8
PS	6	0	0	66.8	12.2	0	0	0	0	0	0	5402.4	2502.6	121.8
PS	7	0	0	66.8	14.7	0	0	0	0.1	0	0	3530.8	3644.6	0
PS	8	2.1	0	1246.6	334	3.2	1517.2	0	23.5	0	0	0	1137.6	73.4
PS	9	0	2.9	4702.4	869.2	15.8	5562.7	0	17.1	4199.2	0	320.8	0	18.6
PS	10	99.7	5.9	12001.5	4714.8	60.2	4577.9	0	185.2	4821.7	0	867.2	0	577.8
PS	11	224.5	8.8	15633.1	11977.5	152	128.6	0	444	299.4	0	927.8	0	1475.5
PS	12	210.2	12.4	12705.5	13928.7	555.9	428.5	0	134.8	145.7	0	3.5	0	6.8
PS	13	596.4	18.3	8208.8	14612.1	3878.1	171.8	0	15	171.1	2.8	58.7	1.8	37.9
PS	14	624.9	57.1	2288.1	7017.2	7849.5	142.6	87.5	15.1	606.5	541.7	111.9	197	29.7
PS	15	687.6	116.2	2567.5	5064.5	3042.8	275.6	749.1	51	1448.2	812.8	731.3	1496.8	8.1
PS	16	683.9	127	718	9990.4	1153.7	942	1836.1	228.8	552	874.8	1492.2	6446.1	22.8
PS	17	437.6	175.7	419.3	5041.3	1715.5	3326.9	801.3	310.5	666.4	2824	1294.3	5306.7	35.6
PS	18	181.8	507.6	71.6	1420.8	3256.2	4234.3	1739.8	256.2	1874.1	767.8	139.9	2484.5	167.7
PS	19	198.4	102	142.2	332.4	2792.2	2580.2	1427.5	469.1	1045.5	166	292.9	346.7	102.8
PS	20	377.6	44.7	136.7	123.6	2266.4	1516.1	1908.4	1465.6	707.4	224.3	165.4	141.2	148.9
PS	21	745.8	126.4	347.9	104.7	2067.7	714.1	2303.3	2560.4	399.2	426.8	98.6	81.1	139.6

gear	Len	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
PS	22	651.1	259.2	384	54.7	1153.6	242.2	3146.2	4573	1591.2	1628.4	46.8	34.6	101.5
PS	23	363.8	177.7	708.8	27.3	375.7	143.9	1925.3	3156.8	2899.1	933.7	54.7	28.4	117.2
PS	24	73	55.8	414.4	86.3	91	70	2024.3	2048.2	3495.1	587.9	21.1	30.4	85.9
PS	25	69.6	16.6	354.8	185.7	12	45.7	1117	1076.7	2125.9	1023.5	18.4	15.5	47.2
PS	26	26.2	9.3	73.6	69.9	67.2	26	395.5	848.6	1458.8	30.9	20.3	13.3	12.1
PS	27	1.3	14	190.5	390.5	75	12.5	211.2	249.1	506.4	10.9	8.7	8.6	7.1
PS	28	3.3	56.1	48.2	442.7	35.1	0.3	136.7	48.1	429.8	5.5	5.1	7.5	5.9
PS	29	8.8	42.1	12.3	665.5	173.2	71.1	56.4	1.5	3.4	1.8	3.2	0.4	0
PS	30	1.3	60.7	44.4	676.6	374.5	114.7	17.5	2	0	1.8	6.2	0.1	0
PS	31	4	37.4	43.9	339.9	267	122.6	12.9	0.8	2	1.8	0.3	0.1	0
PS	32	0	18.7	51.8	127.1	475.7	442.7	5.5	0.1	0	0	0	0	0
PS	33	0.7	18.7	59.4	41.3	317.8	158.2	3.7	0	0	0	0	0	0
PS	34	4.5	22.3	57	0	211.7	158.2	5.5	0	2.4	0	0	0	0
PS	35	3.2	26	33.3	0	158.9	55.9	1.8	0	6	0	0	0	0
PS	36	3.8	0	28.6	0	3	39.9	1.8	0	1.2	0	0	0	0
PS	37	15.8	0	30	0	56	0	0	0	2.4	0	0	0	0
PS	38	9.5	0	16.6	0	105.4	8	0	0	2.4	0	0	0	0
PS	39	6.3	0	5.3	0	133.1	0	0	0	0	0	0	0	0
PS	40	9.5	0	7.7	0	52.9	35.6	0	0	0	0	0	0	0
PS	41	0	0	6.6	0	0	0	0	0	1.2	0	0	0	0
PS	42	0	0	1.3	0	0	0	0	10.1	0	0	0	0	0
PS	43	0	0	0.5	0	0	0	0	0	0	0	0	0	0
OTH	19	0	0	0	0	0	0	0	6.1	0	0	0	0	0
OTH	20	0	0	0	0	0	0	190.3	38.4	0	0	0	0	0
OTH	21	0	0	0	0	0	0	24.8	43.2	0	0	0	0	0
OTH	22	0	0	0	0	0	0	18.9	25.4	0	0	0	0	0.3
OTH	23	0	0	0	0	0	0	0.8	43.2	0	0	0	0	0.1
OTH	24	0	0	0	0	0	0	77.7	13.1	0	0	0	0	0.1
OTH	25	0	0	0	0	0	0	0	8.7	0	0	0	0	0.1
OTH	26	0	0	0	0	0	0	0.8	2.7	0	0	0	0	0
OTH	27	0	0	0	0	0	0	0	3.8	0	0	0	0	0
OTH	28	0	0	0	0	0	0	1.6	12.8	0	0	0	0	0.4
OTH	29	0	0	0	0	0	0	0	3.6	0	0	0	0	0.5
OTH	30	0	0	0	0	0	0	0	2.7	0	0	0	0	0.5
OTH	31	0	0	0	0	0	0	0	0	0	0	0	0	0.1
OTH	32	0	0	0	0	0	0	0	2	0	0	0	0	0.1
OTH	33	0	0	0	0	0	0	0	0.4	0	0	0	0	0.1
OTH	34	0	0	0	0	0	0	0	0	0	0	0	0	0.1
OTH	35	0	0	0	0	0	0	0	0.2	0	0	0	0	0.1
OTH	36	0	0	0	0	0	0	0	4.7	0	0	0	0	0
OTH	37	0	0	0	0	0	0	0	0.6	0	0	0	0	0.1
OTH	38	0	0	0	0	0	0	0	0.8	0	0	0	0	0.1
OTH	39	0	0	0	0	0	0	0	0.8	0	0	0	0	0
OTH	41	0	0	0	0	0	0	0	0.2	0	0	0	0	0
OTH	42	0	0	0	0	0	0	0	0	0	0	0	0	0.1

gear	Len	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OTH	45	0	0	0	0	0	0	0	0	0	0	0	0	0.1
OTH	46	0	0	0	0	0	0	0	0.2	0	0	0	0	0
OTB	9	0	0	0	0	0	0	0	0	0	0	2.3	0	0
OTB	10	0	0	0	0	0	0	3.3	0	0	146.2	1.8	0	0
OTB	11	0	0	0	0	0	0	0	9.2	0	0	5.4	0	0
OTB	12	0	0	0	0	0	0	0	23	0	4.7	5	10.6	0
OTB	13	0	0	0	0	0	0	7	228	0	42.3	33.3	17	0
OTB	14	0	0	0	0	0	0	16.3	287.8	0	499.1	41.5	12.7	0
OTB	15	0	0	0	0	0	0	23.3	197.3	0	171.7	42.2	17	0
OTB	16	0	0	0	0	0	40.1	14.4	341.3	0	61.2	19.9	14.9	5.9
OTB	17	0	0	0	0	3.6	58	5	141.6	0	71.3	11.3	0	11.8
OTB	18	0	0	0	0	47.6	158.4	14.5	97.7	12.2	31.8	29.1	0	53.2
OTB	19	0	0	0	0	99.7	142.5	4.7	51.1	37.6	51.8	93.9	0	53.1
OTB	20	0	0	0	0	98.4	77.4	2.1	76.4	69.2	65	131.7	8.2	155.9
OTB	21	0	0	0	0	24.6	12.7	11.7	30.6	69.1	52.9	119.2	15.1	194.3
OTB	22	0	0	0	0	10.3	23.5	10.2	29.5	147.1	104.2	128.5	15.1	215
OTB	23	0	0	0	0	3.6	40.1	38	173.4	165.4	117.5	120.7	62.2	164.4
OTB	24	0	0	0	0	3.1	26	63.1	272.2	177.9	158.3	161.5	62.2	107.8
OTB	25	0	0	0	0	1.5	50.9	39.6	296.4	193.6	255.9	268.5	15.1	100.1
OTB	26	0	0	0	0	0	31.9	31.5	395.5	144.6	347.7	200.1	55.3	60
OTB	27	0	0	0	0	0	14.7	32.3	438.1	228.9	415.2	139	35.9	49.8
OTB	28	0	0	0	0	0	24.7	22.3	431.6	459.8	381.8	158	64.8	39.4
OTB	29	0	0	0	0	0	19.9	34.3	171.5	144.1	244.2	98.3	41.5	63.8
OTB	30	0	0	0	0	0	8.6	43	169	210.1	113.9	81.8	6.9	8.5
OTB	31	0	0	0	0	2.6	9.4	21.6	79.3	211.8	43.1	61.1	0	0
OTB	32	0	0	0	0	5.3	6.9	21.5	24.8	101.7	24.7	24.5	0	0.3
OTB	33	0	0	0	0	0	8.6	11.8	42.9	93	69.8	15.5	0	1.1
OTB	34	0	0	0	0	19.2	13.7	13.5	25.6	91.6	14.7	7.4	0	0.6
OTB	35	0	0	0	0	26.5	20.7	19.6	24.3	62.8	6.1	7.4	0	0.6
OTB	36	0	0	0	0	13.9	12	18.5	5.6	51.1	17.3	15.4	0	0
OTB	37	0	0	0	0	2.6	10.3	17.5	14.1	20.1	2.7	8.1	0	0
OTB	38	0	0	0	0	0	0.8	10.9	0.9	0	0.5	4.2	0	0.3
OTB	39	0	0	0	0	0	0	11.1	11.1	17.8	1.7	2.1	0	0
OTB	40	0	0	0	0	0	0	3.3	0	4	0	0	0	0
PS	22	0	0	0	0	0	0	0	0	0	0	0	0	8.9
PS	23	0	0	0	0	0	0	0	0	0	0	0	0	44.5
PS	24	0	0	0	0	0	0	0	0	0	0	0	0	124.6
PS	25	0	0	0	0	0	0	0	0	0	0	0	0	89
PS	26	0	0	0	0	0	0	0	0	0	0	0	0	8.9
PS	27	0	0	0	0	0	0	0	0	0	0	0	0	8.9
OTH	13	0	0	0	0	0	0	0	0	31.8	0	0	0	0
OTH	14	0	0	0	0	0	0	0	0	254.5	9.2	0	0	0
OTH	15	0	0	0	0	0	0	0	0	127.2	0	0	0	0
OTH	16	0	0	0	0	0	0	0	3	160.1	0.7	0	0	0
OTH	17	0	0	0	0	0	0	0	0	223.5	29	8.2	0	0

gear	Len	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OTH	18	0	0	0	0	0	0	0	3	116.6	30.8	21.9	0	2.7
OTH	19	0	0	0	0	0	0	0	0	169.5	113.8	65.6	0	3.3
OTH	20	0	0	0	0	0	0	0	3	143.2	67.3	67.1	0	9.5
OTH	21	0	0	0	0	0	0	2.8	51.2	222.8	71	86.5	0.2	10.1
OTH	22	0	0	0	0	0	1.8	54.4	90	463.3	82	88	1.8	21.4
OTH	23	0	0	0	0	0	0.5	24.5	165.5	684.9	17.1	90.9	1.9	24.8
OTH	24	0	0	0	0	0	3.9	30	168.6	279.6	36.1	82.5	7.9	36.5
OTH	25	0	0	0	0	0	3.3	63.7	131.8	267.4	59.1	44.4	10.1	16.1
OTH	26	0	0	0	0	0	1.9	72.2	90	214.5	27.5	16.6	15	20.8
OTH	27	0	0	0	0	0	1.4	71.2	36.2	141	60	17.2	13.7	25.7
OTH	28	0	0	0	0	0	2.2	38.6	39.3	115.2	41.7	7.8	14.1	25.4
OTH	29	0	0	0	0	0	2.6	23.1	15.4	38.5	25.2	4.2	9.8	17.4
OTH	30	0	0	0	0	0	1.9	15.7	4.7	83.2	15.9	6.4	7.1	14.5
OTH	31	0	0	0	0	0	1.9	17.9	11.8	48.5	16.5	4.1	2.5	11.3
OTH	32	0	0	0	0	0	3.5	23.9	4	10.1	11.5	1.4	1.3	11.8
OTH	33	0	0	0	0	0	3.1	30.1	8.4	4.5	14	1.6	2.2	7.4
OTH	34	0	0	0	0	0	5.4	9.5	7.9	8.3	7.3	3.1	1.4	1.8
OTH	35	0	0	0	0	0	5.1	14.1	9.2	7.7	5.9	2.5	0.8	3.5
OTH	36	0	0	0	0	0	2.4	7.1	13	5.8	4.2	0.1	0.2	0
OTH	37	0	0	0	0	0	3.1	4.6	6.1	5.8	3.7	0.7	0.3	0.7
OTH	38	0	0	0	0	0	4.9	2.6	1.6	1.1	2.6	0.4	0.2	0
OTH	39	0	0	0	0	0	6.6	3.6	0.1	0.4	0.8	0	0	0
OTH	40	0	0	0	0	0	3.7	0	0.2	0	0.2	0.6	0	0.7
OTH	41	0	0	0	0	0	2.6	1.2	0.1	0	0	0	0	0
OTH	42	0	0	0	0	0	2.9	0	3.1	0	0	0	0	0
OTH	43	0	0	0	0	0	5.6	1.4	3.1	0	0	0	0	0
OTH	44	0	0	0	0	0	7.3	1.2	0.3	0	0	0.2	0	0
OTH	45	0	0	0	0	0	2.4	0	0.1	0	0	0.1	0	0
OTH	47	0	0	0	0	0	4	0	0.1	0	0	0	0	0
OTH	48	0	0	0	0	0	8.5	0	0.1	0	0	0	0	0
OTH	49	0	0	0	0	0	1.7	0	0.1	0	0	0	0	0
OTB	10	0	0	0	23.6	0	0	0	0	0	0	0	0	0
OTB	11	0	0	0	23.6	0	0	48.6	0	0	18.5	0	0	1
OTB	12	0	0	0	172	0	0	308.1	0	0	122.8	0	12.1	1
OTB	13	0	0	0	360.9	0	0	741.8	0	0	525.2	3	185.6	5.9
OTB	14	0	0	0	310.3	0	0	92	0	5.1	493.4	13.7	238.6	44.9
OTB	15	0	0	0	860.1	0	0	4.1	10.2	4.1	176	234.1	1475.3	70.3
OTB	16	0	0	0	700.7	0	0	12.3	20.4	100.8	142.6	635.3	1138.1	276.9
OTB	17	0	0	0	666.2	0	0	11.2	19	115	314.9	1089.6	2294.2	373.1
OTB	18	0	0	0	730.8	0	0	36.6	22.6	296.4	532.3	1021.7	3803.2	315.4
OTB	19	0	0	0	268.2	0	0	86.5	36.8	241.2	557.5	351.2	5610.3	508.8
OTB	20	0	0	0	1021.2	0	0	159.3	44.6	290.4	308.7	209.8	5627.9	716.8
OTB	21	0	0	0	226	0	0	247.6	128.4	240.2	128.4	380	4787.6	543.9
OTB	22	0	0	0	1000.5	216	0	271.8	176.5	327	79.8	342.3	3638.2	551.2
OTB	23	0	0	0	124.8	0	0	221.7	338.3	243.6	105.1	376	2793.6	603.5

gear	Len	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OTB	24	0	0	0	538.7	432	0	263.2	436	387.6	117.1	391.5	1889.4	534.5
OTB	25	0	0	0	150.1	0	0	311.7	480.1	239.3	173.8	517.4	2338.1	436
OTB	26	0	0	0	138.3	1081	0	368.6	589.8	583.5	392.9	837.5	2670.7	230
OTB	27	0	0	0	23.6	0	0	366.9	473	273.3	580.1	820.3	1319.5	463.3
OTB	28	0	0	0	204.2	504	0	258	280.7	403.8	687.4	752.6	1157	608.2
OTB	29	0	0	0	0	0	0	226.5	211.2	198.2	787.7	669.9	1381.5	643.5
OTB	30	0	0	0	166	216	0	190.9	175.6	736.4	491.3	246.5	751.1	280
OTB	31	0	0	0	0	0	0	108.7	89.4	164.8	159.8	200.3	122.5	133.2
OTB	32	0	0	0	182.9	288	0	96	50.4	596.3	110.9	75.6	185.9	74.5
TB	33	0	0	0	16.9	0	0	55.4	41.4	67	57.6	44.7	123.2	9.8
OTB	34	0	0	0	120.1	72	0	81.4	40.6	770.2	40.8	17	99.2	20.5
OTB	35	0	0	0	52.3	0	0	30.5	41.8	43.9	4.6	13.7	93	3.9
OTB	36	0	0	0	187.7	0	0	68	55.1	264.8	11	4.3	12	0
OTB	37	0	0	0	13.5	0	0	56	32.7	25.8	7.5	9.2	81	1
OTB	38	0	0	0	0	0	0	0	21.1	52.2	6.4	1.5	3	1
OTB	39	0	0	0	0	0	0	5.6	0	0	5.6	1.5	0	0
OTB	40	0	0	0	13.5	0	0	0	0	0	1.9	0	0	0
OTB	41	0	0	0	1.7	0	0	0	4.4	0	3.8	0	0	0
OTH	7	0	0	0	0	0	0	0	0	0	0	70	0	0
OTH	9	0	0	0	0	0	0	0	0	0	0	90	0	0
OTH	10	0	0	0	0	0	0	0	0	0	0	105.9	0	3.5
OTH	11	0	0	0	0	0	0	0	0	0	0	162.9	0	0
OTH	12	0	0	0	0	0	0	0	0	0	0	202.3	20.2	0
OTH	13	0	0	0	0.1	0	0	0	0	0.1	0	209.3	173.1	17.3
OTH	14	0	0	0	1.7	0	0	0	0	1.4	0	1532.8	231.9	3.5
OTH	15	0	0	0	3.1	0	0	0	0	3.9	0	214.6	211.6	72.6
OTH	16	0	0	0	3.2	0	0	0	0	2.1	0	268.7	176.7	0
OTH	17	0	0	0	2.9	0	0	0	1.1	8.1	0	302.2	375.9	110.9
OTH	18	0	0	0	2.9	0	0	0	2.2	17.5	0	441.5	110.3	90.4
OTH	19	0	0	0	4.6	0	0	0	4.1	16.5	0	345.7	662.6	215.3
OTH	20	0	0	0	6.7	0	0	0	3.7	6.9	0	252.9	832.6	201.6
OTH	21	0	0	0	8.8	0	0	0	1.1	3.9	0	221.8	498.2	152.7
OTH	22	0	0	0	8.2	0	0	0	2.2	20.1	0	2923.3	1154.2	62.6
OTH	23	0	0	0	5.4	0	0	0	2.4	0.6	0	1584.6	1025.9	17.5
OTH	24	0	0	0	4	0	0	0	1.1	0	0	248.8	1698.8	0
OTH	25	0	0	0	4.1	0	0	0	1.3	0	0	5647.8	557.5	3.5
OTH	26	0	0	0	2.9	0	0	0	0.2	51	0	11061.4	940	0
OTH	27	0	0	0	3.3	0	0	0	0.4	0	0	19160.7	1712.4	0
OTH	28	0	0	0	1.3	0	0	0	0.4	77	0	16467.4	2006.6	0
OTH	29	0	0	0	1.3	0	0	0	0.4	0	0	7033.5	1101.1	0
OTH	30	0	0	0	0.3	0	0	0	0.4	51.1	0	8392.2	1754.5	0
OTH	31	0	0	0	0.5	0	0	0	0	0	0	3007.4	1077.5	0
OTH	32	0	0	0	1	0	0	0	0	26.1	0	1668.7	651	0
OTH	33	0	0	0	0.5	0	0	0	0	0	0	3027.4	246.5	0
OTH	34	0	0	0	1	0	0	0	0	0.2	0	340	350	0

gear	Len	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OTH	35	0	0	0	0.4	0	0	0	0	0.1	0	350	24	0
OTH	36	0	0	0	0.2	0	0	0	0	0.1	0	3057.4	48	0
OTH	37	0	0	0	0.2	0	0	0	0	0	0	0	48	0
OTH	38	0	0	0	0.1	0	0	0	0	0	0	3077.4	72	0
OTH	39	0	0	0	0.4	0	0	0	0	0	0	390	138	0
OTH	40	0	0	0	0	0	0	0	0	0	0	1748.7	72	0
OTH	41	0	0	0	0	0	0	0	0	0	0	3107.4	120	0
OTH	42	0	0	0	0	0	0	0	0	0	0	0	72	0
OTH	43	0	0	0	0	0	0	0	0	0	0	0	210	0
OTH	45	0	0	0	0	0	0	0	0	0	0	450	0	0
OTH	46	0	0	0	0	0	0	0	0	0	0	0	72	0

Discards

Discards area available since 2005 and belongs mainly to OTB (Table 6.7.2.5, Figure 6.7.2.3). The discards from other gears (OTH) are mostly by GTR (table 6.7.2.2.2). Discards are missing in 2007 and data at length were never reported.

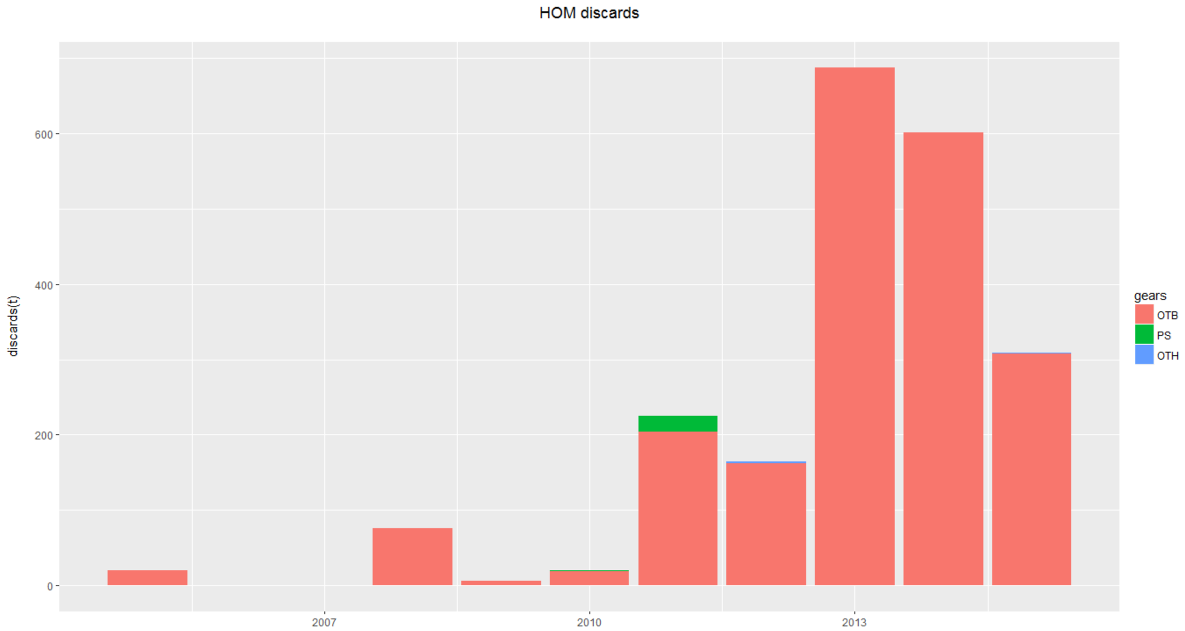


Figure 6.7.2.3. Atlantic Horse Mackerel in GSAs 1,5,6,7. Total discards by year and main fishing gear in the region 1 (GSAs 1, 5, 6, 7)

Table 6.7.2.5. Atlantic Horse Mackerel in GSAs 1,5,6,7. Year trend on total discards and percent contribution by main gear in the Region 1.

Year	OTB	PS	OTH	**Total**	%OTB	%PS	%OTH
2005	20	0	0	20	100.0	0.0	0.0
2006	163	0	0	164	99.8	0.2	0.0
2007	0	0	0	0	0.0	0.0	0.0

2008	75	0	0	75	100.0	0.0	0.0
2009	4938	0	0	4938	100.0	0.0	0.0
2010	6327	1	0	6328	100.0	0.0	0.0
2011	4985	21	146	5153	96.8	0.4	2.8
2012	1586	0	88	1675	94.7	0.0	5.3
2013	3444	0	11	3455	99.7	0.0	0.3
2014	1472	0	7	1479	99.5	0.0	0.5
2015	7131	0	1	7133	100.0	0.0	0.0

Table 6.7.2.6 . Atlantic Horse Mackerel in GSAs 1,5,6,7. Year trend on total discards by gear in the Region 1.

Year	GNS	GTR	OTB	PS
2005	0.0	0.0	19.6	0.0
2006	0.0	0.0	163.5	0.3
2007	0.0	0.0	0.0	0.0
2008	0.0	0.0	75.5	0.0
2009	0.0	0.0	4938.5	0.0
2010	0.0	0.0	6326.8	1.1
2011	146.2	0.0	4985.2	21.2
2012	85.6	2.8	1586.3	0.0
2013	10.8	0.1	3443.8	0.0
2014	6.7	0.3	1471.8	0.0
2015	1.5	0.0	7131.2	0.0

6.7.3. Fishing effort data

6.7.4. Survey Indices of abundance and biomass by year and size/age

Abundance and biomass indexes were reported to STECF EWG 16-13 through DCF. Atlantic Horse Mackerel time series of abundance and biomass indices from MEDITS surveys are shown and described in the following figures.

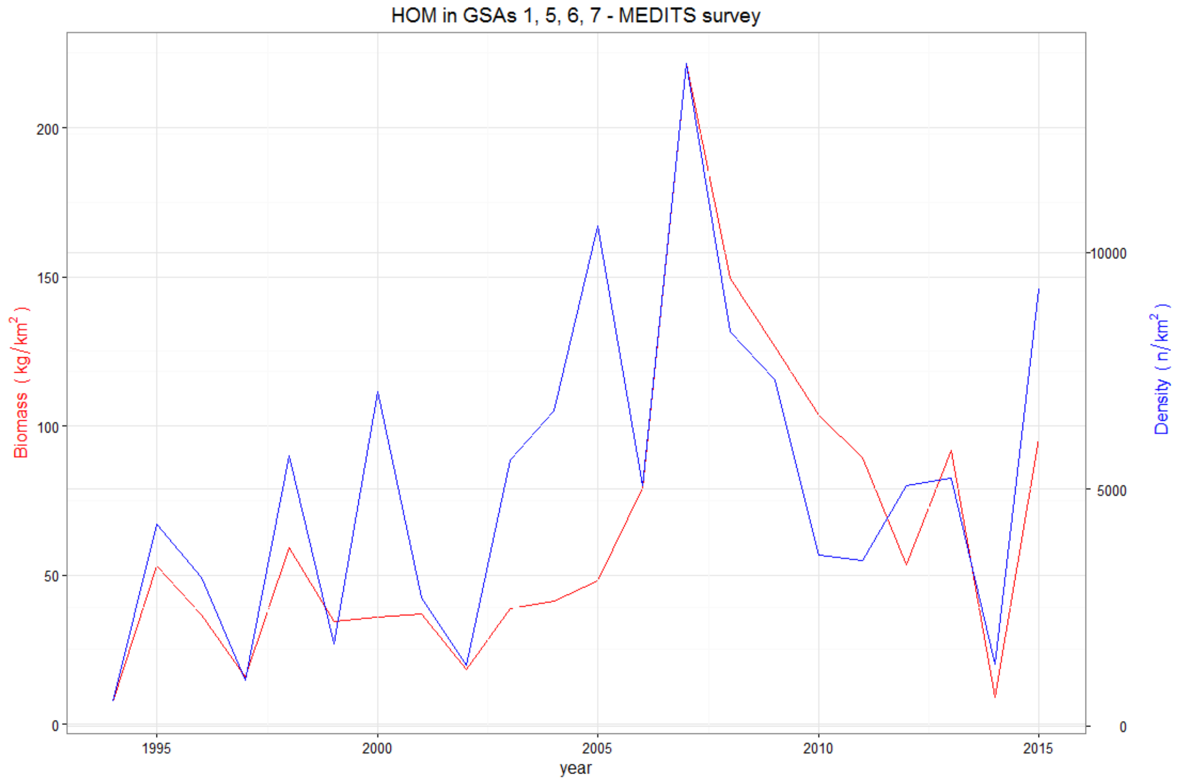


Figure 6.7.4.1. Atlantic Horse Mackerel in GSAs 1, 5, 6, 7. Historical trends of abundance (blue) and biomass index (red) estimated by MEDITS survey.

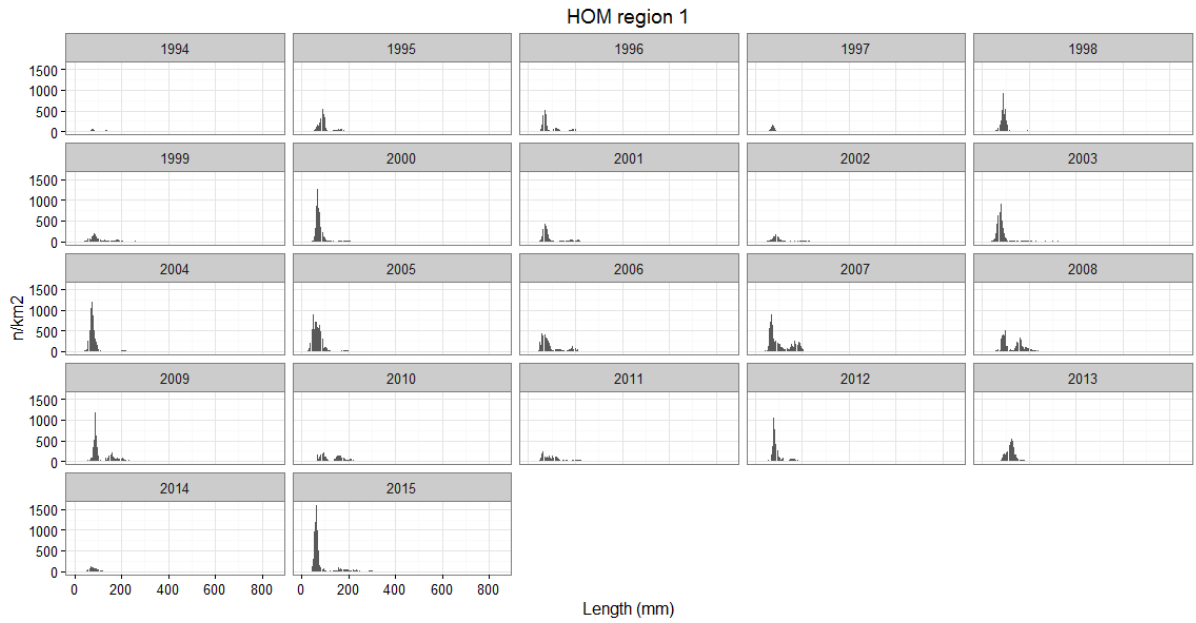


Figure 6.7.4.3. Atlantic Horse Mackerel in GSAs 1, 5, 6, 7. Size structure of the abundance index estimated by MEDITS survey.

6.8 DATA GATHERING OF ATLANTIC HORSE MACKEREL IN GSAs 9,10,11

6.8.1. Stock Identity and Biology

The area, hereafter named region 2 (GSAs 9, 10, 11), covers a surface of about 89640 km2 in the depth range between 10-800 m (Figure 6.8.1.1).

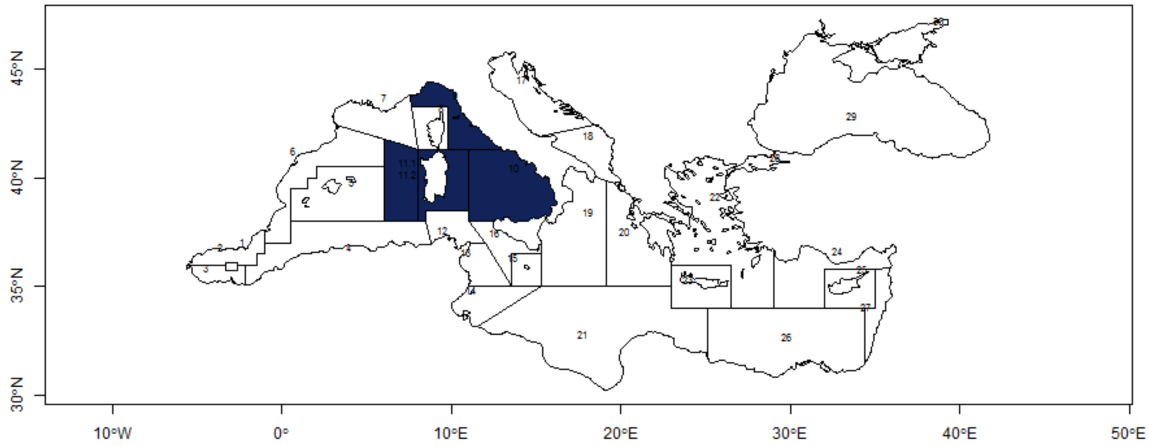


Figure 6.8.1.1. Geographical location of GSAs 9,10,11.

Of the three species of horse mackerel living in Mediterranean (T. trachurus, T. mediterraneaus and T. picturatus), Trachurus trachurus can be distinguish by the accessory lateral line along the whole back which is provided with very large bone scutes. However sometimes, particularly in juveniles, the identification of the species is not easy.
It is a gregarious bentho-pelagic species whit a broad geographical distribution which cover the whole Mediterranean, Black Sea included (Bini, 1968; Relini and Lanteri, 2010), the Atlantic Ocean from Iceland to Senegal and the Canary Islands, Madeira and Cape Verde (Abaunza et al., 2008), and the western coasts of the Pacific Ocean (Karaiskou et al., 2003).
Adults of T. trachurus form large shoals in deep waters and medium-deep waters and is frequently found at a depth between 10 and 500 m. Juveniles swim in small shoals, under floating objects or megaplancton (such as Rhizostoma pulmo or Cotylorhiza tubercolata), and tend to concentrate within 100-150 m depth (Nannini et al., 1997; Matarrese et al., 1998).
The Horse Mackerel species can reach a maximum size of 60 cm TL, although in the Mediterranean Sea, specimens caught with trawl or seine do not exceed 30 cm TL, while those caught with bottom longline can reach up to 50 cm TL (Relini et al., 1999).
As concern feeding HOM change feeding habits with age, shifting from zooplanktivorous (feeds mainly on planktonic crustaceans) to ichthyophagous (youth stages of other fishes, and also adult stages of anchovies and sardine) with rising age (ICES 2013 southern horse mackerel stock annex).

Growth

Growth parameters have been derived from the dataset of biological parameter (gp.csv) as reported in the last data call (Table 6.8.1.1) for the GSA1.

Table 6.8.1.1. Atlantic Horse Mackerel in GSAS 9,10,11. Growth parameters.

Stock Identification	L_inf	k	t0	L-W: a	L-W: b	Source
Region 2	43.2	0.27	-0.9	0.006	3.069	ITA GSA9

Maturity

Maturity ogives were taken from DCF data. L50 is reported at 13-10 cm TL corresponding to an age class of 1.

Table 6.8.1.2. Atlantic Horse Mackerel in GSAS 9,10,11. Proportion of mature fish by age.

Age	0	1	2	3	4	5	6	7	8	9	10
Maturity	0.04	0.24	0.76	0.97	1	1	1	1	1	1	1

Natural mortality

For the natural mortality EWG16-13 refers to the ICES WGHANSA (2013) for the southern horse mackerel stock (Table 6.8.1.3).

Table 6.8.1.3. Natural mortality, as used by ICES WGHANSA for the southern horse mackerel stock.

AGE	0	1	2	3	4	5	6	7	8	9	10
M	0.9	0.6	0.4	0.3	0.2	0.15	0.15	0.15	0.15	0.15	0.15

6.8.2. Catch data

Landings

As reported on the DCF data call total landings (tonnes) area available since 2005. They belong mainly to OTB and PS and other gears (Figure 6.8.2.1, Tables 6.8.2.1 and 6.8.2.2).

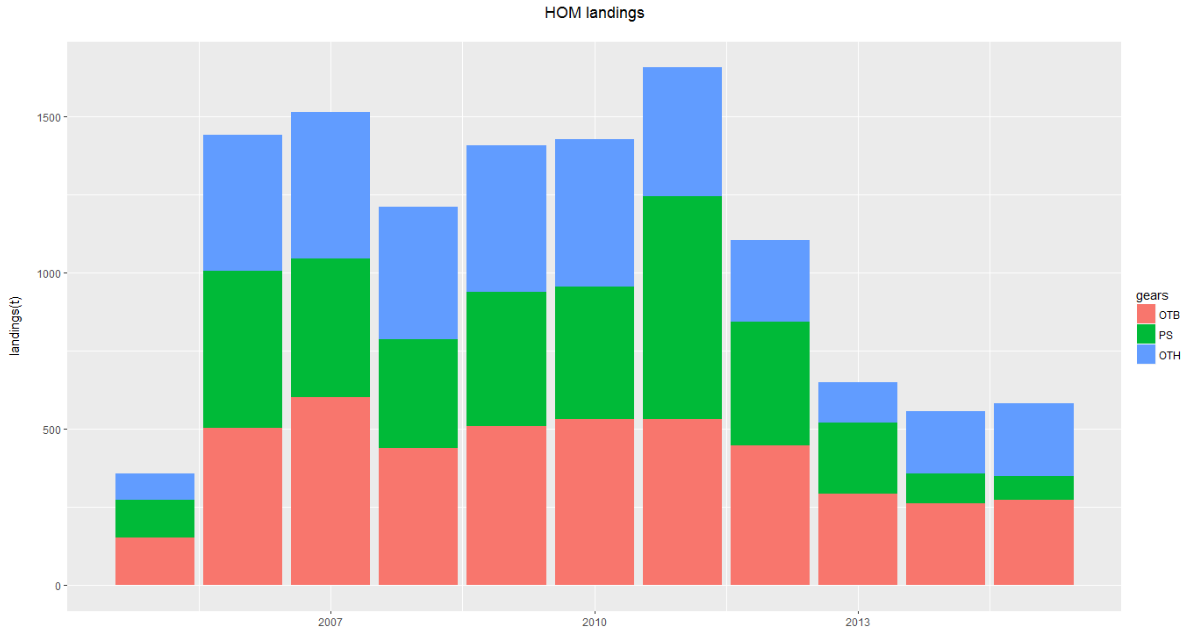


Figure 6.8.2.1. Atlantic Horse mackerel in GSAS 9,10,11. Total landings by year and main fishing gear in the Region 2.

Table 6.8.2.1. Atlantic Horse mackerel in GSAS 9,10,11. Year trend on total landings and percent contribution by main gear in the region 2.

Year	OTB	PS	OTH	Total	%OTB	%PS	%OTH
2005	152	122	83	356	42.6	34.1	23.2
2006	504	504	434	1442	34.9	35.0	30.1
2007	603	443	469	1514	39.8	29.3	30.9
2008	439	348	423	1211	36.3	28.8	34.9
2009	508	430	471	1409	36.1	30.5	33.4
2010	533	422	473	1428	37.3	29.6	33.1
2011	530	716	412	1658	32.0	43.2	24.9
2012	447	398	259	1103	40.5	36.1	23.4
2013	294	228	127	648	45.3	35.1	19.6
2014	263	95	200	558	47.1	17.0	35.9
2015	273	75	235	583	46.8	12.9	40.3

Landings at length were available from 2007 and reported by main fishing gear (Table 6.8.2.2, Fig. 6.8.2.2). No great differences Landings by OTB and PS are detected.

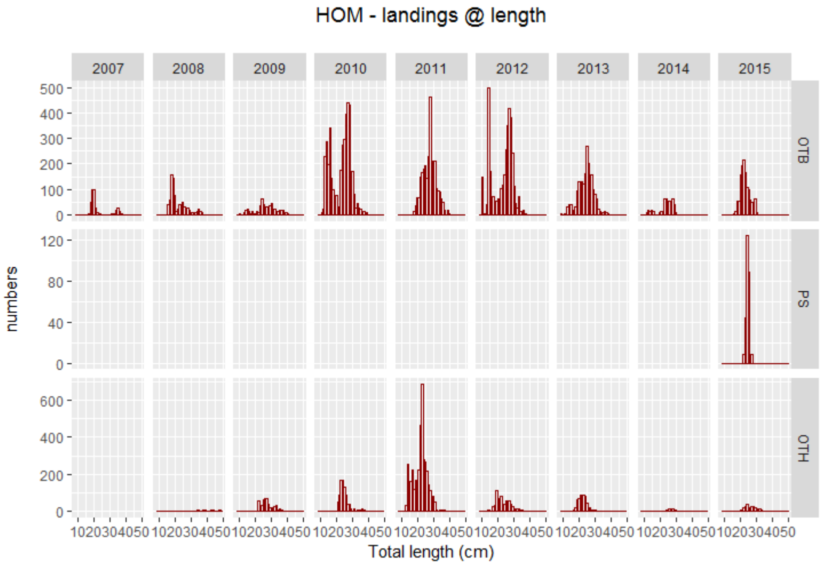


Figure 6.8.2.2. Atlantic Horse mackerel in GSAS 9,10,11. Length at age distribution by year and main fishing gear in the region 2 (GSAs 9, 10, 11)

Table 6.8.2.2. Atlantic Horse mackerel in GSAS 9,10,11. Landings at length by year and main gear in the region 2 (GSAs 9, 10, 11).

Gear	Len	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OTB	9	0	0	0	0	0	0	0	0	0	0	2.3	0	0
OTB	10	0	0	0	0	0	0	3.3	0	0	146.2	1.8	0	0
OTB	11	0	0	0	0	0	0	0	9.2	0	0	5.4	0	0
OTB	12	0	0	0	0	0	0	0	23	0	4.7	5	10.6	0
OTB	13	0	0	0	0	0	0	7	228	0	42.3	33.3	17	0
OTB	14	0	0	0	0	0	0	16.3	287.8	0	499.1	41.5	12.7	0
OTB	15	0	0	0	0	0	0	23.3	197.3	0	171.7	42.2	17	0
OTB	16	0	0	0	0	0	40.1	14.4	341.3	0	61.2	19.9	14.9	5.9
OTB	17	0	0	0	0	3.6	58	5	141.6	0	71.3	11.3	0	11.8
OTB	18	0	0	0	0	47.6	158.4	14.5	97.7	12.2	31.8	29.1	0	53.2
OTB	19	0	0	0	0	99.7	142.5	4.7	51.1	37.6	51.8	93.9	0	53.1
OTB	20	0	0	0	0	98.4	77.4	2.1	76.4	69.2	65	131.7	8.2	155.9
OTB	21	0	0	0	0	24.6	12.7	11.7	30.6	69.1	52.9	119.2	15.1	194.3
OTB	22	0	0	0	0	10.3	23.5	10.2	29.5	147.1	104.2	128.5	15.1	215
OTB	23	0	0	0	0	3.6	40.1	38	173.4	165.4	117.5	120.7	62.2	164.4
OTB	24	0	0	0	0	3.1	26	63.1	272.2	177.9	158.3	161.5	62.2	107.8
OTB	25	0	0	0	0	1.5	50.9	39.6	296.4	193.6	255.9	268.5	15.1	100.1
OTB	26	0	0	0	0	0	31.9	31.5	395.5	144.6	347.7	200.1	55.3	60
OTB	27	0	0	0	0	0	14.7	32.3	438.1	228.9	415.2	139	35.9	49.8
OTB	28	0	0	0	0	0	24.7	22.3	431.6	459.8	381.8	158	64.8	39.4
OTB	29	0	0	0	0	0	19.9	34.3	171.5	144.1	244.2	98.3	41.5	63.8
OTB	30	0	0	0	0	0	8.6	43	169	210.1	113.9	81.8	6.9	8.5
OTB	31	0	0	0	0	2.6	9.4	21.6	79.3	211.8	43.1	61.1	0	0
OTB	32	0	0	0	0	5.3	6.9	21.5	24.8	101.7	24.7	24.5	0	0.3

Gear	Len	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OTB	33	0	0	0	0	0	8.6	11.8	42.9	93	69.8	15.5	0	1.1
OTB	34	0	0	0	0	19.2	13.7	13.5	25.6	91.6	14.7	7.4	0	0.6
OTB	35	0	0	0	0	26.5	20.7	19.6	24.3	62.8	6.1	7.4	0	0.6
OTB	36	0	0	0	0	13.9	12	18.5	5.6	51.1	17.3	15.4	0	0
OTB	37	0	0	0	0	2.6	10.3	17.5	14.1	20.1	2.7	8.1	0	0
OTB	38	0	0	0	0	0	0.8	10.9	0.9	0	0.5	4.2	0	0.3
OTB	39	0	0	0	0	0	0	11.1	11.1	17.8	1.7	2.1	0	0
OTB	40	0	0	0	0	0	0	3.3	0	4	0	0	0	0
PS	22	0	0	0	0	0	0	0	0	0	0	0	0	8.9
PS	23	0	0	0	0	0	0	0	0	0	0	0	0	44.5
PS	24	0	0	0	0	0	0	0	0	0	0	0	0	124.6
PS	25	0	0	0	0	0	0	0	0	0	0	0	0	89
PS	26	0	0	0	0	0	0	0	0	0	0	0	0	8.9
PS	27	0	0	0	0	0	0	0	0	0	0	0	0	8.9
OTH	13	0	0	0	0	0	0	0	0	31.8	0	0	0	0
OTH	14	0	0	0	0	0	0	0	0	254.5	9.2	0	0	0
OTH	15	0	0	0	0	0	0	0	0	127.2	0	0	0	0
OTH	16	0	0	0	0	0	0	0	3	160.1	0.7	0	0	0
OTH	17	0	0	0	0	0	0	0	0	223.5	29	8.2	0	0
OTH	18	0	0	0	0	0	0	0	3	116.6	30.8	21.9	0	2.7
OTH	19	0	0	0	0	0	0	0	0	169.5	113.8	65.6	0	3.3
OTH	20	0	0	0	0	0	0	0	3	143.2	67.3	67.1	0	9.5
OTH	21	0	0	0	0	0	0	2.8	51.2	222.8	71	86.5	0.2	10.1
OTH	22	0	0	0	0	0	1.8	54.4	90	463.3	82	88	1.8	21.4
OTH	23	0	0	0	0	0	0.5	24.5	165.5	684.9	17.1	90.9	1.9	24.8
OTH	24	0	0	0	0	0	3.9	30	168.6	279.6	36.1	82.5	7.9	36.5
OTH	25	0	0	0	0	0	3.3	63.7	131.8	267.4	59.1	44.4	10.1	16.1
OTH	26	0	0	0	0	0	1.9	72.2	90	214.5	27.5	16.6	15	20.8
OTH	27	0	0	0	0	0	1.4	71.2	36.2	141	60	17.2	13.7	25.7
OTH	28	0	0	0	0	0	2.2	38.6	39.3	115.2	41.7	7.8	14.1	25.4
OTH	29	0	0	0	0	0	2.6	23.1	15.4	38.5	25.2	4.2	9.8	17.4
OTH	30	0	0	0	0	0	1.9	15.7	4.7	83.2	15.9	6.4	7.1	14.5
OTH	31	0	0	0	0	0	1.9	17.9	11.8	48.5	16.5	4.1	2.5	11.3
OTH	32	0	0	0	0	0	3.5	23.9	4	10.1	11.5	1.4	1.3	11.8
OTH	33	0	0	0	0	0	3.1	30.1	8.4	4.5	14	1.6	2.2	7.4
OTH	34	0	0	0	0	0	5.4	9.5	7.9	8.3	7.3	3.1	1.4	1.8
OTH	35	0	0	0	0	0	5.1	14.1	9.2	7.7	5.9	2.5	0.8	3.5
OTH	36	0	0	0	0	0	2.4	7.1	13	5.8	4.2	0.1	0.2	0
OTH	37	0	0	0	0	0	3.1	4.6	6.1	5.8	3.7	0.7	0.3	0.7
OTH	38	0	0	0	0	0	4.9	2.6	1.6	1.1	2.6	0.4	0.2	0
OTH	39	0	0	0	0	0	6.6	3.6	0.1	0.4	0.8	0	0	0
OTH	40	0	0	0	0	0	3.7	0	0.2	0	0.2	0.6	0	0.7
OTH	41	0	0	0	0	0	2.6	1.2	0.1	0	0	0	0	0
OTH	42	0	0	0	0	0	2.9	0	3.1	0	0	0	0	0
OTH	43	0	0	0	0	0	5.6	1.4	3.1	0	0	0	0	0

Gear	Len	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OTH	44	0	0	0	0	0	7.3	1.2	0.3	0	0	0.2	0	0
OTH	45	0	0	0	0	0	2.4	0	0.1	0	0	0.1	0	0
OTH	47	0	0	0	0	0	4	0	0.1	0	0	0	0	0
OTH	48	0	0	0	0	0	8.5	0	0.1	0	0	0	0	0
OTH	49	0	0	0	0	0	1.7	0	0.1	0	0	0	0	0
OTB	10	0	0	0	23.6	0	0	0	0	0	0	0	0	0
OTB	11	0	0	0	23.6	0	0	48.6	0	0	18.5	0	0	1
OTB	12	0	0	0	172	0	0	308.1	0	0	122.8	0	12.1	1
OTB	13	0	0	0	360.9	0	0	741.8	0	0	525.2	3	185.6	5.9
OTB	14	0	0	0	310.3	0	0	92	0	5.1	493.4	13.7	238.6	44.9
OTB	15	0	0	0	860.1	0	0	4.1	10.2	4.1	176	234.1	1475.3	70.3
OTB	16	0	0	0	700.7	0	0	12.3	20.4	100.8	142.6	635.3	1138.1	276.9
OTB	17	0	0	0	666.2	0	0	11.2	19	115	314.9	1089.6	2294.2	373.1
OTB	18	0	0	0	730.8	0	0	36.6	22.6	296.4	532.3	1021.7	3803.2	315.4
OTB	19	0	0	0	268.2	0	0	86.5	36.8	241.2	557.5	351.2	5610.3	508.8
OTB	20	0	0	0	1021.2	0	0	159.3	44.6	290.4	308.7	209.8	5627.9	716.8
OTB	21	0	0	0	226	0	0	247.6	128.4	240.2	128.4	380	4787.6	543.9
OTB	22	0	0	0	1000.5	216	0	271.8	176.5	327	79.8	342.3	3638.2	551.2
OTB	23	0	0	0	124.8	0	0	221.7	338.3	243.6	105.1	376	2793.6	603.5
OTB	24	0	0	0	538.7	432	0	263.2	436	387.6	117.1	391.5	1889.4	534.5
OTB	25	0	0	0	150.1	0	0	311.7	480.1	239.3	173.8	517.4	2338.1	436
OTB	26	0	0	0	138.3	1081	0	368.6	589.8	583.5	392.9	837.5	2670.7	230
OTB	27	0	0	0	23.6	0	0	366.9	473	273.3	580.1	820.3	1319.5	463.3
OTB	28	0	0	0	204.2	504	0	258	280.7	403.8	687.4	752.6	1157	608.2
OTB	29	0	0	0	0	0	0	226.5	211.2	198.2	787.7	669.9	1381.5	643.5
OTB	30	0	0	0	166	216	0	190.9	175.6	736.4	491.3	246.5	751.1	280
OTB	31	0	0	0	0	0	0	108.7	89.4	164.8	159.8	200.3	122.5	133.2
OTB	32	0	0	0	182.9	288	0	96	50.4	596.3	110.9	75.6	185.9	74.5
OTB	33	0	0	0	16.9	0	0	55.4	41.4	67	57.6	44.7	123.2	9.8
OTB	34	0	0	0	120.1	72	0	81.4	40.6	770.2	40.8	17	99.2	20.5
OTB	35	0	0	0	52.3	0	0	30.5	41.8	43.9	4.6	13.7	93	3.9
OTB	36	0	0	0	187.7	0	0	68	55.1	264.8	11	4.3	12	0
OTB	37	0	0	0	13.5	0	0	56	32.7	25.8	7.5	9.2	81	1
OTB	38	0	0	0	0	0	0	0	21.1	52.2	6.4	1.5	3	1
OTB	39	0	0	0	0	0	0	5.6	0	0	5.6	1.5	0	0
OTB	40	0	0	0	13.5	0	0	0	0	0	1.9	0	0	0
OTB	41	0	0	0	1.7	0	0	0	4.4	0	3.8	0	0	0
OTH	7	0	0	0	0	0	0	0	0	0	0	70	0	0
OTH	9	0	0	0	0	0	0	0	0	0	0	90	0	0
OTH	10	0	0	0	0	0	0	0	0	0	0	105.9	0	3.5
OTH	11	0	0	0	0	0	0	0	0	0	0	162.9	0	0
OTH	12	0	0	0	0	0	0	0	0	0	0	202.3	20.2	0
OTH	13	0	0	0	0.1	0	0	0	0	0.1	0	209.3	173.1	17.3
OTH	14	0	0	0	1.7	0	0	0	0	1.4	0	1532.8	231.9	3.5
OTH	15	0	0	0	3.1	0	0	0	0	3.9	0	214.6	211.6	72.6

Gear	Len	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OTH	16	0	0	0	3.2	0	0	0	0	2.1	0	268.7	176.7	0
OTH	17	0	0	0	2.9	0	0	0	1.1	8.1	0	302.2	375.9	110.9
OTH	18	0	0	0	2.9	0	0	0	2.2	17.5	0	441.5	110.3	90.4
OTH	19	0	0	0	4.6	0	0	0	4.1	16.5	0	345.7	662.6	215.3
OTH	20	0	0	0	6.7	0	0	0	3.7	6.9	0	252.9	832.6	201.6
OTH	21	0	0	0	8.8	0	0	0	1.1	3.9	0	221.8	498.2	152.7
OTH	22	0	0	0	8.2	0	0	0	2.2	20.1	0	2923.3	1154.2	62.6
OTH	23	0	0	0	5.4	0	0	0	2.4	0.6	0	1584.6	1025.9	17.5
OTH	24	0	0	0	4	0	0	0	1.1	0	0	248.8	1698.8	0
OTH	25	0	0	0	4.1	0	0	0	1.3	0	0	5647.8	557.5	3.5
OTH	26	0	0	0	2.9	0	0	0	0.2	51	0	11061.4	940	0
OTH	27	0	0	0	3.3	0	0	0	0.4	0	0	19160.7	1712.4	0
OTH	28	0	0	0	1.3	0	0	0	0.4	77	0	16467.4	2006.6	0
OTH	29	0	0	0	1.3	0	0	0	0.4	0	0	7033.5	1101.1	0
OTH	30	0	0	0	0.3	0	0	0	0.4	51.1	0	8392.2	1754.5	0
OTH	31	0	0	0	0.5	0	0	0	0	0	0	3007.4	1077.5	0
OTH	32	0	0	0	1	0	0	0	0	26.1	0	1668.7	651	0
OTH	33	0	0	0	0.5	0	0	0	0	0	0	3027.4	246.5	0
OTH	34	0	0	0	1	0	0	0	0	0.2	0	340	350	0
OTH	35	0	0	0	0.4	0	0	0	0	0.1	0	350	24	0
OTH	36	0	0	0	0.2	0	0	0	0	0.1	0	3057.4	48	0
OTH	37	0	0	0	0.2	0	0	0	0	0	0	0	48	0
OTH	38	0	0	0	0.1	0	0	0	0	0	0	3077.4	72	0
OTH	39	0	0	0	0.4	0	0	0	0	0	0	390	138	0
OTH	40	0	0	0	0	0	0	0	0	0	0	1748.7	72	0
OTH	41	0	0	0	0	0	0	0	0	0	0	3107.4	120	0
OTH	42	0	0	0	0	0	0	0	0	0	0	0	72	0
OTH	43	0	0	0	0	0	0	0	0	0	0	0	210	0
OTH	45	0	0	0	0	0	0	0	0	0	0	450	0	0
OTH	46	0	0	0	0	0	0	0	0	0	0	0	72	0

Discards

Discards area available since 2009 and belongs mainly to OTB (table 6.8.2.3, Fig. 6.8.2.3). In 2014, discards on OTB are null then discards from other gears (OTH) are mostly by GNS and represent the 100 % of the total amount (Table 6.8.2.3).

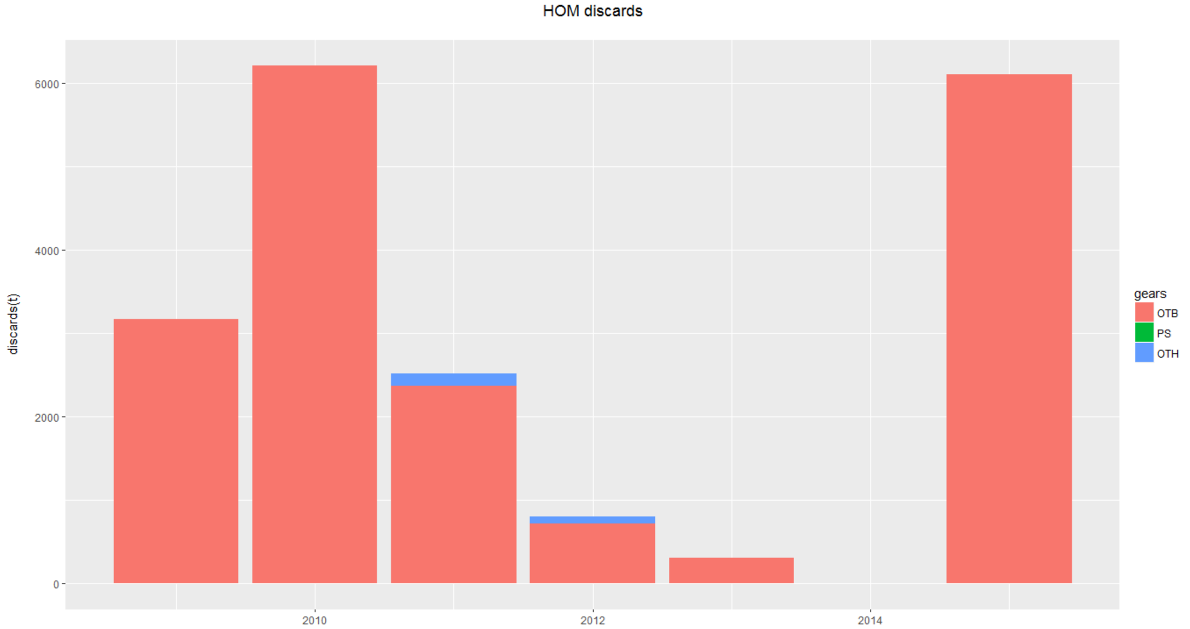


Figure 6.8.2.3. Atlantic Horse mackerel in GSAS 9,10,11. Total discards by year and main fishing gear in the region 2.

Table 6.8.2.3. Atlantic Horse mackerel in GSAS 9,10,11. Total discards by year and main fishing gear in the region 2.

Year	OTB	PS	OTH	Total	%OTB	%PS	%OTH
2009	3174	0	0	3174	100.0	0.0	0.0
2010	6213	0	0	6213	100.0	0.0	0.0
2011	2369	0	146	2516	94.2	0.0	5.8
2012	713	0	86	798	89.3	0.0	10.7
2013	306	0	0	306	100.0	0.0	0.0
2014	0	0	6	6	0.0	0.0	100.0
2015	6106	0	0	6106	100.0	0.0	0.0

Discards at length were available from 2009 for OTB and only for 2011, 2012 and 2014 for GNS, indicated as OTH in Fig. 6.8.2.4

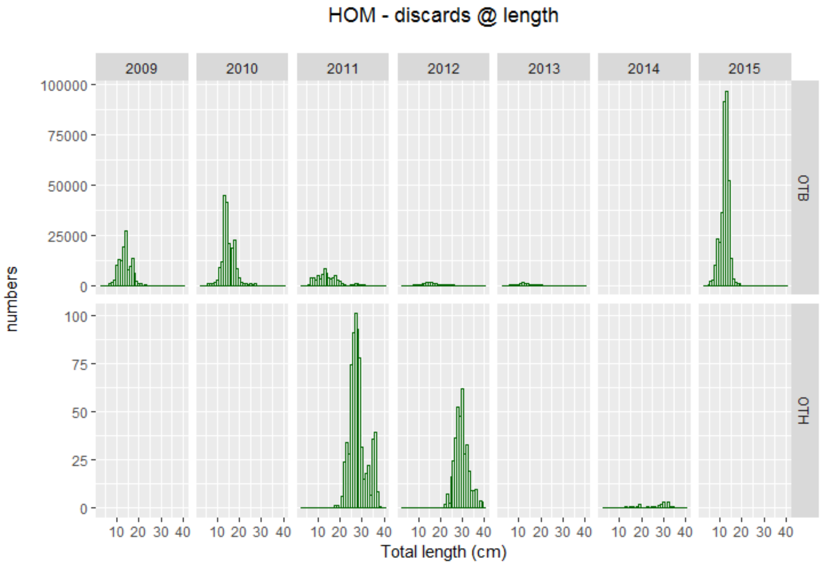


Figure 6.8.2.4. Atlantic Horse mackerel in GSAS 9,10,11. Length at age distribution by year and main fishing gear in the region 2 (GSAs 9, 10, 11)

Table 6.8.2.4. Atlantic Horse mackerel in GSAS 9,10,11. Landings at length by year and main gear in the region 2.

Gear	len	2006	2009	2010	2011	2012	2013	2014	2015
OTB	3	0	0	18.8	0	0	0	0	0
OTB	5	0	31	180.3	0	40.7	80.1	0	636
OTB	6	0	167.9	782.2	550.2	8.3	368.5	0	2216.1
OTB	7	0	993.1	1045.1	3924.9	104.8	358.3	0	2947.7
OTB	8	0	1445	801.7	3669	259.3	676.5	0	9983.1
OTB	9	0	2913.8	1705.1	2932.8	451.7	521.1	0	23459.5
OTB	10	0	9951.9	2644	4953.6	565.3	666.4	0	21474.6
OTB	11	0	12705.3	9102	3287.9	509.1	1223.2	0	36041.8
OTB	12	0	12320.7	11977.8	5740.3	1081.3	1413.6	0	91037.9
OTB	13	0	18943.2	44787.3	8213.5	905.3	1268.6	0	96561.3
OTB	14	0	27304.7	41115.8	6321	1363.1	1136.2	0	51867.2
OTB	15	0	7858.5	21175.4	3985.5	1846.6	745	0	13768.8
OTB	16	0	9534.5	7019.9	3120.1	1387	422.6	0	3061.1
OTB	17	0	13807.4	18799.7	4115.9	1066	466.4	0	1844
OTB	18	0	5990	22821.4	5198.7	791.8	447	0	1281.2
OTB	19	0	2450.5	8253.3	2988.4	509.1	392.2	0	1316.7
OTB	20	0	1203	3773.2	1912.7	536.2	220.5	0	120.4
OTB	21	0	866.9	1774.5	943.7	348.1	131.7	0	30.7
OTB	22	0	127.7	1321	590.2	569.2	126.4	0	41.6
OTB	23	0	353.2	894.5	172	724.5	102.3	0	0
OTB	24	0	42.4	609.3	95.5	676.7	120.4	0	49.8
OTB	25	0	74.6	789.3	365.5	415.7	99.8	0	41.6
OTB	26	0	45.5	378	658.5	234.6	68.2	0	0
OTB	27	0	34	786.7	985	142.9	50.1	0	0

Gear	len	2006	2009	2010	2011	2012	2013	2014	2015
OTB	28	0	7.3	62.7	1061.2	83.8	40.1	0	0
OTB	29	0	4.9	26.1	530.9	38.8	3.6	0	0
OTB	30	0	0	0	321.3	19.8	0	0	0
OTB	31	0	0	0	220.3	13.9	0	0	0
OTB	32	0	0	0	8.4	13.9	0	0	0
OTB	33	0	0	0	11.3	13.9	0	0	0
OTB	34	0	1.2	0	6.6	13.9	0	0	0
OTB	35	0	2.4	0	4.8	0	0	0	0
OTB	36	0	6.1	0	3.6	0	0	0	0
OTB	37	0	6.1	0	1.8	0	0	0	0
OTB	38	0	3.6	0	0	0	0	0	0
OTB	39	0	1.2	0	0	0	0	0	0
OTH	13	0	0	0	0	0	0	1	0
OTH	15	0	0	0	0	0	0	1	0
OTH	16	0	0	0	0	0	0	1	0
OTH	18	0	0	0	1.4	0	0	1	0
OTH	19	0	0	0	1.4	0	0	2.1	0
OTH	20	0	0	0	0.3	0	0	0	0
OTH	21	0	0	0	6	0	0	0	0
OTH	22	0	0	0	23.9	1.9	0	0	0
OTH	23	0	0	0	34.1	7.6	0	1	0
OTH	24	0	0	0	28.1	2.4	0	0	0
OTH	25	0	0	0	74.3	16.2	0	1	0
OTH	26	0	0	0	91.2	24.4	0	0.5	0
OTH	27	0	0	0	101	36.3	0	0	0
OTH	28	0	0	0	92.5	52.6	0	1.5	0
OTH	29	0	0	0	78.1	47.8	0	2.1	0
OTH	30	0	0	0	32	61.8	0	3.1	0
OTH	31	0	0	0	15	28.2	0	0	0
OTH	32	0	0	0	18.2	33	0	3.1	0
OTH	33	0	0	0	22.2	19.2	0	1	0
OTH	34	0	0	0	6.8	9.3	0	1	0
OTH	35	0	0	0	35.7	9.2	0	0	0
OTH	36	0	0	0	39.4	9.6	0	0	0
OTH	37	0	0	0	8.4	0	0	0	0
OTH	38	0	0	0	0.8	3.8	0	0	0
OTH	39	0	0	0	0.5	2.9	0	0	0
OTH	40	0	0	0	0.2	0	0	0	0

6.8.3. Fishing effort data

Fishing effort data were reported to STECF EWG 16-13 through DCF. Fishing effort for GSAs 9, 10, 11 (region 2) were present (Fig 6.8.3.1-5, Table 6.8.3.1) as nominal effort, Gt days at sea, and days at sea by years and main gears which include OTB, PS and all other gears (OTH).

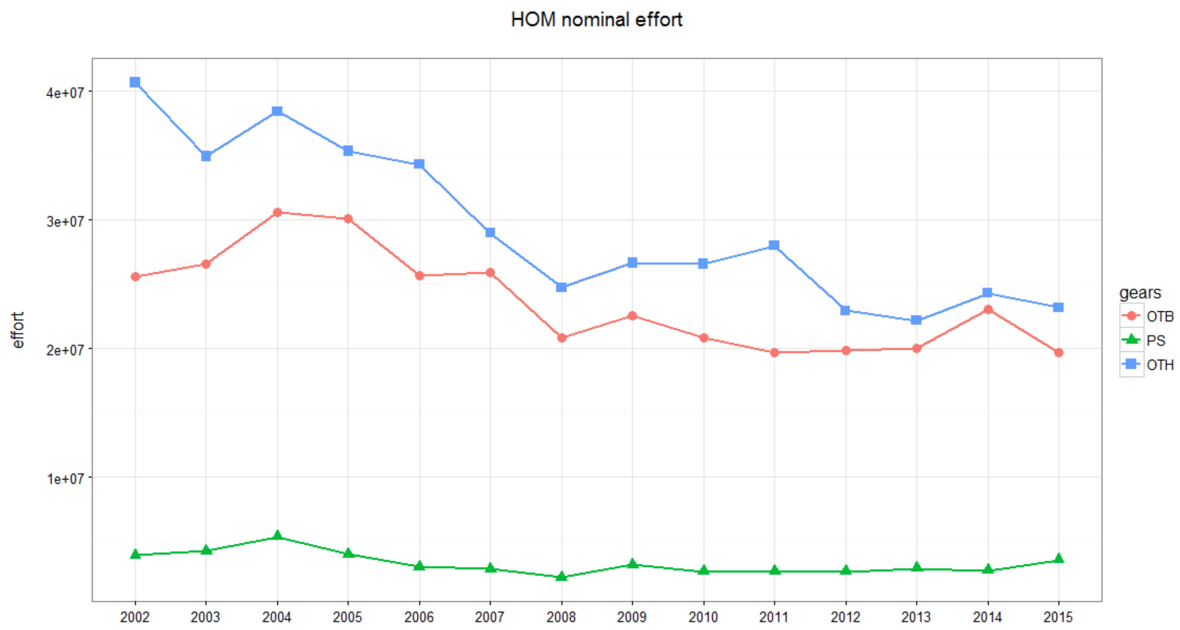


Figure 6.8.3.1. Atlantic Horse mackerel in GSAS 9,10,11. Nominal effort at sea in region 2.

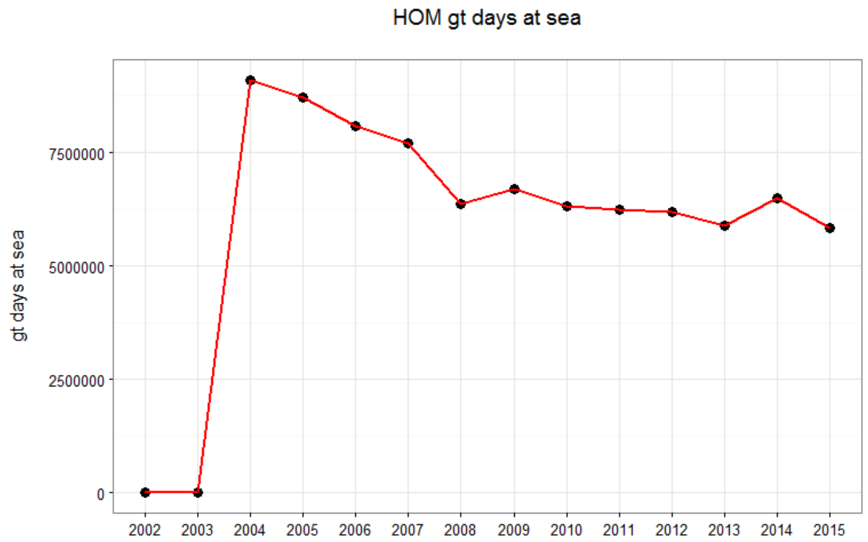


Figure 6.8.3.2. Atlantic Horse mackerel in GSAS 9,10,11Fishing effort data in GT_Days at sea in region 2.

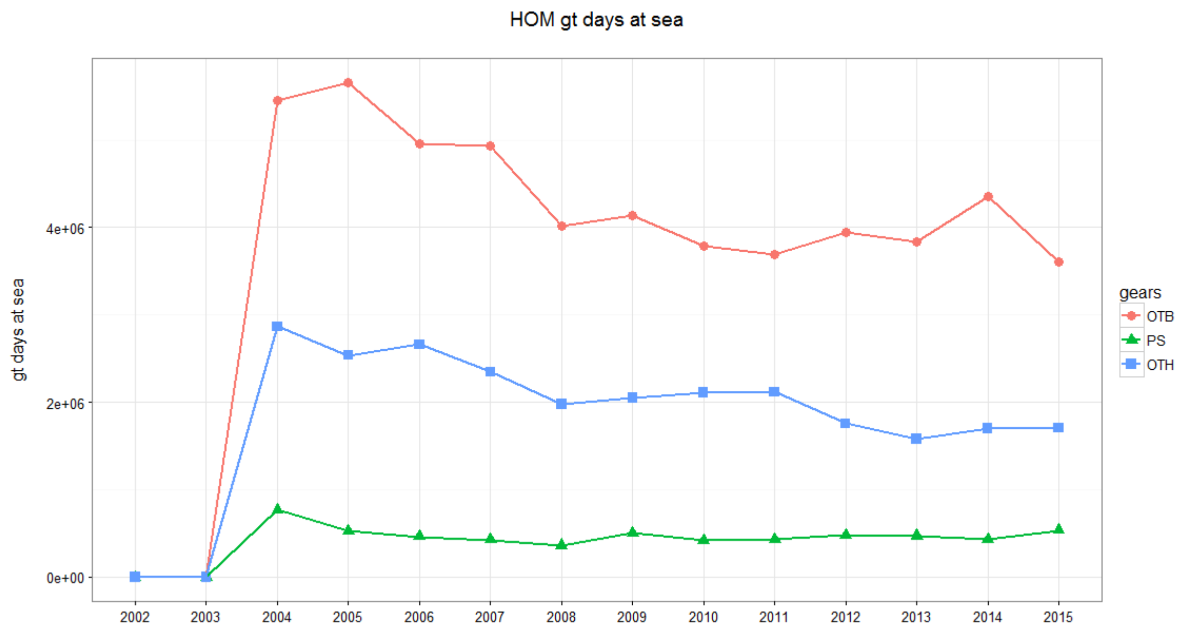


Figure 6.8.3.3. Atlantic Horse mackerel in GSAS 9,10,11. Fishing effort data in GT*Days at sea by fishing gear in region 2.

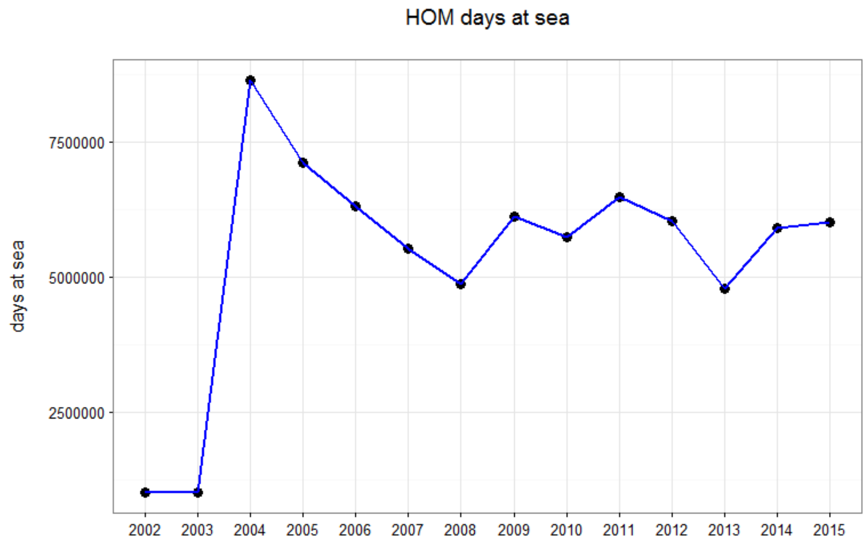


Figure 6.8.3.4. Atlantic Horse mackerel in GSAS 9,10,11Fishing effort data in Days at sea in region 2.

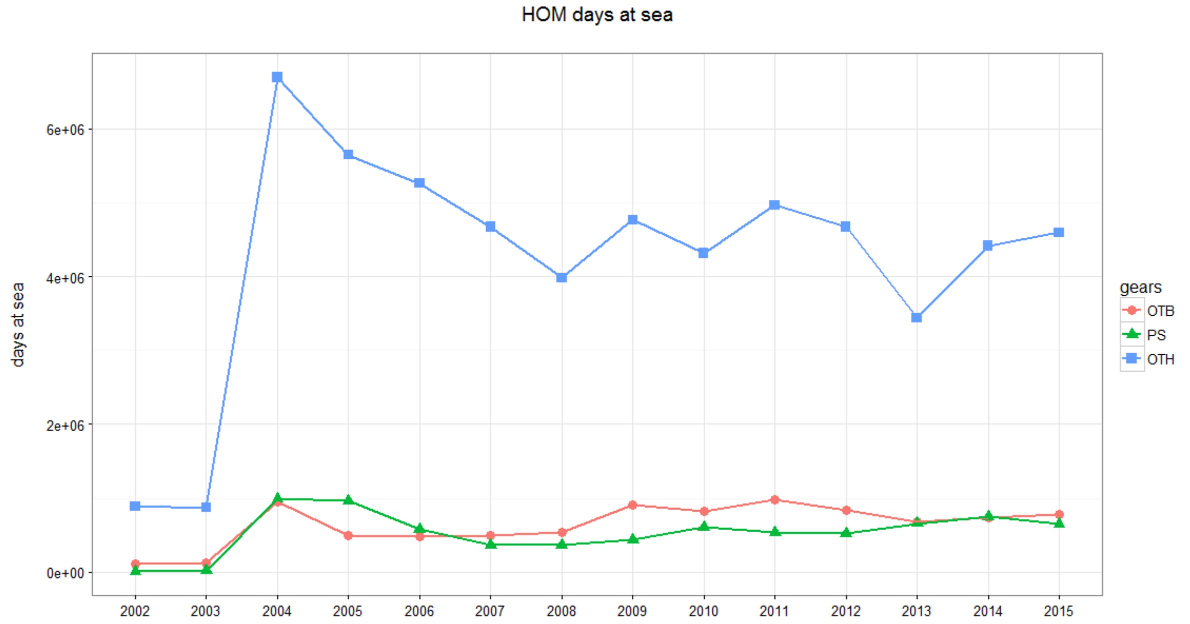


Figure 6.8.3.5. Atlantic Horse mackerel in GSAS 9,10,11. Fishing effort data in Days at sea by main fishing gears in region 2.

Table 6.8.3.1. Atlantic Horse mackerel in GSAS 9,10,11. DCF data on effort in region 2.

nominal_effort
factor(year)

gear	2002 effort	2003 effort	2004 effort	2005 effort	2006 effort	2007 effort	2008 effort	2009 effort	2010 effort	2011 effort	2012 effort	2013 effort	2014 effort	2015 effort
DRB	281809	365061	358139	558741	531762	374390	619714	466159	438958	416682	378111	225168	214676	267020
FPN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FPO	0	0	42030	391578	1119388	1498812	974343	1071094	1069982	1776781	1569018	1398494	1288003	1472900
FYK	0	0	0	0	0	4639	0	0	0	720	0	0	0	1906
GND	0	0	297458	132337	685851	454015	496680	440344	127540	52457	53742	7667	38343	14955
GNS	6504001	6925653	8966066	9959696	6429324	6693459	6001423	6788083	6204823	7013899	5144115	3357838	4765401	3933648
GTR	14021521	16373768	13136951	12741736	15379181	11551313	9383133	9610840	10149344	10272814	9376203	12223851	11588290	9121880
LA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LHM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LLD	0	0	1606449	2233868	2192747	2198688	2019362	2421251	3719195	3728507	3258596	2085043	2066175	4107614
LLS	0	0	6036498	3249513	3150160	2463346	2092615	1717309	1836022	2167023	1621079	1828631	3179887	2425201
LTL	0	0	0	0	13928	5408	589	3169	0	20109	5658	28516	12334	1809
OTB	25607249	26555175	30597146	30054689	25657959	25937181	20826826	22541273	20867779	19718982	19873334	20017955	23071338	19693721
OTM	0	0	0	0	0	0	0	0	0	0	0	0	383607	686978
OTT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PS	3943654	4263625	5354735	3998928	3037943	2832784	2220934	3176208	2642790	2696033	2653745	2889480	2736791	3550534
PTM	0	0	6173	0	4599	0	0	0	100	0	902	0	0	0
SB	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TBB	0	0	0	0	0	0	0	0	0	0	0	0	0	0

gt_days_at_sea
factor(year)

gear	2002 "gt_days"	2003 "gt_days"	2004 "gt_days"	2005 "gt_days"	2006 "gt_days"	2007 "gt_days"	2008 "gt_days"	2009 "gt_days"	2010 "gt_days"	2011 "gt_days"	2012 "gt_days"	2013 "gt_days"	2014 "gt_days"	2015 "gt_days"
DRB	0	0	29191	39963	35831	27247	107492	38252	35346	33223	31682	22721	21039	25239
FPN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FPO	0	0	8821	32606	70603	96185	56471	74486	67714	105374	102956	84508	88310	101595
FYK	0	0	0	0	0	789	391	444	664	792	0	0	0	1379
GND	0	0	24278	16881	51284	39974	36301	33395	11314	4458	4389	510	2289	984
GNS	0	0	694687	695697	469735	471099	406055	457638	427758	455569	373690	244053	329240	279890
GTR	0	0	924883	831671	1057953	810195	603458	621770	656204	682253	571026	795686	650968	575525
LA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LHM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LLD	0	0	154707	138350	249383	306966	267471	285024	512326	465021	420800	195619	187415	352144
LLS	0	0	282058	204190	255790	197833	156614	119431	125073	155844	117427	133641	254283	157367
LTL	0	0	158	0	777	301	43	194	0	1414	446	1685	809	196
OTB	0	0	5456690	5656408	4956461	4935993	4016040	4140052	3787900	3687969	3945979	3838024	4350383	3603507
OTM	0	0	0	0	0	0	0	0	0	0	0	0	107419	121444
OTT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PS	0	0	772611	528341	463117	427055	363271	503585	421316	434200	478821	471455	434185	534445
PTM	0	0	475	0	231	0	0	0	6	0	57	0	0	0
SB	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TBB	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	days_at_sea factor(year) 2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
gear	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"
DRB	2514	3537	102174	105584	103414	98845	86803	83676	83289	68364	351314	73950	76192	82923
FPN	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FPO	0	0	444701	469589	390616	169591	162290	165636	162800	246433	377094	337937	356331	482516
FYK	0	0	0	0	0	25975	4805	7887	10452	10512	0	0	0	50120
GND	0	0	528066	473984	458612	345841	320569	375432	310676	276885	158566	14967	156162	161261
GNS	212455	182159	997923	841824	769803	896631	737040	965371	832989	1082095	954241	816597	934775	944017
GTR	512914	513225	859560	765734	747674	740189	591870	669041	603811	679971	586358	561698	571035	589260
LA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LHM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LLD	0	0	678514	647170	540194	307857	468175	524086	494008	503449	529051	445076	486791	568128
LLS	0	0	842084	781449	737193	699620	519366	612366	549506	600248	544939	440511	510967	581138
LTL	0	0	187448	0	74358	43722	25771	28535	0	130324	69182	9943	105953	52933
OTB	115104	120422	955477	496967	480246	491774	532863	912258	826313	976141	837844	688528	741996	779293
OTM	0	0	0	0	0	0	0	0	0	0	0	0	18738	55137
OTT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PS	13711	16022	996779	965214	576253	361772	361987	439246	608414	532832	526600	658583	746678	649177
PTM	0	0	201588	0	38986	0	0	0	27827	0	58245	0	0	0
SB	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SV	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TBB	0	0	0	0	0	0	0	0	0	0	0	0	0	0

6.8.4. Survey Indices of abundance and biomass by year and size/age

Abundance and biomass indexes were reported to STECF EWG 16-13 through DCF. Atlantic Horse Mackerel time series of abundance and biomass indices from MEDITS surveys are shown and described in the following figures for region 2 (GSAs 9, 10, 11).

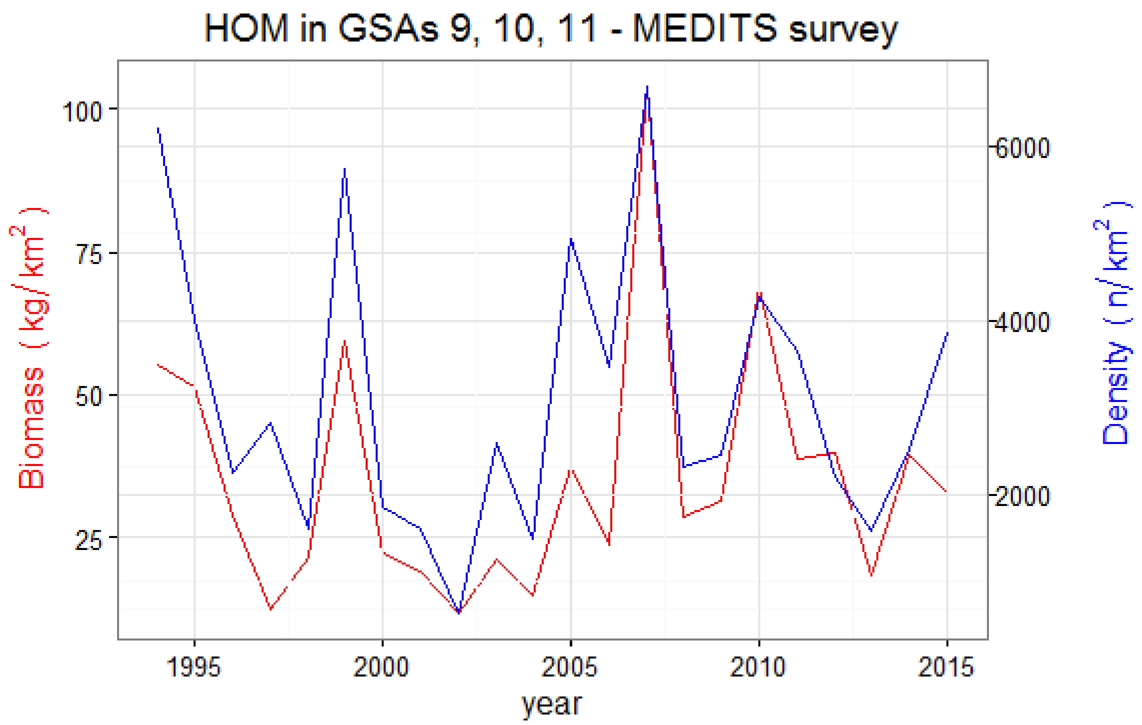


Figure 6.8.4.1. Atlantic Horse mackerel in GSAs 9,10,11. Historical trends of abundance (blue) and biomass index (red) estimated by MEDITS survey.

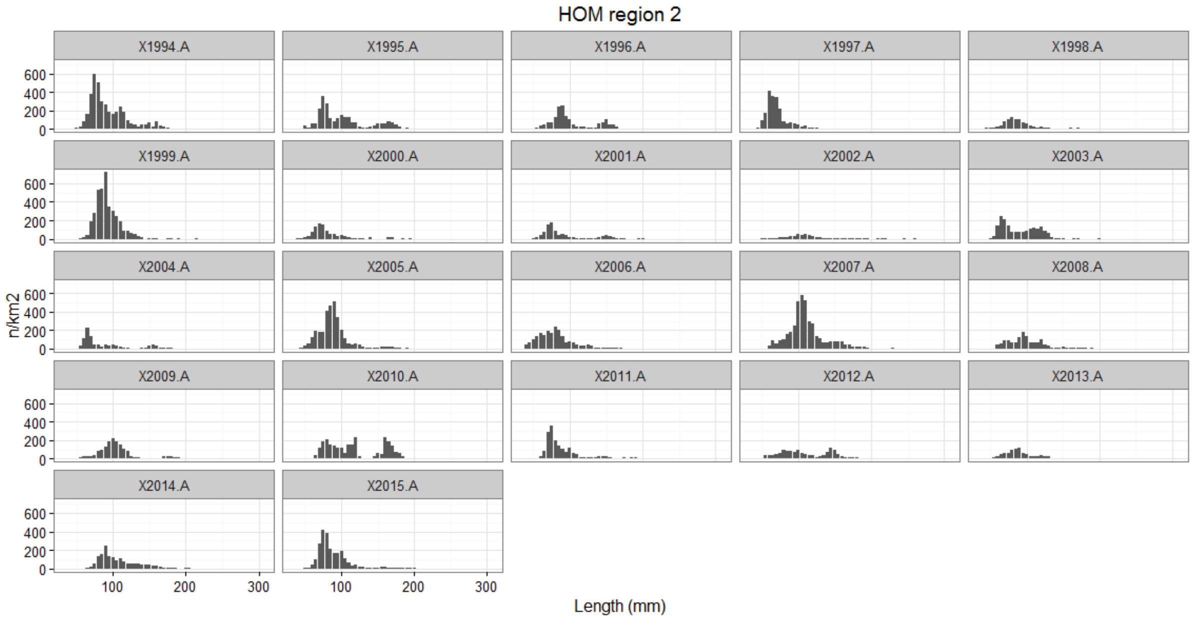
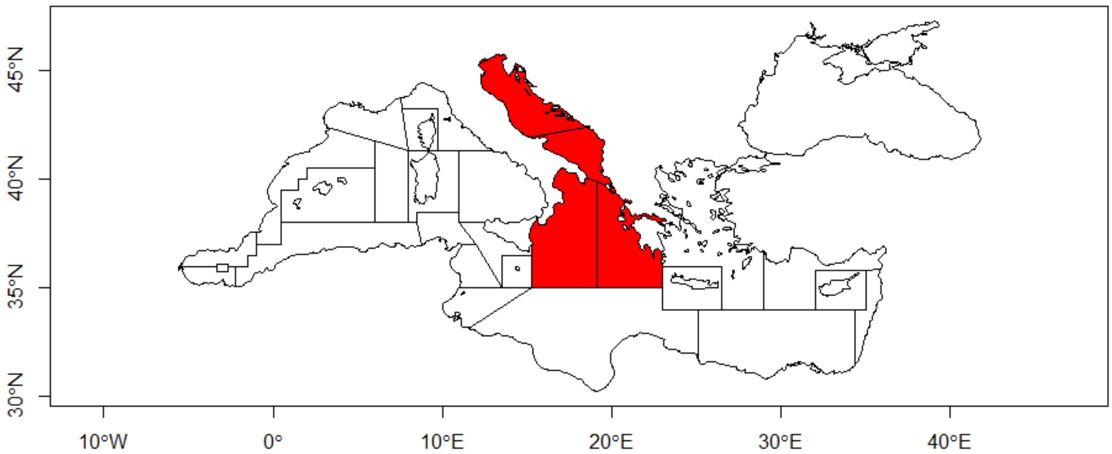


Figure 6.8.4.2. Atlantic Horse Mackerel in region 2 (GSAs 9, 10, 11). Size structure of the abundance index estimated by MEDITS survey.

6.9. DATA GATHERING OF ATLANTIC HORSE MACKEREL IN GSAs 17,18,19,20

6.9.1 Identity and Biology

The area, hereafter named region 3 (GSAs 17-18-19-20), belongs to 5 countries (ITA, SVN, HRC, ALB, MTN). It covers a surface of about 154439 km^2 in the depth range between 10-800 m (Figure 6.3.1.1).



6.9.1.2 Growth

Growth parameters have been derived from the dataset of biological parameter (gp.csv) as reported in the last data call (Table 6.9.2.1) for the GSA18.

Table 6.9.1.1. Atlantic Horse Mackerel. Growth parameters.

Stock Identification	L_inf	k	t0	L-W: a	L-W: b	Source
Region 3	44	0.192	-1.31	0.0099	2.945	ITA GSA18

6.9.1.3 Maturity

Maturity ogives were taken from DCF data. L_{50} is reported at 17-21 cm TL corresponding to an age class of 1.

Table 6.9.1.2. Atlantic Horse Mackerel. Proportion of mature fish by age.

Age	0	1	2	3	4	5	6	7	8	9	10
maturity	0.053	0.248	0.618	0.832	0.9	0.9	0.95	1	1	1	1

6.9.2 Natural mortality

For the natural mortality EWG16-13 refers to the ICES WGHANSA (2013) for the southern horse mackerel stock (Table 6.9.1.3).

Table 6.9.1.3. Natural mortality, as used by ICES WGHANSA for the southern horse mackerel stock.

AGE	0	1	2	3	4	5	6	7	8	9	10
M	0.9	0.6	0.4	0.3	0.2	0.15	0.15	0.15	0.15	0.15	0.15

6.9.2 Catch data

6.9.2.1 Landings

As reported on the DCF data call total landings (tonnes) area available since 2006. They belong mainly to OTB and PS and other gears (GNS) (Figure 6.9.2.1, tables 6.9.2.1 and 6.9.2.2).

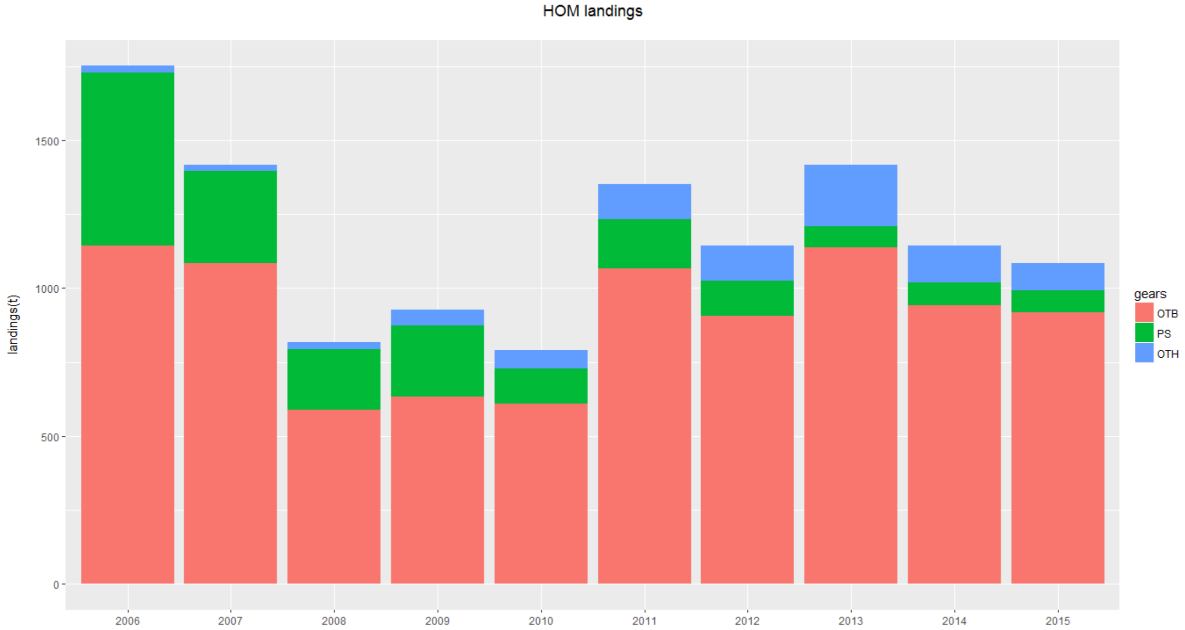


Figure 6.9.2.1. Total landings by year and main fishing gear in the region 3 (GSAs 17-20)

Table 6.9.2.1. Year trend on total landings and percent contribution by main gear in the region 3 (GSAs 17-20)

year	OTB	PS	OTH	total	%OTB	%PS	%OTH
2006	1145	583	24	1752	65.3	33.3	1.4
2007	1084	311	22	1417	76.5	21.9	1.6
2008	588	205	24	817	72.0	25.1	2.9
2009	631	241	55	927	68.1	26.0	5.9
2010	610	117	63	790	77.2	14.8	8.0
2011	1065	168	118	1351	78.8	12.4	8.7
2012	905	120	119	1144	79.1	10.5	10.4
2013	1139	70	207	1416	80.4	4.9	14.6
2014	941	77	124	1142	82.4	6.7	10.9
2015	918	75	92	1085	84.6	6.9	8.5

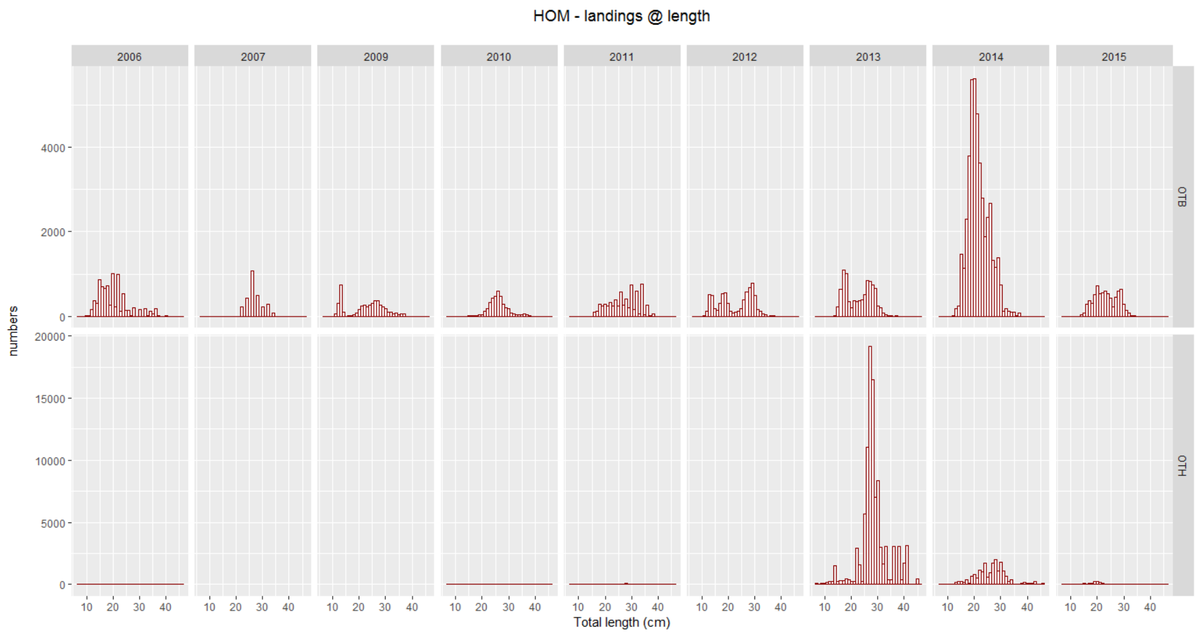


Figure 6.9.2.2. Length at age distribution by year and main fishing gear in the region 2 (GSAs 9, 10, 11)

Table 6.9.2.3. Landings at length by year and main gear in the region 3 (GSAs 17-20)

gear2	len	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OTB	10	0	0	0	23.6	0	0	0	0	0	0	0	0	0
OTB	11	0	0	0	23.6	0	0	48.6	0	0	18.5	0	0	1
OTB	12	0	0	0	172	0	0	308.1	0	0	122.8	0	12.1	1
OTB	13	0	0	0	360.9	0	0	741.8	0	0	525.2	3	185.6	5.9
OTB	14	0	0	0	310.3	0	0	92	0	5.1	493.4	13.7	238.6	44.9
OTB	15	0	0	0	860.1	0	0	4.1	10.2	4.1	176	234.1	1475.3	70.3
OTB	16	0	0	0	700.7	0	0	12.3	20.4	100.8	142.6	635.3	1138.1	276.9
OTB	17	0	0	0	666.2	0	0	11.2	19	115	314.9	1089.6	2294.2	373.1
OTB	18	0	0	0	730.8	0	0	36.6	22.6	296.4	532.3	1021.7	3803.2	315.4
OTB	19	0	0	0	268.2	0	0	86.5	36.8	241.2	557.5	351.2	5610.3	508.8
OTB	20	0	0	0	1021.2	0	0	159.3	44.6	290.4	308.7	209.8	5627.9	716.8
OTB	21	0	0	0	226	0	0	247.6	128.4	240.2	128.4	380	4787.6	543.9
OTB	22	0	0	0	1000.5	216	0	271.8	176.5	327	79.8	342.3	3638.2	551.2
OTB	23	0	0	0	124.8	0	0	221.7	338.3	243.6	105.1	376	2793.6	603.5
OTB	24	0	0	0	538.7	432	0	263.2	436	387.6	117.1	391.5	1889.4	534.5
OTB	25	0	0	0	150.1	0	0	311.7	480.1	239.3	173.8	517.4	2338.1	436
OTB	26	0	0	0	138.3	1081	0	368.6	589.8	583.5	392.9	837.5	2670.7	230
OTB	27	0	0	0	23.6	0	0	366.9	473	273.3	580.1	820.3	1319.5	463.3
OTB	28	0	0	0	204.2	504	0	258	280.7	403.8	687.4	752.6	1157	608.2
OTB	29	0	0	0	0	0	0	226.5	211.2	198.2	787.7	669.9	1381.5	643.5

gear2	len	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OTB	30	0	0	0	166	216	0	190.9	175.6	736.4	491.3	246.5	751.1	280
OTB	31	0	0	0	0	0	0	108.7	89.4	164.8	159.8	200.3	122.5	133.2
OTB	32	0	0	0	182.9	288	0	96	50.4	596.3	110.9	75.6	185.9	74.5
OTB	33	0	0	0	16.9	0	0	55.4	41.4	67	57.6	44.7	123.2	9.8
OTB	34	0	0	0	120.1	72	0	81.4	40.6	770.2	40.8	17	99.2	20.5
OTB	35	0	0	0	52.3	0	0	30.5	41.8	43.9	4.6	13.7	93	3.9
OTB	36	0	0	0	187.7	0	0	68	55.1	264.8	11	4.3	12	0
OTB	37	0	0	0	13.5	0	0	56	32.7	25.8	7.5	9.2	81	1
OTB	38	0	0	0	0	0	0	0	21.1	52.2	6.4	1.5	3	1
OTB	39	0	0	0	0	0	0	5.6	0	0	5.6	1.5	0	0
OTB	40	0	0	0	13.5	0	0	0	0	0	1.9	0	0	0
OTB	41	0	0	0	1.7	0	0	0	4.4	0	3.8	0	0	0
OTH	7	0	0	0	0	0	0	0	0	0	0	70	0	0
OTH	9	0	0	0	0	0	0	0	0	0	0	90	0	0
OTH	10	0	0	0	0	0	0	0	0	0	0	105.9	0	3.5
OTH	11	0	0	0	0	0	0	0	0	0	0	162.9	0	0
OTH	12	0	0	0	0	0	0	0	0	0	0	202.3	20.2	0
OTH	13	0	0	0	0.1	0	0	0	0	0.1	0	209.3	173.1	17.3
OTH	14	0	0	0	1.7	0	0	0	0	1.4	0	1532.8	231.9	3.5
OTH	15	0	0	0	3.1	0	0	0	0	3.9	0	214.6	211.6	72.6
OTH	16	0	0	0	3.2	0	0	0	0	2.1	0	268.7	176.7	0
OTH	17	0	0	0	2.9	0	0	0	1.1	8.1	0	302.2	375.9	110.9
OTH	18	0	0	0	2.9	0	0	0	2.2	17.5	0	441.5	110.3	90.4
OTH	19	0	0	0	4.6	0	0	0	4.1	16.5	0	345.7	662.6	215.3
OTH	20	0	0	0	6.7	0	0	0	3.7	6.9	0	252.9	832.6	201.6
OTH	21	0	0	0	8.8	0	0	0	1.1	3.9	0	221.8	498.2	152.7
OTH	22	0	0	0	8.2	0	0	0	2.2	20.1	0	2923.3	1154.2	62.6
OTH	23	0	0	0	5.4	0	0	0	2.4	0.6	0	1584.6	1025.9	17.5
OTH	24	0	0	0	4	0	0	0	1.1	0	0	248.8	1698.8	0
OTH	25	0	0	0	4.1	0	0	0	1.3	0	0	5647.8	557.5	3.5
OTH	26	0	0	0	2.9	0	0	0	0.2	51	0	11061.4	940	0
OTH	27	0	0	0	3.3	0	0	0	0.4	0	0	19160.7	1712.4	0
OTH	28	0	0	0	1.3	0	0	0	0.4	77	0	16467.4	2006.6	0
OTH	29	0	0	0	1.3	0	0	0	0.4	0	0	7033.5	1101.1	0
OTH	30	0	0	0	0.3	0	0	0	0.4	51.1	0	8392.2	1754.5	0
OTH	31	0	0	0	0.5	0	0	0	0	0	0	3007.4	1077.5	0
OTH	32	0	0	0	1	0	0	0	0	26.1	0	1668.7	651	0
OTH	33	0	0	0	0.5	0	0	0	0	0	0	3027.4	246.5	0
OTH	34	0	0	0	1	0	0	0	0	0.2	0	340	350	0
OTH	35	0	0	0	0.4	0	0	0	0	0.1	0	350	24	0
OTH	36	0	0	0	0.2	0	0	0	0	0.1	0	3057.4	48	0
OTH	37	0	0	0	0.2	0	0	0	0	0	0	0	48	0
OTH	38	0	0	0	0.1	0	0	0	0	0	0	3077.4	72	0
OTH	39	0	0	0	0.4	0	0	0	0	0	0	390	138	0
OTH	40	0	0	0	0	0	0	0	0	0	0	1748.7	72	0

gear2	len	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OTH	41	0	0	0	0	0	0	0	0	0	0	3107.4	120	0
OTH	42	0	0	0	0	0	0	0	0	0	0	0	72	0
OTH	43	0	0	0	0	0	0	0	0	0	0	0	210	0
OTH	45	0	0	0	0	0	0	0	0	0	0	450	0	0
OTH	46	0	0	0	0	0	0	0	0	0	0	0	72	0

6.9.2.2 Discards

Discards area available since 2006 and belongs to OTB (table 6.9.2.4, Figure 6.9.2.4). Discards are missing in 2007-8.

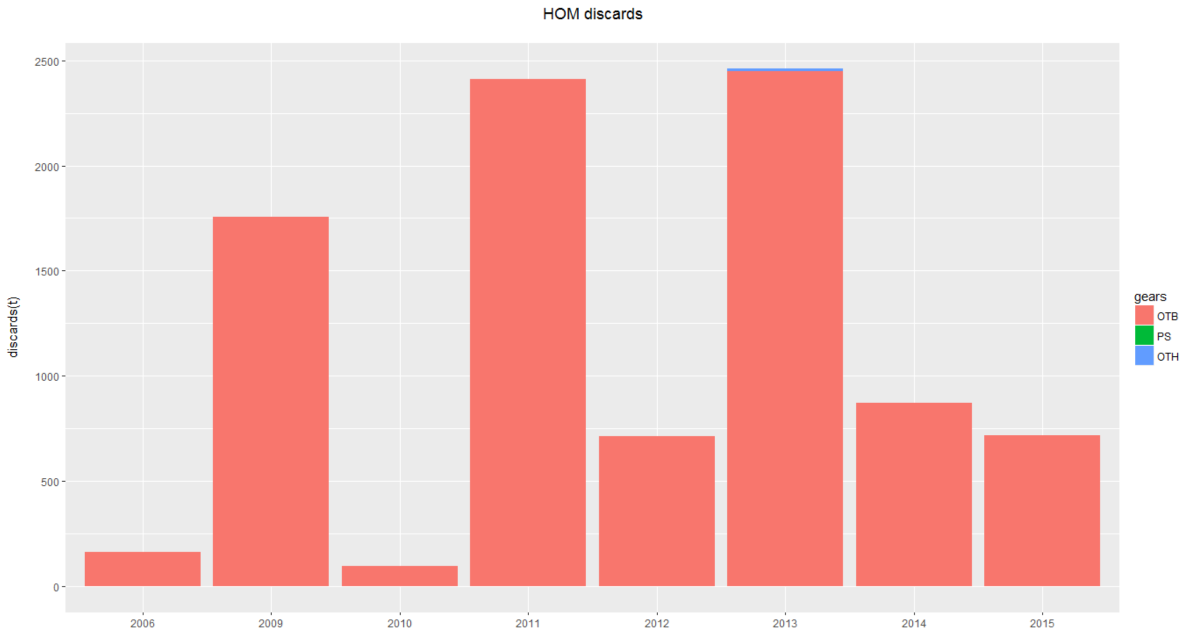


Figure 6.9.2.4. Total discards by year and main fishing gear in the region 3 (GSAs 17-20)

Table 6.9.2.4. Total discards by year and main fishing gear in the region 3 (GSAs 17-20).

year	OTB	PS	OTH	total	%OTB	%PS	%OTH
2006	163	0.3	0	164	99.8	0.2	0.0
2007	0	0	0	0	0.0	0.0	0.0
2008	0	0	0	0	0.0	0.0	0.0
2009	1758	0	0	1758	100.0	0.0	0.0
2010	95	0	0	95	100.0	0.0	0.0
2011	2412	0	0	2412	100.0	0.0	0.0
2012	712	0	0	712	100.0	0.0	0.0
2013	2450	0	11	2461	99.6	0.0	0.4
2014	870	0	0	870	100.0	0.0	0.0
2015	718	0	0	718	100.0	0.0	0.0

Discards at length were available from 2009 for OTB and only for 2013 and 2014 for GNS, indicated as OTH in figure 6.9.2.5.

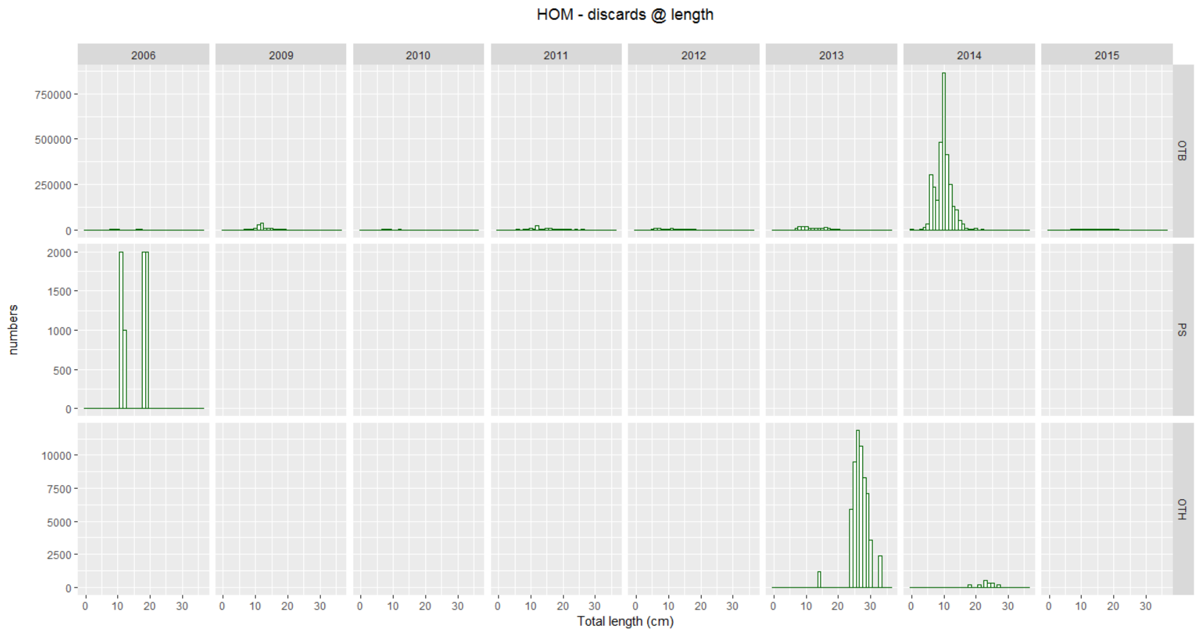


Figure 6.9.2.5. Length at age distribution by year and main fishing gear in the region 3 (GSAs 17-20)

Table 6.9.2.5. Landings at length by year and main gear in the region 3 (GSAs 17-20)

gear2	len	2006	2009	2010	2011	2012	2013	2014	2015
OTB	0	0	0	0	0	0	0	3264	0
OTB	3	0	0	0	0	0	0	1632	0
OTB	4	0	0	0	40	6.8	0	11425	0
OTB	5	0	22.8	14.4	35.5	2043.1	4.4	34274	14.5
OTB	6	133.7	284.9	193.7	2322	8858.6	480.4	303572	194
OTB	7	408.4	954.4	1322.1	273.2	8148.4	6006.9	236676	1589.5
OTB	8	1730.3	2909.6	2215.3	4258.6	3899.7	18015.4	164924.9	2316.5
OTB	9	3378.9	3019.6	1067.3	755.7	3662.1	15614.8	483733.9	1867.1
OTB	10	1339.7	9914.9	501.5	6991.9	4581.1	15604.7	864776.5	1200.8
OTB	11	157.4	25546.2	437.8	4801.5	6390.8	6256.4	416062.1	1246.5
OTB	12	205	34587.1	580.4	19988.6	3786.5	7133.9	248507	1240.4
OTB	13	346.1	9455.5	492.6	3535.1	2470.5	9424.1	128640.3	911.4
OTB	14	251	6050.4	167.2	5316.4	2197.7	6246.8	110729.3	792.3
OTB	15	258.4	5647.5	60.5	5793.1	2327	5703.3	51303.6	866.1
OTB	16	699.5	3358	124.4	8389.1	1648.3	10409.6	33146.1	1349.8
OTB	17	698.1	1495.1	101.3	3723.5	1298.2	7811.9	7190.6	1906.8
OTB	18	384.7	1079.8	150.5	3305.2	798.2	3276.4	2849.9	1581.2

gear2	len	2006	2009	2010	2011	2012	2013	2014	2015
OTB	19	142.6	622.1	116.3	2899.6	518.5	1595.6	4889.5	1003.1
OTB	20	46	254.3	46.2	2397.8	307	1068.7	7596	2121.8
OTB	21	25.2	88.9	20.3	1119.4	181.8	360	93.7	1251.6
OTB	22	0	17.1	49.7	1221.3	44.7	377.7	1253	301.7
OTB	23	57.9	0	19.4	388.9	59.7	419.4	28.7	107.3
OTB	24	19.3	0	3.3	737	14.8	243.8	4.9	58
OTB	25	19.3	11.4	5.5	28.2	27.8	113.3	5.1	0
OTB	26	0	5.7	3.1	569.2	82.8	254.6	0	0
OTB	27	0	11.4	2.2	40	3.4	153.5	0	0
OTB	28	0	5.7	0	389.3	5.4	280	0	2.9
OTB	29	0	0	0	8.6	3.9	170.8	0	0
OTB	30	0	0	0	131	1	72.3	0	0
OTB	31	0	0	0	7.4	1	18.1	0	0
OTB	32	0	0	0	32	0	0	0	0
OTB	34	0	0	0	34	0	0	0	0
OTB	36	0	0	0	14	0	0	0	0
PS	11	2000	0	0	0	0	0	0	0
PS	12	1000	0	0	0	0	0	0	0
PS	18	2000	0	0	0	0	0	0	0
PS	19	2000	0	0	0	0	0	0	0
OTH	14	0	0	0	0	0	1185.3	0	0
OTH	18	0	0	0	0	0	0	171	0
OTH	21	0	0	0	0	0	0	171	0
OTH	23	0	0	0	0	0	0	513	0
OTH	24	0	0	0	0	0	5926.6	342	0
OTH	25	0	0	0	0	0	9482.5	342	0
OTH	26	0	0	0	0	0	11853.2	0	0
OTH	27	0	0	0	0	0	10667.9	171	0
OTH	28	0	0	0	0	0	8297.2	0	0
OTH	29	0	0	0	0	0	7111.9	0	0
OTH	30	0	0	0	0	0	3556	0	0
OTH	33	0	0	0	0	0	2370.6	0	0

6.9.3 Fishing effort

Fishing effort data were reported to STECF EWG 16-13 through DCF. Fishing effort for GSAs 17, 18, 19, 20 (region 3) were present (figure 6.2.3.1-5, tabale 6.2.3.1) as nominal effort, Gt days at sea, and days at sea by years and main gears which include OTB, PS and all other gears (OTH).

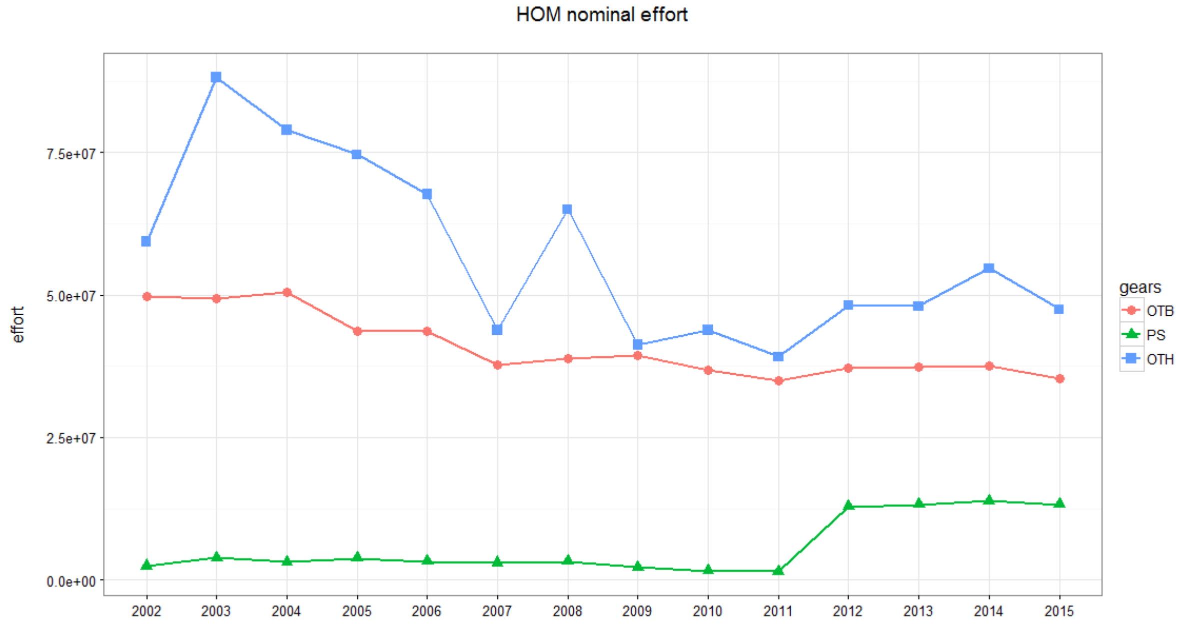


Figure 6.9.2.6. Nominal effort at sea by year in region 3 (GSAs 17, 18, 19, 20).

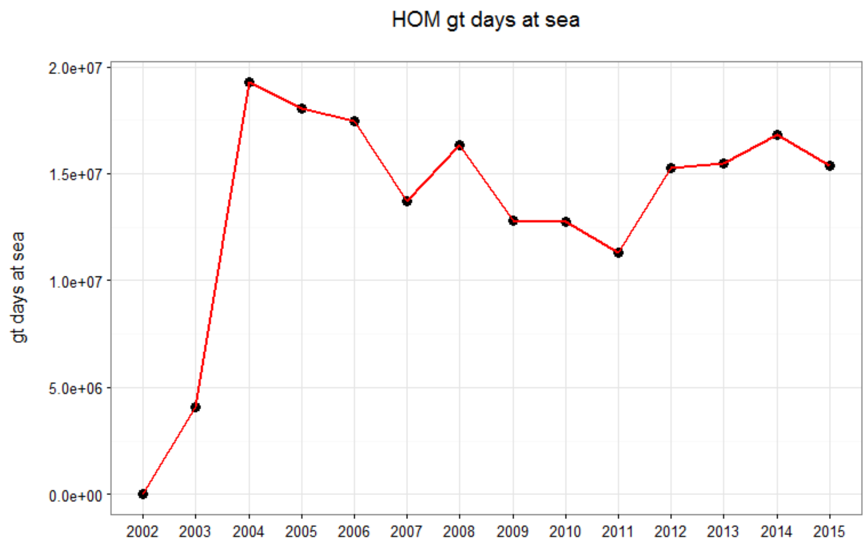


Figure 6.9.2.7. Fishing effort data in GT_Days at sea in region 3 (GSAs 17, 18, 19, 20).

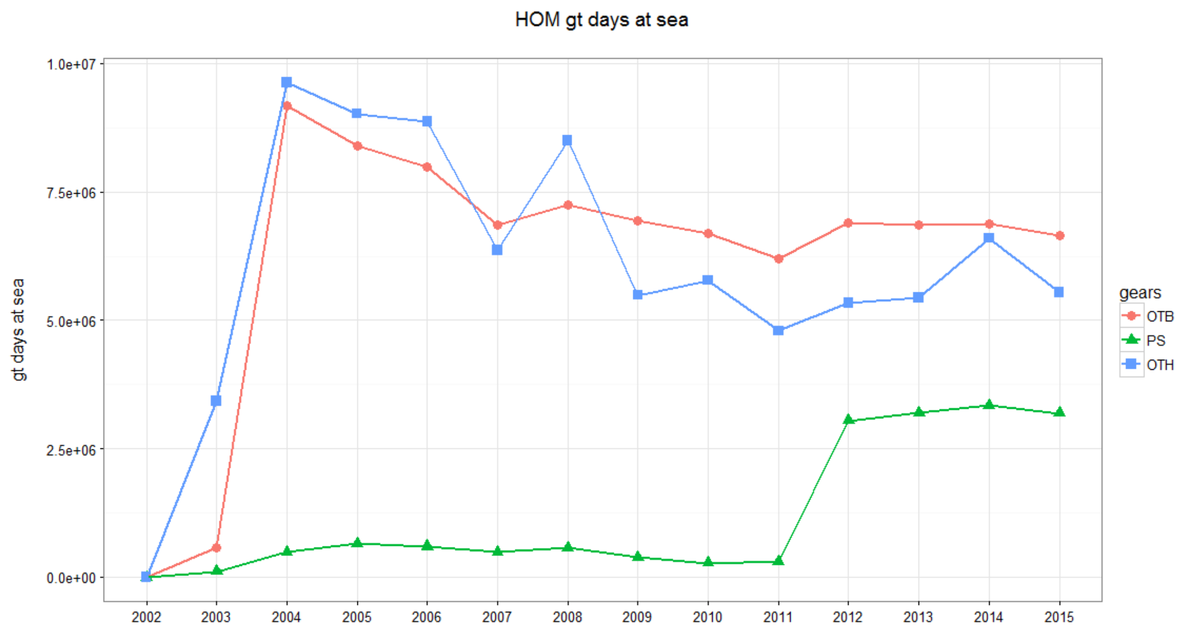


Figure 6.9.2.8. Fishing effort data in GT*Days at sea by fishing gear in region 3 (GSAs 17, 18, 19, 20).

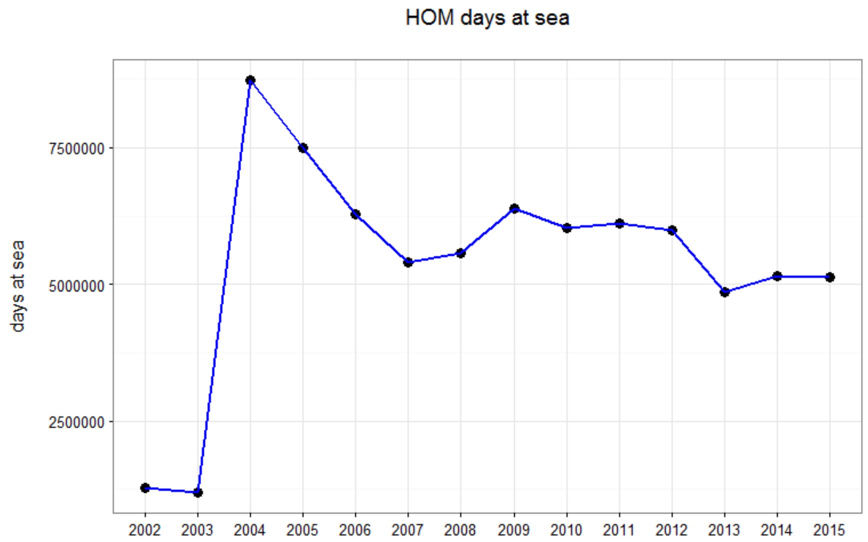


Figure 6.9.2.9. Fishing effort data in Days at sea by year in region 3 (GSAs 17, 18, 19, 20).

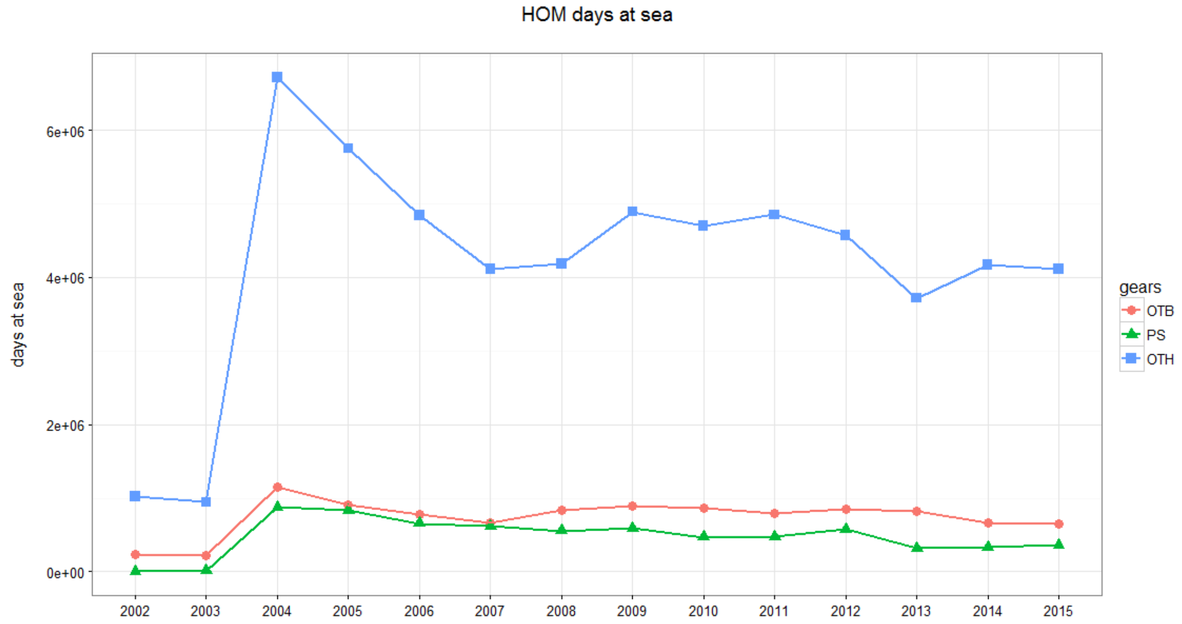


Figure 6.9.2.10. Fishing effort data in Days at sea by main fishing gears in region 3 (GSAs 17, 18, 19, 20).

Table 6.9.2.6. DCF data on effort in region 3 (GSAs 17, 18, 19, 20).

nominal_effort
factor(year)

gear	2002 effort	2003 effort	2004 effort	2005 effort	2006 effort	2007 effort	2008 effort	2009 effort	2010 effort	2011 effort	2012 effort	2013 effort	2014 effort	2015 effort
DRB	7481466.62	8102660.98	7688066.00	6464115.00	7101260.00	7455650.00	6483398.00	4959933.00	4966357.00	6008492.00	5778069.11	5282983.43	6552129.56	5998908.71
FPN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FPO	0.00	0.00	2078230.00	1037993.29	2248509.56	1901331.20	2243365.09	2352020.60	2138392.78	1777725.07	2367485.67	1952950.70	1973542.99	1901650.31
FYK	0.00	0.00	668999.00	795617.12	1258941.09	1436531.08	781895.57	990060.29	1233239.81	922930.73	1517963.19	911296.22	1222213.45	1520137.08
GND	0.00	0.00	728507.00	227190.85	505902.57	271801.01	240138.74	257369.74	610618.26	528509.94	559974.00	53176.00	117346.50	195106.59
GNS	11019579.93	8648936.27	6731652.00	8246194.42	7540534.87	5346277.29	4701309.23	6011339.65	5884147.01	6893904.39	10040752.95	8943460.80	11102671.98	8986635.93
GTR	4669872.77	9192253.63	4966178.00	3967508.69	2386779.06	2835786.57	3167125.71	3691230.42	4171817.80	4235994.29	5974228.34	8356329.67	9407794.92	8170880.03
LA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LHM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LHP	0.00	0.00	0.00	35.10	0.00	11.03	164.74	140.24	6601.52	6798.41	803177.44	1057460.32	1025208.84	897112.97
LLD	0.00	0.00	5463281.00	6711798.00	4557530.00	4623824.00	5687989.00	4078293.00	4495699.00	2604998.00	3960690.54	4310612.95	4202820.36	3214459.87
LLS	0.00	125676.08	2438921.93	2340143.62	2947019.60	1696800.52	2810632.29	1564326.78	2116904.15	1980031.52	3086923.22	3703691.30	3876521.05	3448736.93
LTL	0.00	0.00	0.00	111047.00	155819.00	23117.00	33950.00	0.00	0.00	0.00	45176.48	63924.12	65251.48	63090.96
OTB	49805921.15	49394422.56	50509966.22	43668818.09	43580378.22	37745608.90	38852055.11	39331315.44	36803227.86	34922385.91	37257222.72	37284729.62	37527115.22	35346313.80
OTM	0.00	0.00	12160.00	18187.00	23022.00	0.00	376.00	1493.94	0.00	9781.00	318000.06	8.33	491.91	49201.79
OTT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PS	2459402.41	3819853.57	3184177.03	3761977.82	3232073.47	3008813.20	3220906.15	2168813.87	1544342.32	1520454.32	12835952.42	13206688.00	13899453.96	13229731.16
PTM	7841347.07	7636049.46	9964004.00	8923513.00	8110360.00	8588140.00	7313886.00	7596766.00	7843201.00	6361141.00	7004265.00	7494420.00	8209538.00	6305819.00
SB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	125.10	244.24	82.98	88.08
SV	0.00	863066.37	697643.69	604097.62	623628.17	0.00	807597.34	0.00	0.00	0.00	373711.68	364023.14	319141.64	261614.79
TBB	0.00	0.00	4232537.00	3812915.00	4946237.00	5231834.00	4136346.00	4386154.00	3817491.00	2584717.00	3254459.87	2769862.81	3730600.07	3455027.33

gt_days_at_sea
factor(year)

gear	2002 "gt days"	2003 "gt days"	2004 "gt days"	2005 "gt days"	2006 "gt days"	2007 "gt days"	2008 "gt days"	2009 "gt days"	2010 "gt days"	2011 "gt days"	2012 "gt days"	2013 "gt days"	2014 "gt days"	2015 "gt days"
DRB	0.00	0.00	849661.00	760190.00	859016.00	967819.00	846129.00	572849.00	575112.00	746843.00	676262.80	617884.28	701044.17	704713.23
FPN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FPO	0.00	0.00	72431.00	37211.54	89111.99	80398.39	74011.17	88288.55	74046.87	62239.34	105442.13	94037.40	103081.68	166963.88
FYK	0.00	0.00	23008.00	19562.31	47889.76	64376.36	41957.18	52508.67	63740.60	50773.33	43092.99	31229.33	47873.20	53260.04
GND	0.00	0.00	39238.00	26681.56	46181.97	27307.83	20637.72	10152.15	32052.58	28023.45	30239.40	3547.00	12383.05	21481.85
GNS	0.00	0.00	391537.00	461926.07	459599.64	355505.41	290107.56	365171.82	386959.22	404459.89	581803.32	625592.85	867777.81	631686.91
GTR	0.00	0.00	395186.00	350039.75	218468.44	241898.22	250223.02	295094.63	303479.21	309745.41	404076.27	543229.58	1089818.44	627245.11
LA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LHM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LHP	0.00	0.00	0.00	7.44	0.00	1.41	15.59	13.43	716.06	706.93	33485.42	40262.60	39026.37	33512.63
LLD	0.00	0.00	999231.00	1113821.00	820933.00	823812.00	899130.00	605313.00	610346.00	410608.00	557550.66	711992.89	565975.27	462595.93
LLS	0.00	9109.77	218373.16	173458.38	228062.58	158648.83	256745.24	133046.84	158586.51	178463.32	243405.22	270088.38	342870.35	295355.53
LTL	0.00	0.00	0.00	9999.00	14561.00	1902.00	3598.00	0.00	0.00	0.00	2073.85	2712.46	2507.68	2351.63
OTB	0.00	574443.31	9176936.29	8394430.27	7991685.86	6860371.43	7249803.25	6947260.47	6683722.28	6206050.59	6889025.46	6861222.86	6878851.32	6657468.63
OTM	0.00	0.00	1216.00	2302.00	3315.00	0.00	29.12	345.28	0.00	1454.00	43807.57	0.67	225.74	11581.07
OTT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PS	0.00	105428.98	489993.26	652804.30	597140.13	488316.63	567097.52	378866.73	275543.55	305086.78	3042082.11	3196828.56	3347461.38	3185269.37
PTM	0.00	0.00	2137257.00	1922777.60	2122447.20	2264691.00	1890607.60	1870307.60	2007897.20	1538386.80	1634276.00	1671748.00	1763411.00	1464497.22
SB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.12	17.45	6.26	6.16
SV	0.00	83099.03	65506.99	58441.15	57058.49	0.00	75248.75	0.00	0.00	0.00	28498.49	27112.11	24122.05	19934.93
TBB	0.00	0.00	1003129.00	785589.00	1052912.00	1096364.00	843741.00	1045203.00	921158.00	665155.00	772756.12	657602.95	892695.44	831255.56

days_at_sea
factor(year)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
gear	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"	"days@sea"
DRB	6.94e+04	7.50e+04	5.07e+05	1.83e+05	1.88e+05	2.35e+05	2.14e+05	1.80e+05	1.65e+05	1.56e+05	3.03e+05	1.12e+05	1.38e+05	1.29e+05
FPN	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
FPO	0.00e+00	0.00e+00	5.90e+05	5.28e+05	3.91e+05	3.66e+05	3.39e+05	4.69e+05	4.17e+05	4.31e+05	4.14e+05	2.70e+05	3.90e+05	4.44e+05
FYK	0.00e+00	0.00e+00	3.76e+05	2.80e+05	2.44e+05	2.24e+05	2.88e+05	3.92e+05	3.63e+05	3.06e+05	3.10e+05	1.85e+05	3.02e+05	2.94e+05
GND	0.00e+00	0.00e+00	2.82e+05	2.86e+05	2.78e+05	1.86e+05	1.87e+05	1.49e+05	1.31e+05	1.96e+05	1.19e+05	1.43e+05	1.09e+05	1.56e+05
GNS	4.46e+05	3.35e+05	8.26e+05	7.20e+05	6.54e+05	5.14e+05	6.82e+05	9.66e+05	8.89e+05	8.49e+05	9.86e+05	7.83e+05	7.43e+05	7.77e+05
GTR	2.34e+05	2.55e+05	8.56e+05	7.39e+05	6.03e+05	5.17e+05	5.07e+05	6.03e+05	5.78e+05	6.94e+05	5.68e+05	5.84e+05	8.23e+05	5.93e+05
LA	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
LHM	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
LHP	0.00e+00	0.00e+00	0.00e+00	3.00e+00	0.00e+00	1.00e+00	1.30e+01	1.40e+01	9.00e+01	1.25e+02	1.04e+04	1.18e+04	1.19e+04	1.02e+04
LLD	0.00e+00	0.00e+00	7.64e+05	6.03e+05	4.43e+05	5.38e+05	4.81e+05	3.88e+05	4.18e+05	2.94e+05	2.96e+05	3.92e+05	3.43e+05	3.48e+05
LLS	0.00e+00	0.00e+00	4.48e+05	4.12e+05	5.22e+05	4.29e+05	3.61e+05	4.09e+05	4.04e+05	4.03e+05	3.66e+05	3.85e+05	3.51e+05	3.18e+05
LTL	0.00e+00	0.00e+00	0.00e+00	2.37e+05	1.58e+05	5.84e+04	3.32e+04	0.00e+00	0.00e+00	0.00e+00	1.41e+04	5.88e+02	5.75e+02	5.73e+02
OTB	2.41e+05	2.28e+05	1.15e+06	9.09e+05	7.86e+05	6.59e+05	8.30e+05	8.94e+05	8.63e+05	7.93e+05	8.50e+05	8.16e+05	6.62e+05	6.57e+05
OTM	0.00e+00	0.00e+00	1.52e+05	1.32e+05	8.95e+04	0.00e+00	2.00e+00	4.00e+00	0.00e+00	1.13e+04	3.45e+04	6.66e-02	2.68e+01	4.36e+04
OTT	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
PS	7.60e+03	1.18e+04	8.78e+05	8.30e+05	6.57e+05	6.20e+05	5.53e+05	5.94e+05	4.71e+05	4.75e+05	5.72e+05	3.18e+05	3.33e+05	3.61e+05
PTM	2.35e+04	2.56e+04	4.92e+05	2.22e+05	1.10e+05	1.14e+05	1.85e+05	1.80e+05	1.73e+05	1.71e+05	1.49e+05	1.38e+05	1.45e+05	1.35e+05
SB	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.28e+00	7.29e+00	2.87e+00	3.99e+00
SV	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.72e+03	6.80e+03	5.72e+03	4.75e+03
TBB	0.00e+00	0.00e+00	2.32e+05	2.10e+05	2.37e+05	2.00e+05	1.75e+05	2.92e+05	2.75e+05	3.13e+05	1.43e+05	1.32e+05	1.39e+05	1.75e+05

6.9.4 Survey Indices of abundance and biomass by year and size/age

Abundance and biomass indexes were reported to STECF EWG 16-13 through DCF. The trend in abundance and biomass indices of MEDITS surveys in the region 3 (GSAs 17, 18, 19, 20) shows two peack in 2004 and 2014 (fig. 6.9.4.1).

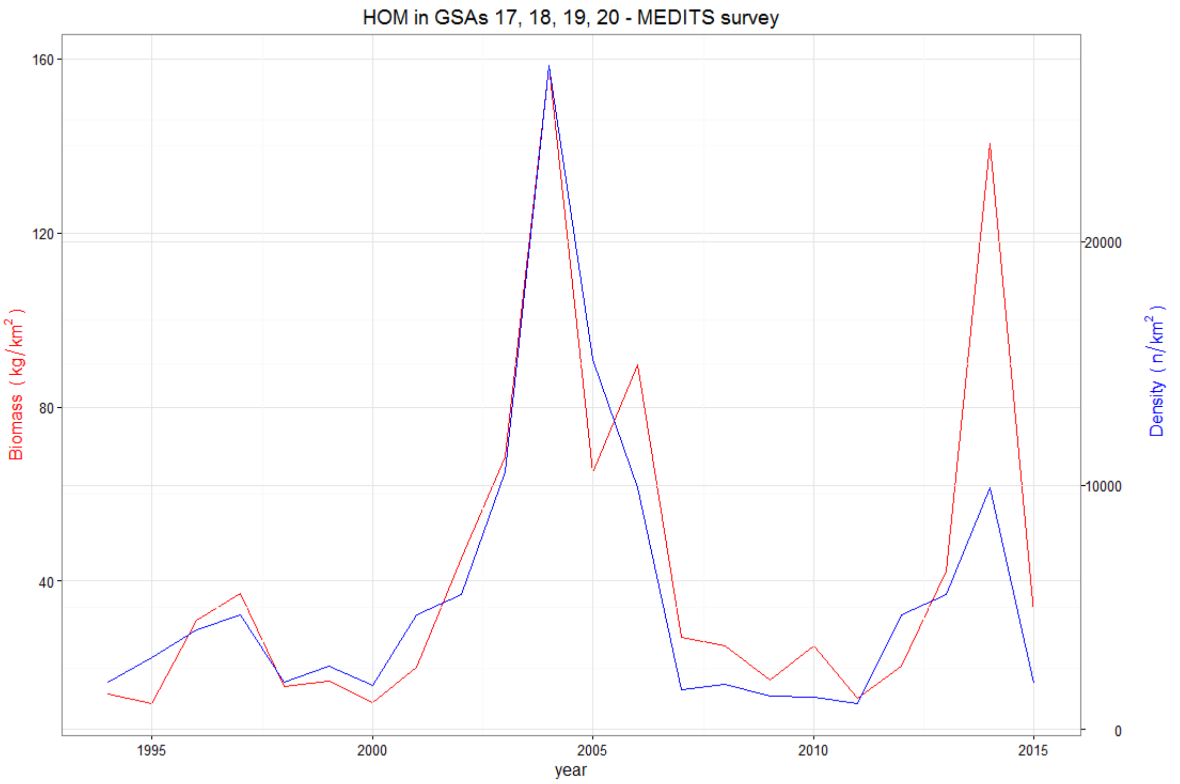


Figure 6.9.4.1. Atlantic Horse Mackerel in region 3 (GSAs 17, 18, 19, 20). Historical trends of abundance (blue) and biomass index (red) estimated by MEDITS survey

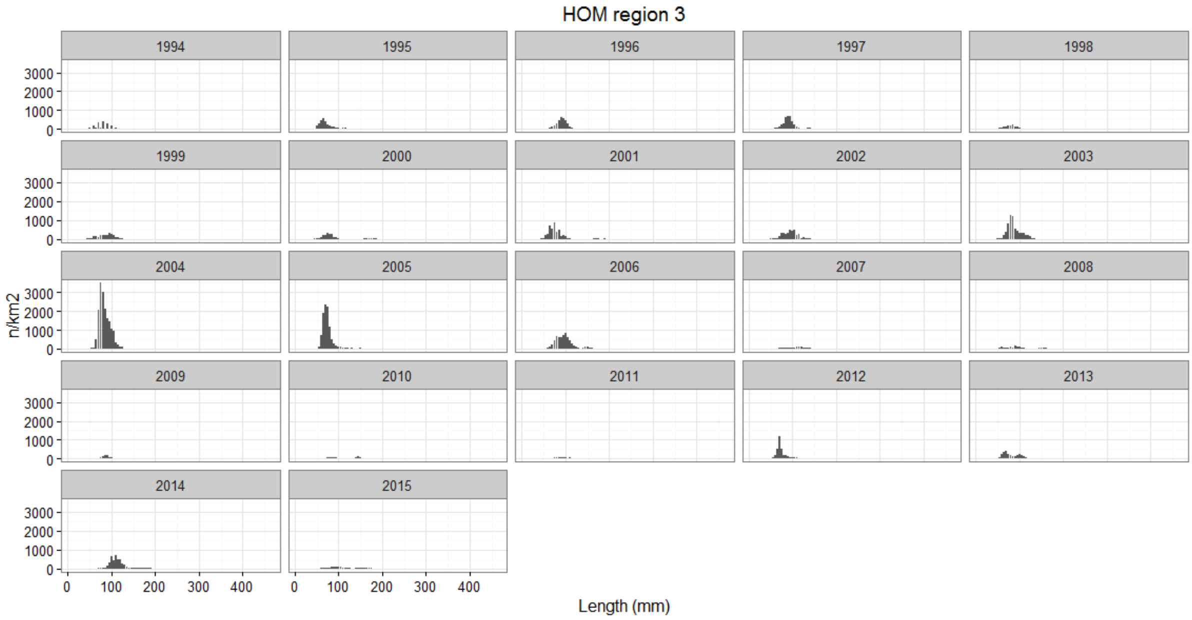


Figure 6.9.4.2. Atlantic Horse Mackerel in region 3 (GSAs 17, 18, 19, 20). Size structure of the abundance index estimated by MEDITS survey.

6.10. DATA GATHERING OF EUROPEAN ANCHOVY IN GSA 9

6.10.1. Stock Identity and Biology

The assessment covers the entire GSA 9 area corresponding to the northern part of the Tyrrhenian Sea. However, the GSA 9 may not correspond to a single stock unit. Hydrological exchanges between the northern and southern part of Tyrrhenian Sea (GSA 9 and 10) for instance are well known, which should at least affect larval transport and then recruitment of juvenile anchovy in both areas. Similarly, part of the young recruited anchovy population may come from larval transport from spawners of the GSA 10. However, due to a lack of specific information about the stock structure of the anchovy population in the western Mediterranean, this stock was assumed to be confined within the GSA 9 boundaries in this assessment.

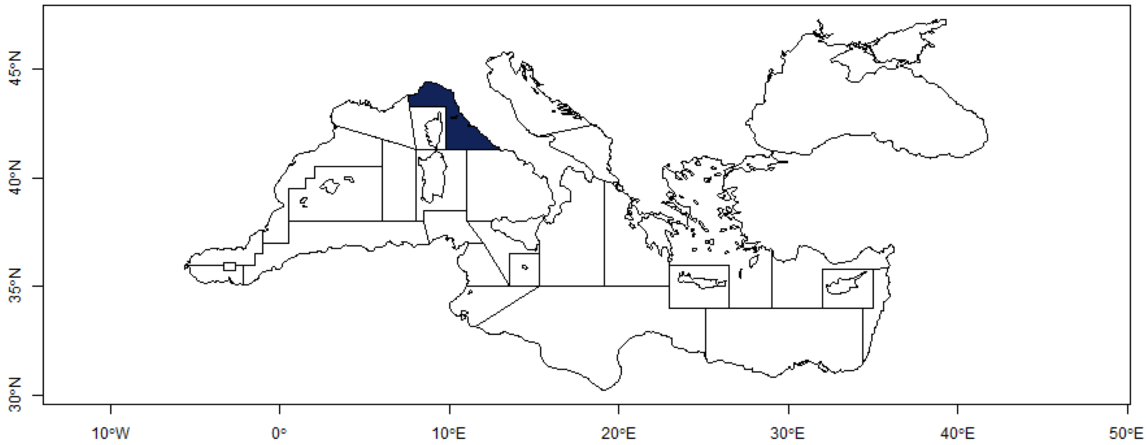


Figure 6.10.1.1. Geographical location of GSA 9.

Growth

Growth parameters are those evaluated from MEDIAS survey data on the 2013-2015 period by joining GSA 9 and 10 . The applied model it was the VBGF.

Table 6.10.1.1. European Anchovy in GSA 9. Growth parameters obtained by the VBGM fitting with their standard errors (S.e.) and relative upper (UCI) and lower (LCI) confidence intervals by bootstrap methodology.

	GSA 9 and 10			
Sex combined	***Estimate***	***S.e.***	***95% LCI***	***95% UCI***
L_∞ (cm)	17.0***	6	16.0	17.0
K	0.41***	0.04	0.40	0.49
t_0	-1.69***	0.09	-1.76	-1.53

Signif. codes: '' p < 0.001***

Maturity

Maturity ogives were taken from DCF data.

Table 6.10.1.2. European Anchovy in GSA 9. Proportion of mature fish by age and sex.

Age	Female	Male	Mean
0	0.08	0.04	0.06
1	0.47	0.44	0.455
2	0.89	0.93	0.91
3	0.99		0.995

Natural mortality

Natural mortality was estimated from DCF data for the period 2006-2015 using Gislason (2010) and is shown in Table 6.10.1.3. The input parameters used were:

Table 6.10.1.3. European Anchovy in GSA 9. Natural mortality vector.

Age	M
0	**1.02**
1	**0.73**
2	**0.6**
3	**0.54**

6.10.2. Catches data

Data of catches at age were extracted from the repository of the *Data Collection Framework* of anchovy (*Engraulis encrasicolus*) to create data files for subsequent Stock assessment modelling. Other 2 files provided data on total landing per year, and mean weight for year and age class. Data ranged from 2006 to 2015.

Furthermore age structure from landing and from MEDIAS survey data available (2014 and 2015) were compared in order to evaluate the opportunity to use both data sets with the XSA stock assessment model. Results showed a high degree of consistency in age class proportion between landings and MEDIAS samples (Fig. 6.10.1.1-2). Only Age 0 class in 2014 from survey was different mainly because of the sampling duration and timing of the MEDIAS survey.

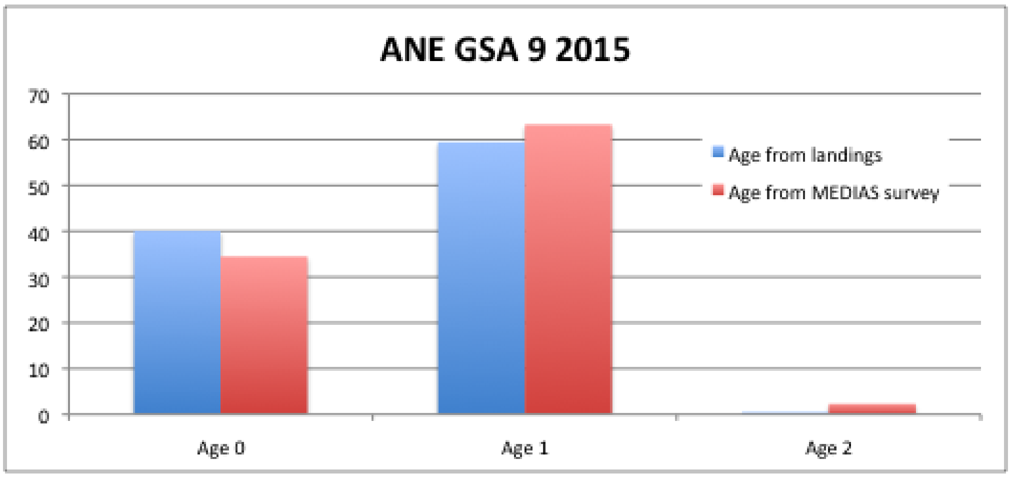


Figure 6.10.2.1. European Anchovy in GSA 9. Age structure obtained by otolith readings of landing and acoustic survey samples during 2015 (MEDIAS Total length range : 6.5-14.5 cm)

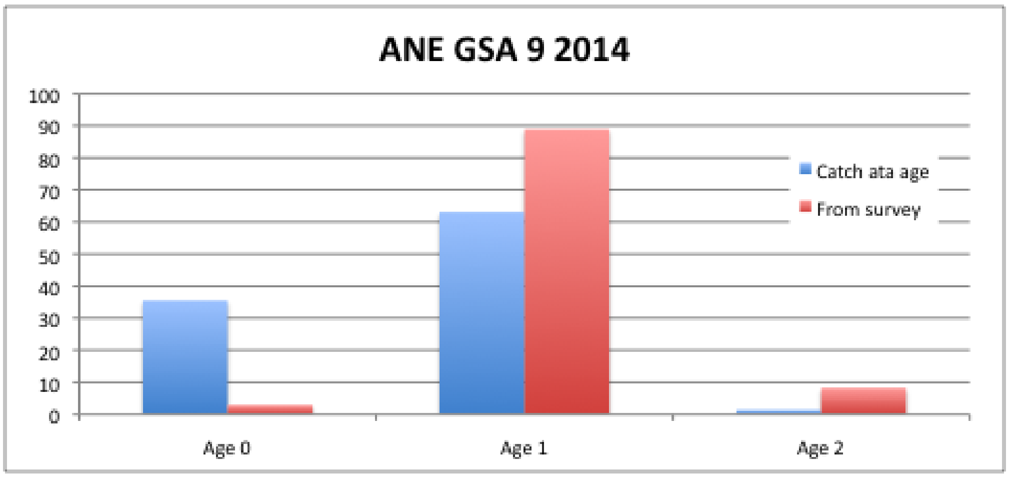


Figure 6.10.2.2. European Anchovy in GSA 9. Age structure obtained by otolith readings of landing and acoustic survey samples during 2014 (MEDIAS Total length range : 7.5-16 cm).

General description of the fisheries

The number of GNS strongly decreased from 2013. The other part of the fleet, which is able to catch anchovy in the GSA, appeared quite stable in number among years. Pelagic trawlers only appear more consistent only in 2006 with 45 vessels.

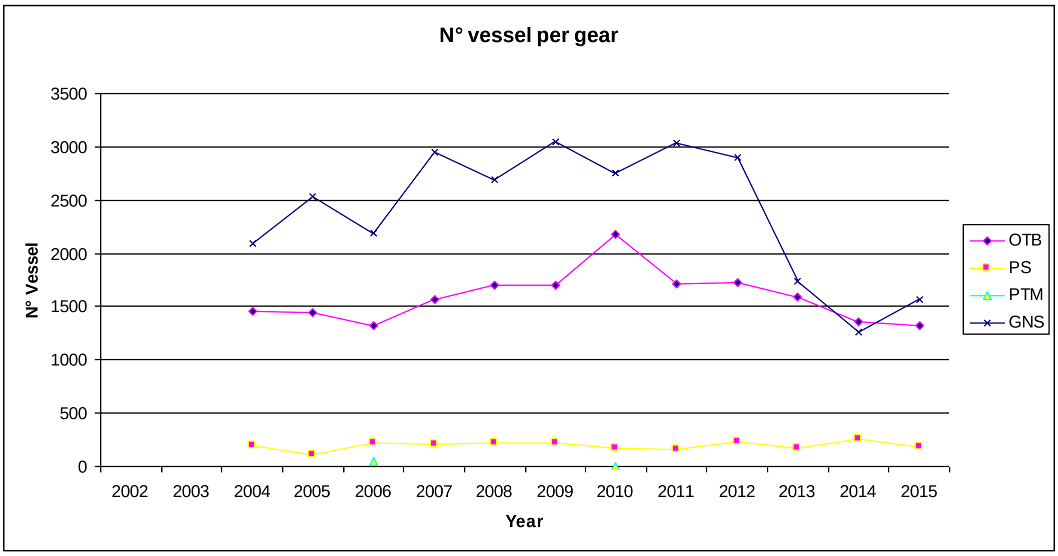


Figure 6.10.2.3. European Anchovy in GSA 9. Number of vessel by gear

Landings

Landings data were reported to STECF EWG 16-13 through the DCF. In GSA 9 the landings come mainly from Purse Seiners, and by bottom trawls to lesser extent. Landings data are presented in the following tables and figures.

Table 6.10.2.1. European Anchovy in GSA 9. Landings in tons by year and fishing gear.

Year	*GNS*	*OTB*	*PS*	*Total*
2005	25	120	1956	2100
2006	13	81	3630	3725
2007	13	84	2193	2290
2008	18	92	1240	1350
2009	4	121	2379	2504
2010	6	100	2893	2999
2011	2	93	4355	4449
2012	0	124	4788	4912
2013		1073	4330	5402
2014	0	41	3399	3440
2015	0	50	3908	3958

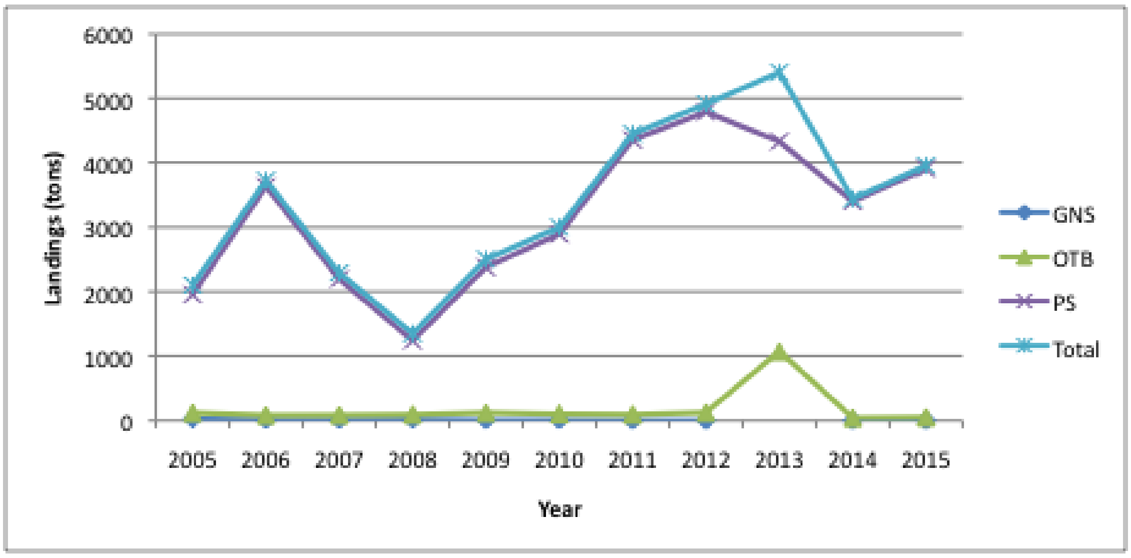
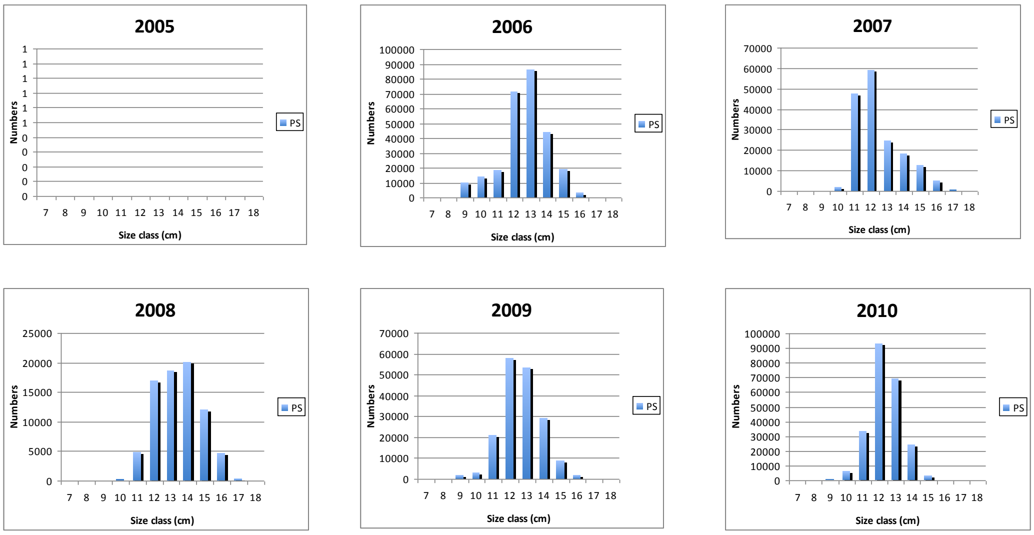


Figure 6.10.2.4. European Anchovy in GSA 9. Landings data in tons by fishing gear and overall.



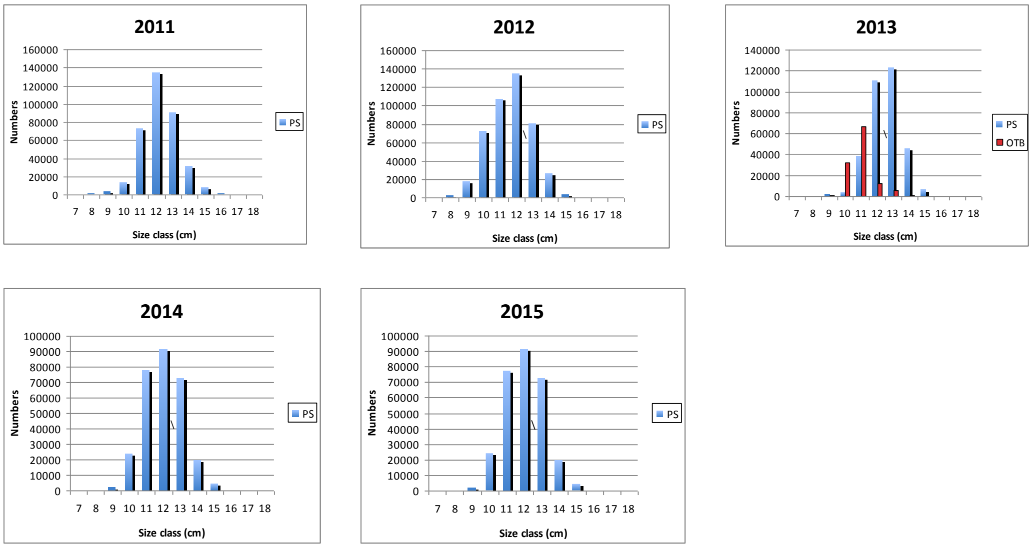


Figure 6.10.2.5. European Anchovy in GSA 9. Size structure of the landings data by fishing gear. Note that only in 2013 length frequency data were also available for OTB.

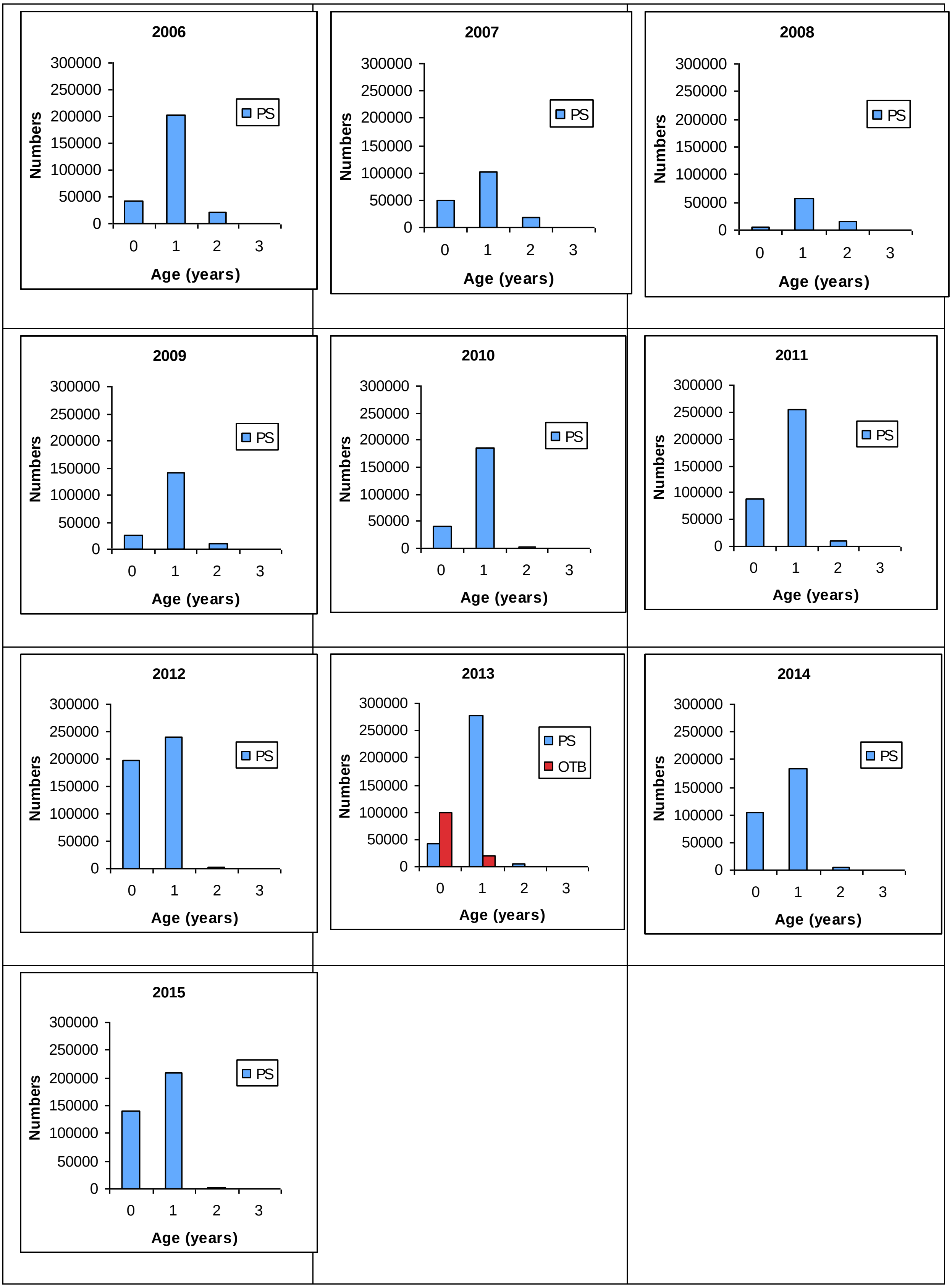


Figure 6.10.2.6.. European Anchovy in GSA 9. Age structure of the landings data by fishing gear.

No landings have been reported for in 2005, for GSA 9. Age structure of the landings is missing for all the years for the bottom trawls except in 2013.

Discards

Discards data were reported to STECF EWG 16-13 through the DCF. No discards for anchovy in GSA 9 were recorded in the period (2009-2015).

6.10.3. Fishing effort

Fishing effort data were reported to STECF EWG 16-13 through DCF. Fishing effort for GSA 9 was present for all the years except for GT_days at sea data 2002 and 2003. Fishing effort data are presented in the following tables and figures.

Table 6.10.3.1. European Anchovy in GSA 9. Fishing effort in GT*Days at sea by year and fishing gear.

Year	GNS	OTB	PS	PTM
2002	-	-	-	-
2003	-	-	-	-
2004	289033	2460274	243874	-
2005	258808	2423342	225140	-
2006	236405	2226848	176505	231
2007	252525	2167545	156080	-
2008	189679	1902655	156092	-
2009	221035	2029772	219762	-
2010	198250	1910812	188976	6
2011	228565	1837137	171094	-
2012	158680	1891882	191198	-
2013	80939	1939445	172782	-
2014	95948	1863253	171483	-
2015	112631	1879796	172442	-

Table 6.10.3.2. European Anchovy in GSA 9. Fishing effort in Days at sea by year and fishing gear.

Year	GNS	OTB	PS	PTM
2002	212455	62616	5453	-
2003	182159	63331	6242	-
2004	359917	368389	285652	-
2005	340701	323405	270583	-
2006	264764	304544	185822	38986
2007	272794	289865	89847	-
2008	257993	280173	153593	-
2009	318883	310149	142010	-
2010	293850	291989	144312	27827
2011	355187	316537	94198	-
2012	284624	278708	115854	-
2013	304410	281610	128835	-
2014	243758	286846	240145	-
2015	316781	374989	109223	-

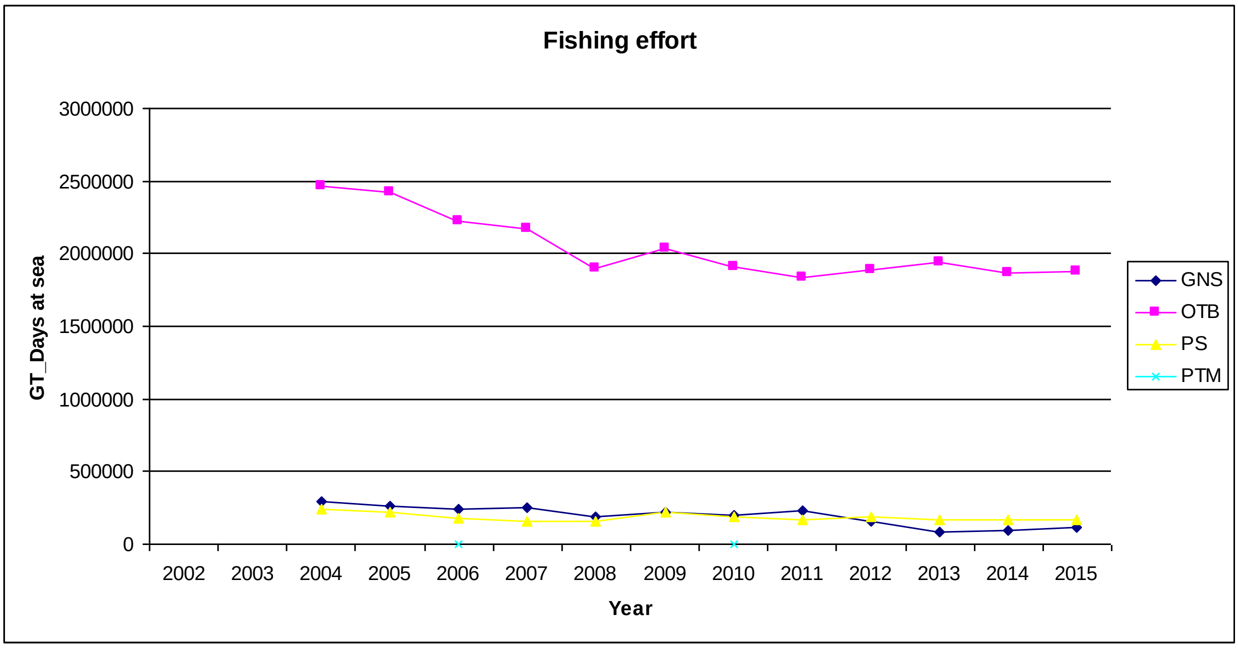


Figure 6.10.3.1. European Anchovy in GSA 9. Fishing effort data in GT*Days at sea.

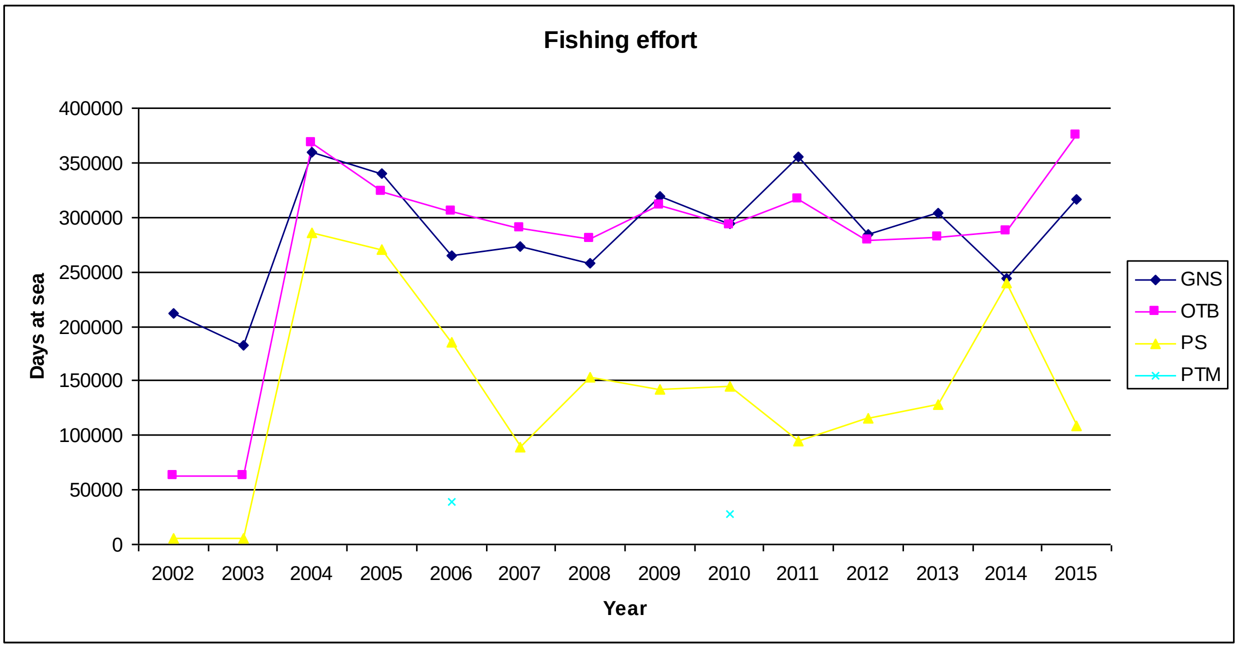


Figure 6.10.3.2. European Anchovy in GSA 9. Fishing effort data in Days at sea by fishing gear.

6.10.4. Survey Indices of abundance and biomass by year and size/age

Survey #1 (Extension of the MEDIAS in the GSAs 9 and 10)

The scientific survey used is an acoustic survey that has been conducted in summer of 2009 (17^{th} August to 9^{th} September), and in late the spring– early summer during 2011 (10^{th} May to 10^{th} June), 2013 (17^{th} May to 9^{th} June) and 2014 (8^{th} – 25^{th} June). The first two surveys were funded by the Italian National Research Council while the other two were carried out in the framework of the RITMARE project. A further acoustic survey, funded by the Italian Ministry of Agriculture, Food and Forestry (MIPAAF), was carried out in the period 1-27 August 2015. The five surveys follow the Mediterranean Acoustic Survey (MEDIAS) protocol.

Methods

The echo survey sampling strategy mainly adopted a parallel transects design in areas with wide continental shelf, and a zig-zag transects design on the continental shelf located in the southern part of GSA 10 (Fig. 1). The minimum sampling depth varied between 10 and 20 m, depending on the area. A Simrad EK60 scientific echo sounder, working with a split beam transducer at 38 kHz, was used for acquiring acoustic data; the system was calibrated according to standard techniques (Foote et al., 1987). Acoustic data were recorded along the transects at a speed of 8–10 knots; the post-processing was then performed using the Myriax Echoview software.

In each EDSU (Elementary Distance Sampling Unit = 1 nmi), the acoustic nautical area scattering coefficient (NASC; MacLennan et al., 2002) and density (t nmi-2) for anchovy and sardine were evaluated by associating trawl hauls and nearest trawl haul, irrespective of the echo traces (Petitgas et al., 2003).

Geographical distribution

A recent study on spatial distribution of anchovy and sardine in the Tyrrhenian Sea in the period 2009-2014 has been published (Bonanno et al., 2016). Below are the maps for Anchovy from this publication and the spatial distribution obtained during the survey in summer 2015.

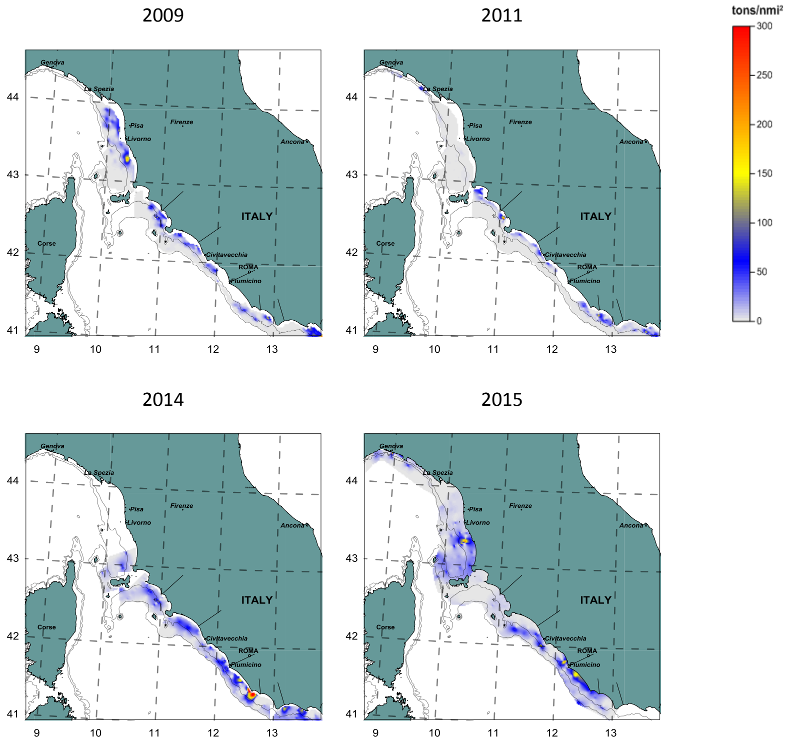


Figure 6.10.4.1. European Anchovy in GSA 9. Spatial distribution of anchovies from acoustic survey (from Bonanno et al., 2016 and form the echo survey in summer 2015).

Trends in abundance and biomass

Abundance and biomass indexes for the survey carried out in summer 2015 were reported to STECF EWG 16-13 through DCF. The results of the four acoustic surveys, carried out in the period 2009-2014, were made available by a research group of the Italian National Council of the Researches (CNR-IAMC) during the meeting. European Anchovy time series of abundance and biomass indices from the five surveys are shown and described in the following figures.

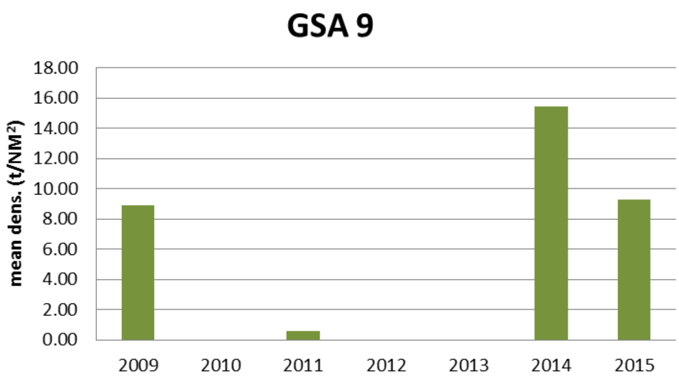


Figure 6.10.4.2. European Anchovy in GSA 9. Biomass density estimated by direct acoustic method from echo survey.

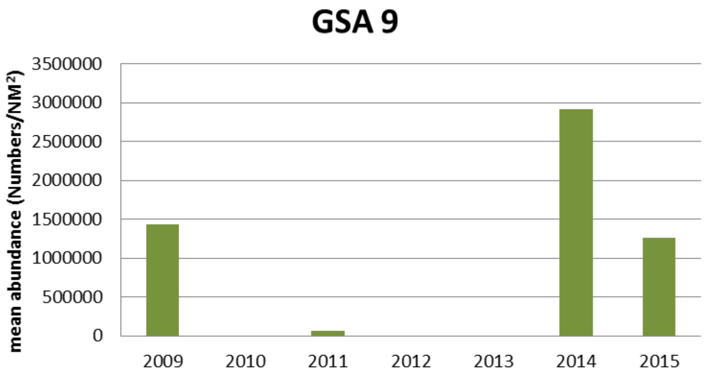


Figure 6.10.4.3. European Anchovy in GSA 9. Abundance density estimated by direct acoustic method from echo survey.

No data on biomass or abundance were collected in GSA 9 for the years 2010, 2012 and 2013.

Trends in biomass and abundance by length or age

European Anchovy time series of abundance and biomass indices from the four acoustic surveys are shown in the following figures.

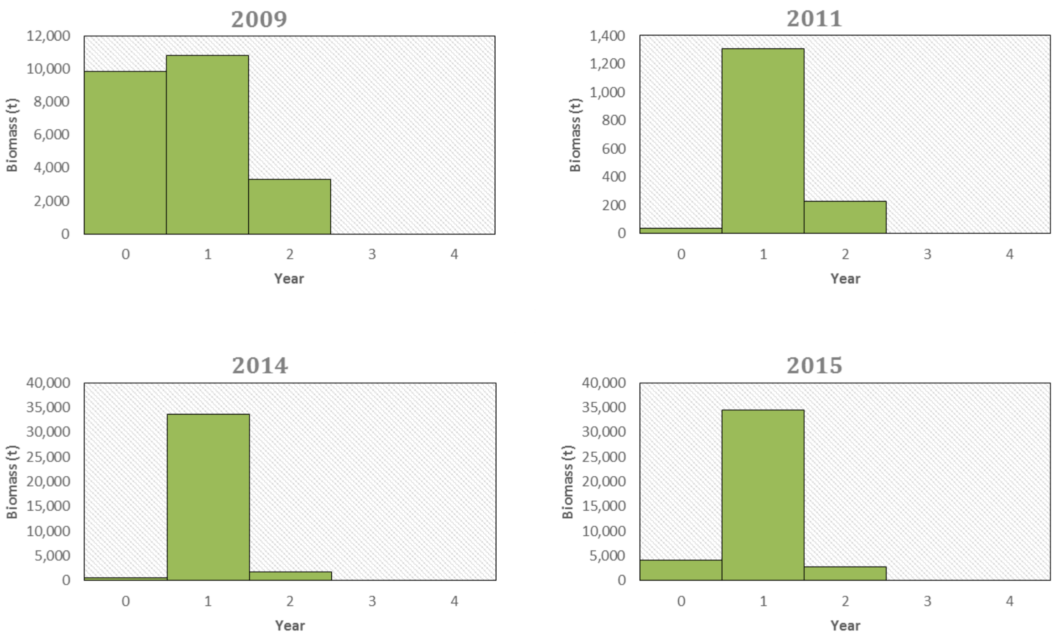


Figure 6.10.4.5. European Anchovy in GSA 9. Age structure of the Biomass index estimated by direct acoustic method.

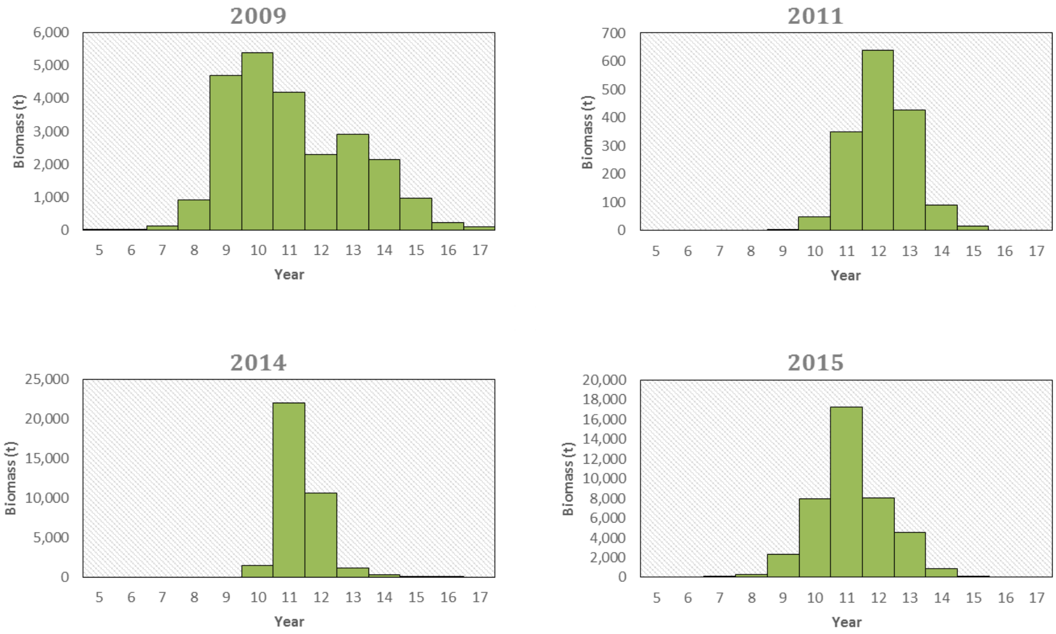


Figure 6.10.4.6. European Anchovy in GSA 9. Size structure of the Biomass index estimated by direct acoustic method.

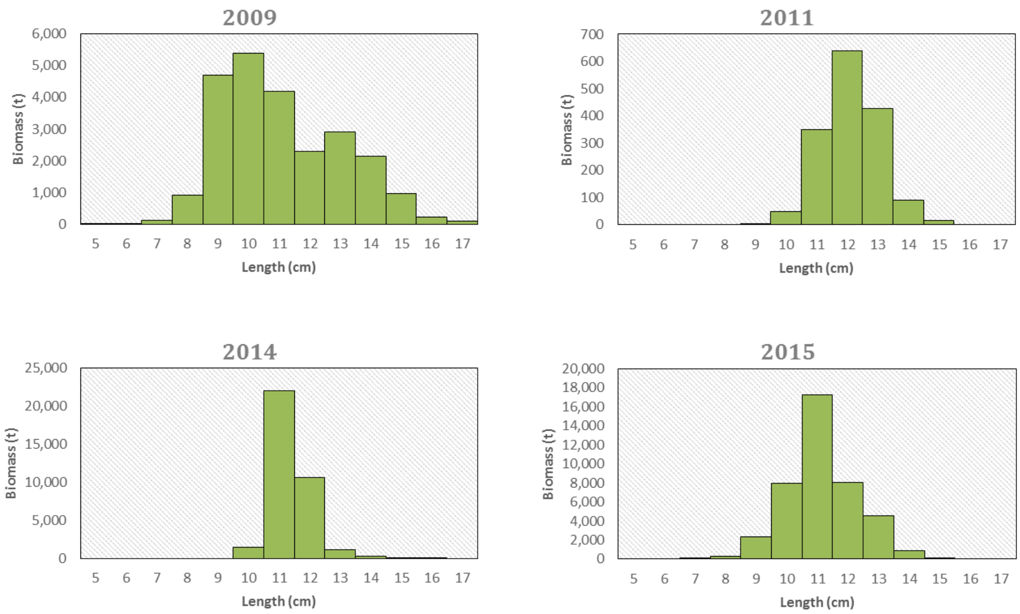


Figure 6.10.4.7. European Anchovy in GSA 9. Age structure of the Abundance index estimated by direct acoustic method.

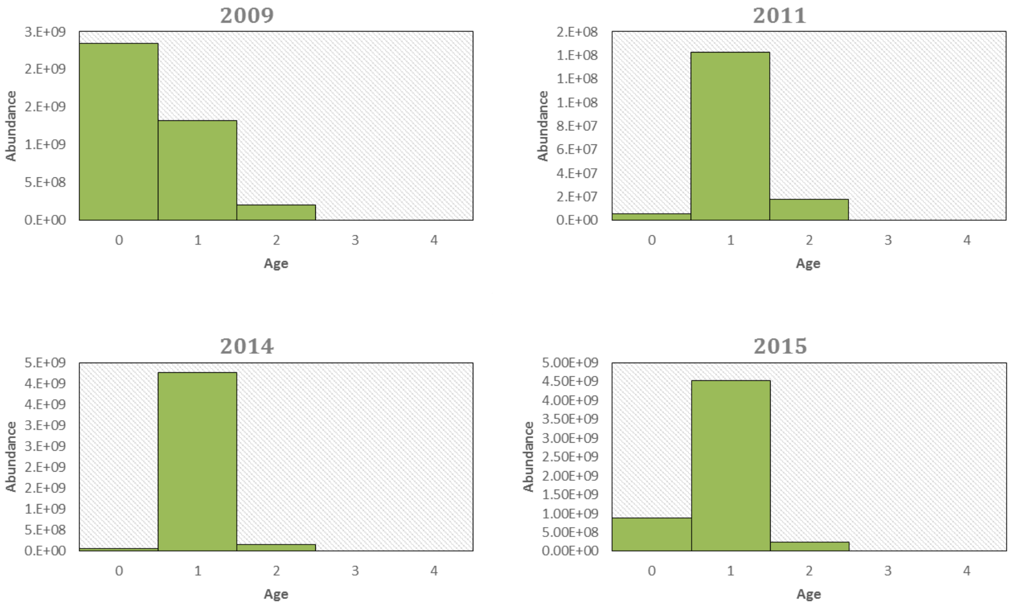


Figure 6.10.4.8. European Anchovy in GSA 9. Size structure of the Abundance index estimated by direct acoustic method.

6.11. DATA GATHERING OF EUROPEAN ANCHOVY IN GSA 10

6.11.1. Stock Identity and biology

The assessment covers the entire GSA 10 area corresponding to the northern part of the Tyrrhenian Sea. However, the GSA 10 may not correspond to a single stock unit. Hydrological exchanges between the northern and southern part of thyrrenians ea (GSA 9 and 10) for instance are well known, which should at least affect larval transport and then recruitment of juvenile anchovy in both areas. Similarly, part of the young recruited anchovy population may come from larval transport from spawners of the GSA 10. However, due to a lack of specific information about the stock structure of the anchovy population in the western Mediterranean, this stock was assumed to be confined within the GSA 10boundaries in this assessment.

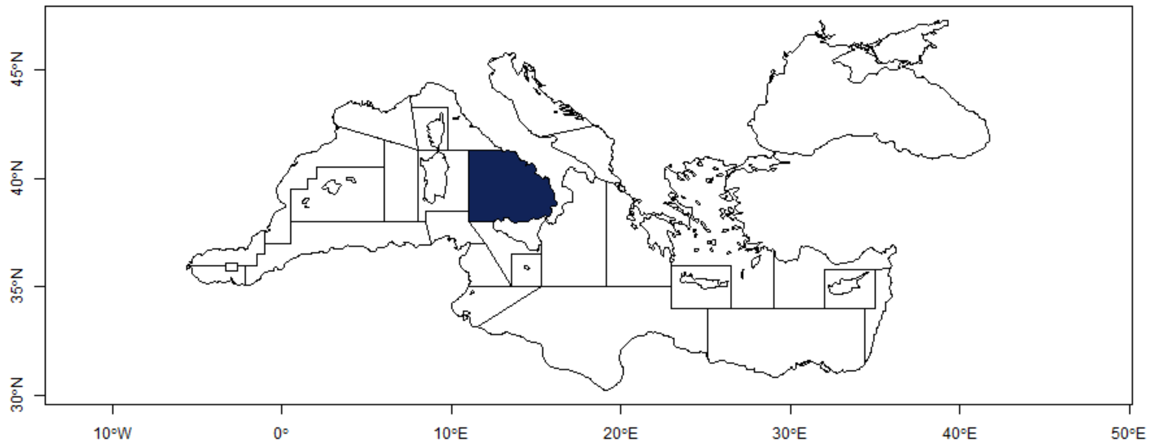


Figure 6.11.1.1. Geographical location of GSA 10.

Growth

Growth parameters are those evaluated from MEDIAS survey data on the 2003-2015 period by joining GSA 9 and 10. The applied model it was the VBGF.

Table 6.11.1.1. European Anchovy in GSA 10. Growth parameters obtained by the VBGM fitting with their standard errors (S.e.) and relative upper (UCI) and lower (LCI) confidence intervals by bootstrap methodology.

	GSA 9 and 10			
Sex combined	***Estimate***	***S.e.***	***95% LCI***	***95% UCI***
L_∞ (cm)	17.0***	6	16.0	17.0
K	0.41***	0.04	0.40	0.49
t_0	-1.69***	0.09	-1.76	-1.53

Signif. codes: '' p < 0.001***

Maturity

Maturity ogives were taken from DCF data in GSA 10.

Table 6.11.1.2. European Anchovy in GSA 10. Proportion of mature fish by age and sex.

Age	Female	Male	Mean
0	0.07	0.21	0.14
1	0.73	0.85	0.76
2	0.99	0.99	0.99
3	1	0.99	1
4	1	1	1
5	1	1	1
6	1	1	1

Natural mortality

Natural mortality was estimated using Gislason (2010) and is shown in Table 6.11.1.3..

Table 6.11.1.3. European Anchovy in GSA 10. Natural mortality in the period 2007-2015.

Age	M
0	**1.02**
1	**0.73**
2	**0.6**

6.11.2. Catches data

Data of catches at age were extracted from the repository of the *Data Collection Framework* of anchovy (*Engraulis encrasicolus*) to create data files for subsequent Stock assessment modelling. Other 2 files provided data on total landing per year, and mean weight for year and age class. Data ranged from 2002 to 2015.

Furthermore age structure from landing and from MEDIAS survey available data (2014 and 2015) were compared in order to evaluate the opportunity to use both data sets with the XSA stock assessment model . Results showed a very scarce degree of consistency in age class proportion between Catch at age data and MEDIAS samples (Figure 6.3.1.2 and 6.3.1.3). Namely the number of age classes were more numerous than in survey data: from survey were observed 3 year classes (0-2) while from Catch at age there were 5 classes in 2014 and 9 classes in 2015.

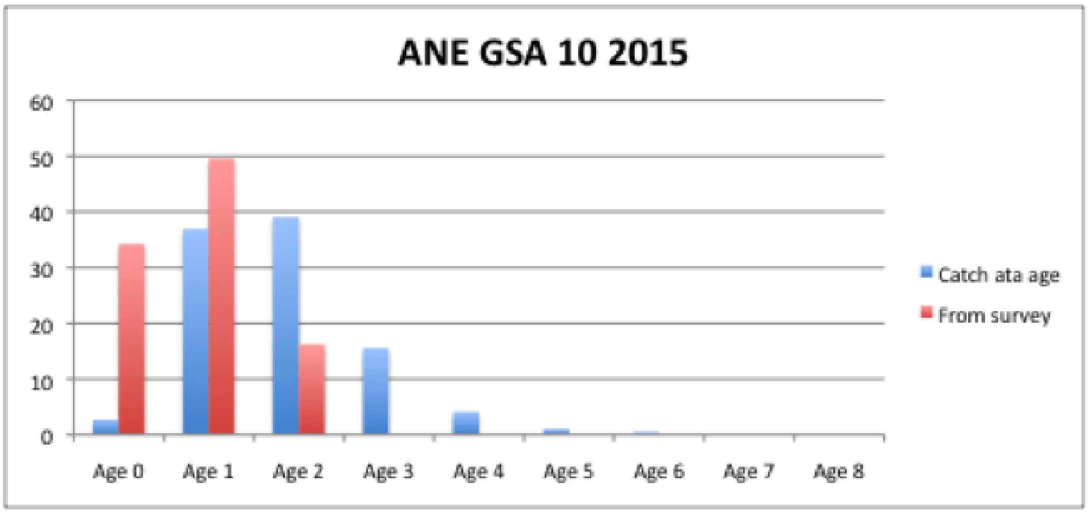


Figure 6.11.2.1. European Anchovy in GSA10. Age structure obtained by otolith readings of landing and acoustic survey samples during 2015 (MEDIAS Total length range : 6.0-17.5 cm)

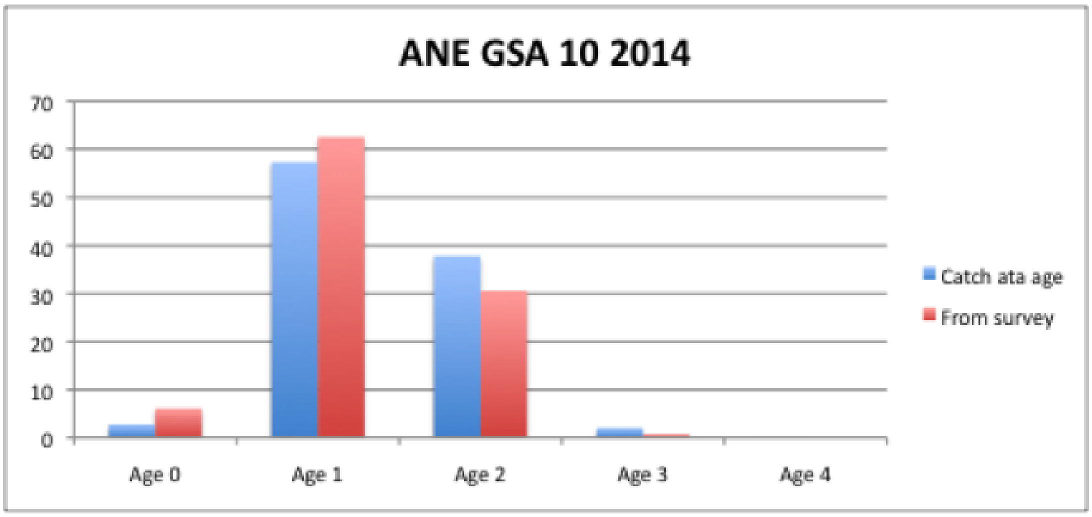


Figure 6.11.2.2. European Anchovy in GSA10. Age structure obtained by otolith readings of landing and acoustic survey samples during 2014 (MEDIAS Total length range : 8.0 -16.5 cm).

General description of the fisheries

The number of GNS was the higher among the different gear and it increased from 2009 to 2014. The other part of the fleet which is able to catch anchovy in the GSA appeared quite stable in number among years. Pelagic trawlers were recorded only in 2004 and 2012 respectively with 28 and 19 vessel units.

Landings

Landings data were reported to STECF EWG 16-13 through the DCF. In GSA 10 the landings come mainly from Purse Seiners, and by bottom trawls to lesser extent. The available Landings data from the DCF for the GSA 10 are presented in the following tables and figures.

Table 6.11.2.1. European Anchovy in GSA 10. Landings in tons by year and fishing gear.

Year	GND	GNS	GTR	OTB	OTM	PS	Total (year)
2002	-	-	569	49	-	2153	3254
2003	-	-	18	24	-	1270	1407
2004	-	-	-	63	-	2964	3027
2005	197	2	8	37	-	4437	4686
2006	111	-	1	85	-	8136	8378
2007	87	-	-	37	-	3875	4002
2008	85	0	1	51	-	3550	3687
2009	147	-	-	89	-	5377	5613
2010	294	-	-	93	-	6092	6479
2011	42	2	-	106	-	7149	7299
2012	83	1	-	125	-	5871	6088
2013	-	-	-	115	-	4034	4150
2014	5	1	-	121	147	3085	3361
2015	-	0	0	154	179	3332	3667
Total (gear)	**1050**	**7**	**597**	**1149**	**327**	**61328**	**65098**

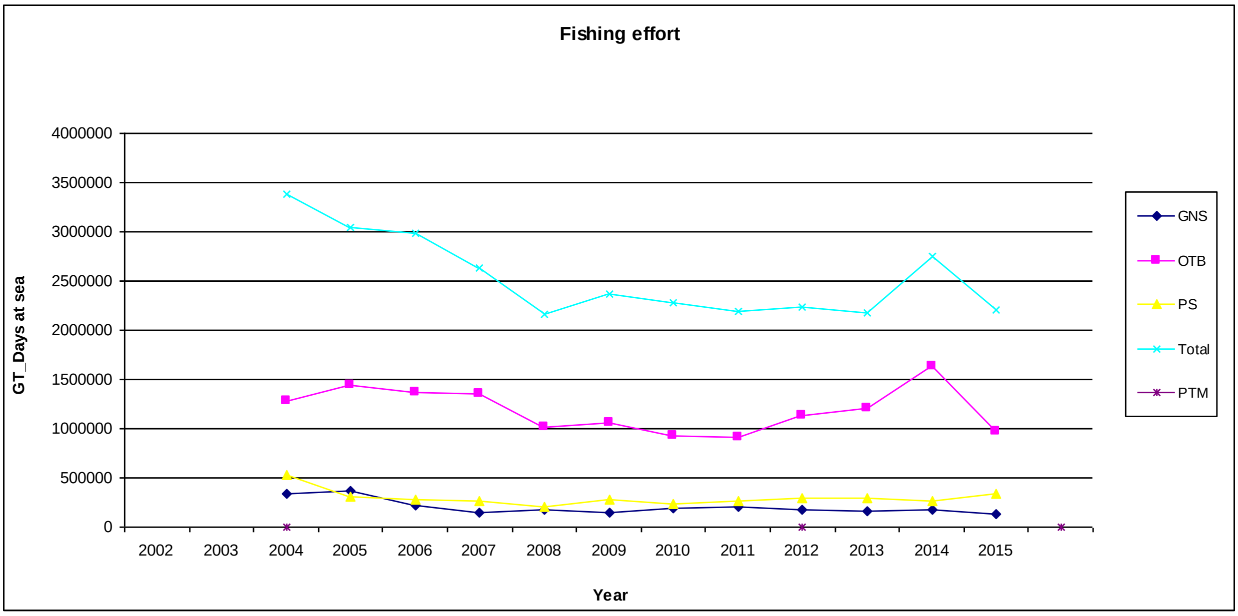
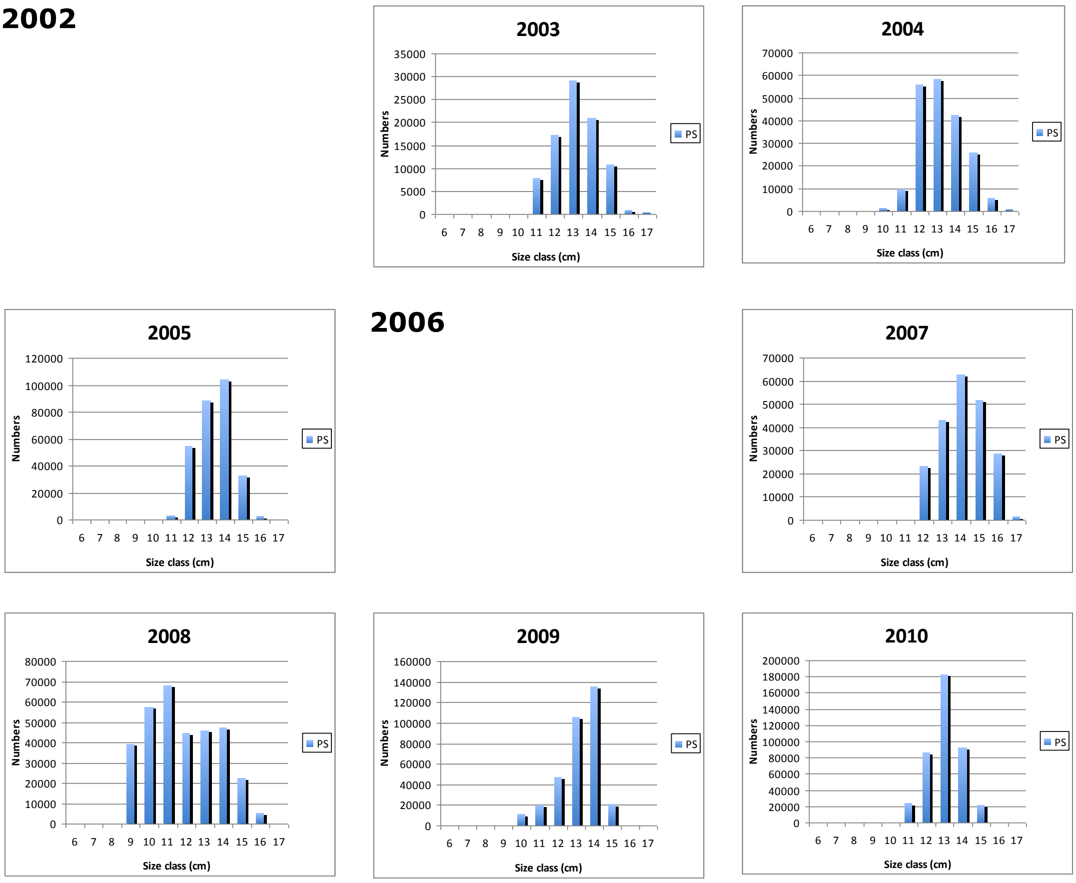


Figure 6.11.2.3. European Anchovy in GSA 10. Landings data in tons by fishing gear and overall.



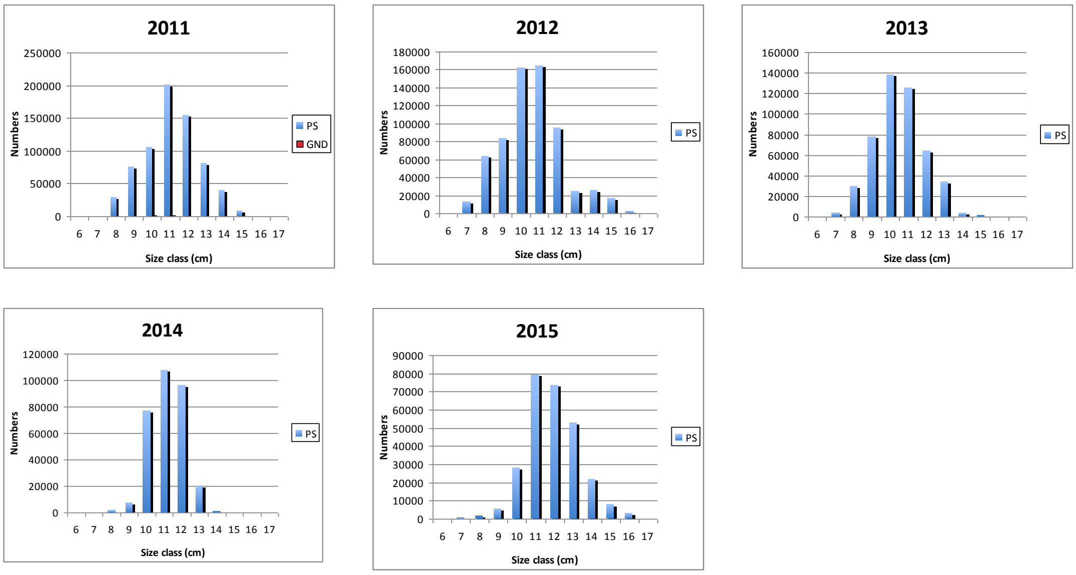
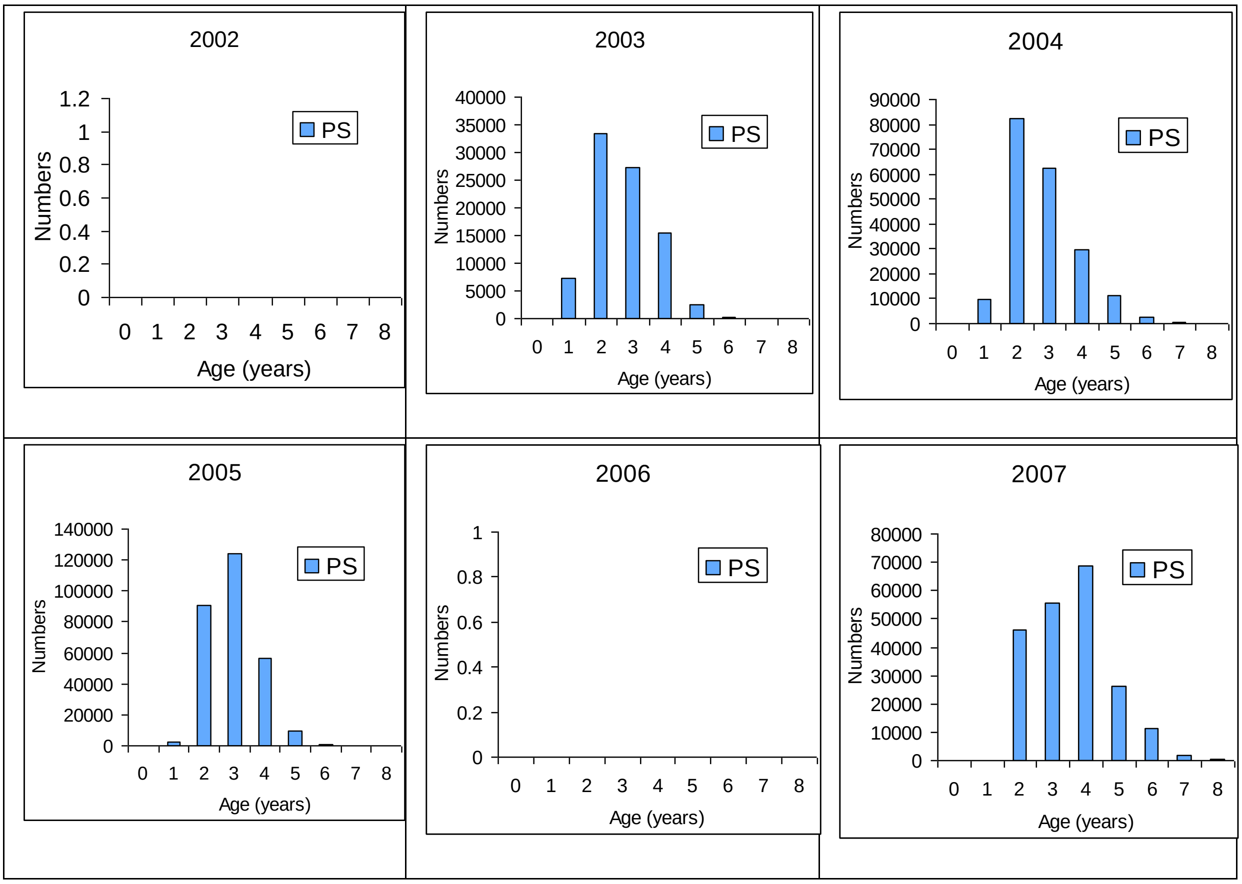


Figure 6.11.2.4. European Anchovy in GSA 10. Size structure of the landings data by fishing gear. Note that no length frequency data were also available for OTB along the whole considered period.



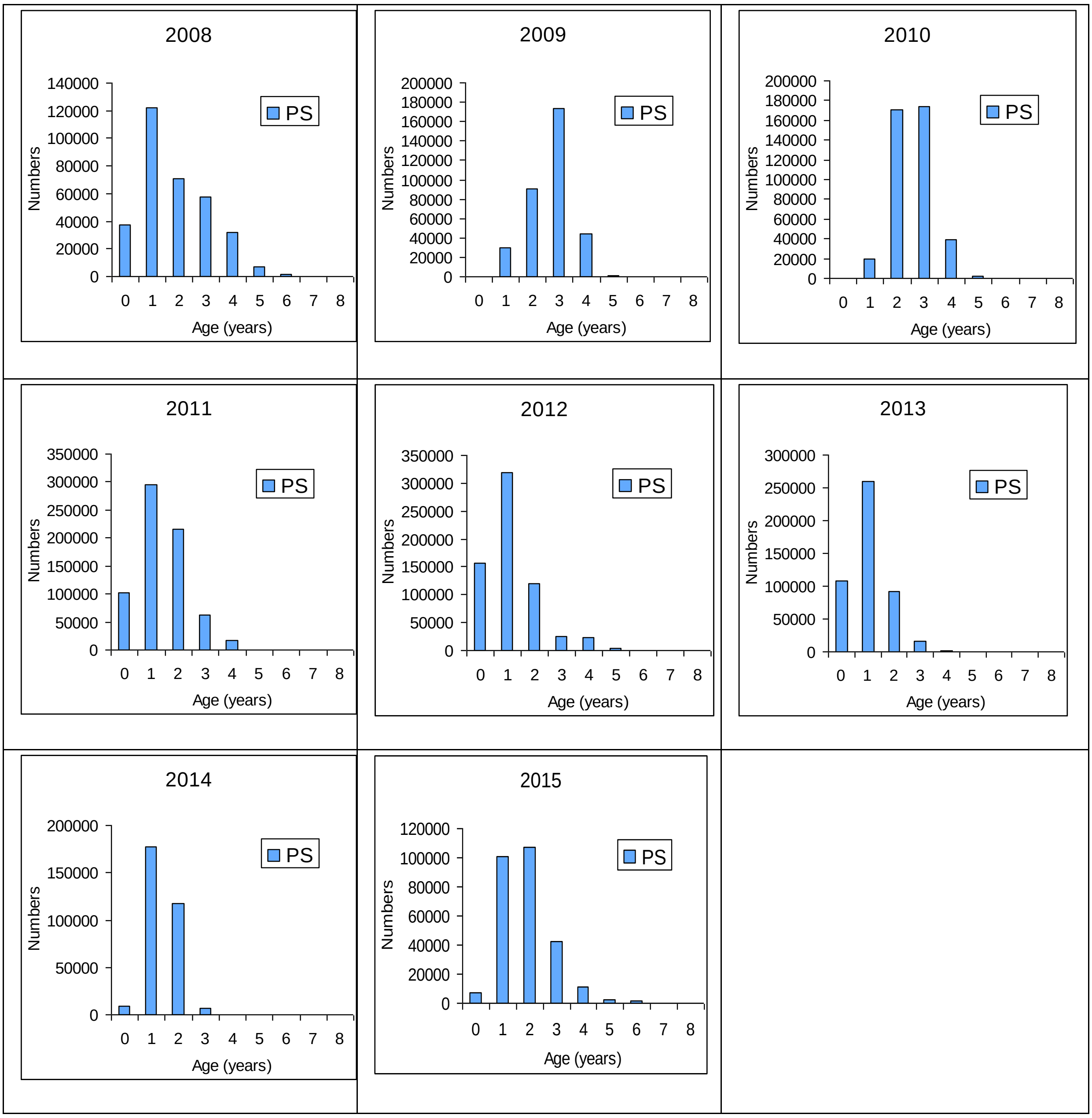


Figure 6.11.2.5. European Anchovy in GSA 10. Age structure of the landings data by fishing gear. Note that only PS samples were available in DCF data for age determination.

No landings have been reported for in 2002 and 2006, for GSA 10. Age structure of the landings from the bottom trawls (OTB) is missing for all the years.

Discards

Discards data were reported to STECF EWG 16-13 through the DCF. Discards for anchovy in GSA 10 was recorded only for Purse seine fleet (PS). The size structure of the discarded anchovy showed that the most abundant anchovy discarded were under minimum legal size (juveniles; Basilone et al. 2004).

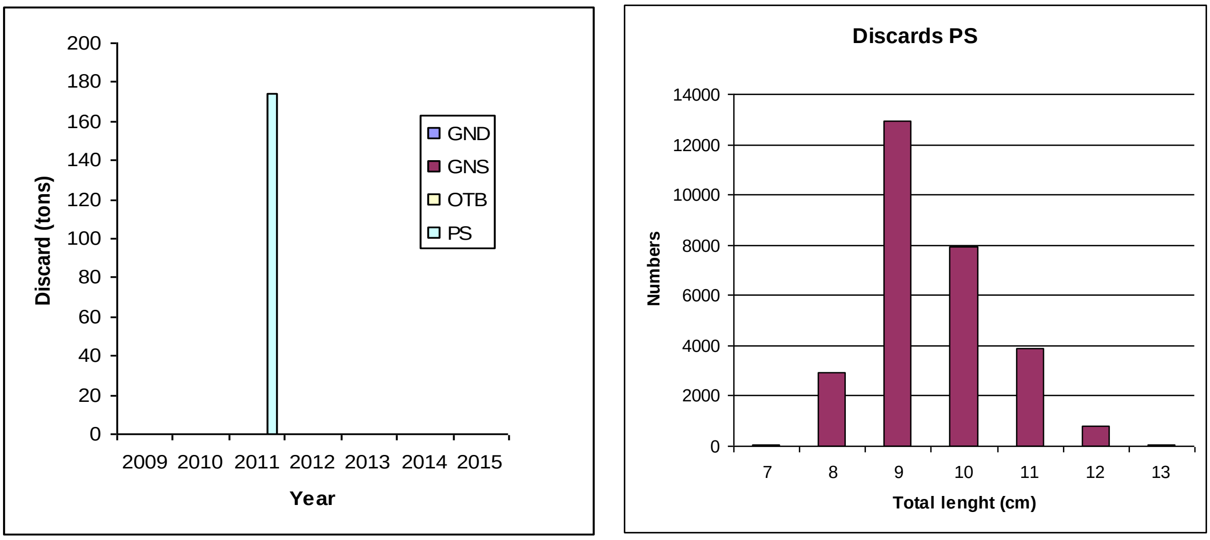


Figure 6.11.2.6. European Anchovy in GSA 10. Total discards and discards size structure by fishing gear.

6.11.3. Fishing effort data

Fishing effort data were reported to STECF EWG 16-13 through DCF. Fishing effort for GSA 10 was recorded for all the years except for GT_days at sea data in 2002 and 2003. Fishing effort data are presented in the following tables and figures.

Table 6.11.3.1. European Anchovy in GSA 10. Fishing effort in GT*Days at sea by year and fishing gear.

Year	DRB	FPO	GND	GNS	GTR	LLD	LLS	LTL	OTB	OTM	PS	PTM	Total
2002													
2003													
2004	7020	6050	23116	333949	264201	118528	204675	158	1274428		527621	475	3387109
2005	16261	26544	16308	365776	158576	77567	130253		1447582		303201		3048087
2006	18109	12407	49292	213574	377004	107859	128861		1370881		286612		2980738
2007	8939		39974	148766	327315	47486	96753		1354061		270975		2637172
2008	13553		36301	176750	235911	56463	115469		1017588		207179		2167164
2009	11184		33252	153684	195701	160627	80929		1065025		283823		2365065
2010	12210		10833	186442	203275	362818	90320		933293		232340		2285463
2011	11227	717	3684	204682	203044	281860	130835	789	911156		263106		2198502
2012	14678	6058	4389	177119	178421	224510	89885	174	1131380		287623	57	2231071
2013	5327	27149	510	158525	194817	121023	106365		1203248		298673		2179718
2014	7875	8647	2289	173614	176657	115173	221637	809	1639130	107419	262647		2750765
2015	9359	11027	984	132503	171185	262771	127997	196	966497	121444	335612		2199239

Table 6.11.3.2. European Anchovy in GSA 10. Fishing effort in Days at sea by year and fishing gear.

Year	DRB	FPO	GND	GNS	GTR	LLD	LLS	LTL	OTB	OTM	PS	PTM	Total
2002	658				357895				37949		8258		404760
2003	205				311474				38134		9780		359593
2004	57588	389037	428503	474436	430026	446625	446625	187448	541461		682933	201588	4286270
2005	60292	335666	376122	335666	367704	395958	395958		124234		694631		3086231
2006	60829	248966	405704	344875	357634	245857	405704		133834		390431		2593836
2007	55580		345841	454246	363750	87754	363750		120326		271924		2063172
2008	52520		320569	361391	320569	288969	320569		182574		208394		2055556
2009	50004		339424	490533	339424	316867	339424		451327		297236		2624240
2010	48534		250301	354913	298834	268299	298834		359572		464102		2343391
2011	33571	86854	266283	586976	333836	326015	333836	98540	498102		438635		3002649
2012	230539	231682	158566	513041	293239	297261	293239	44497	411390		410746	58245	2942444
2013	41317	193223	14967	472679	261636	244230	261636		332890		529748		2352325
2014	43200	208832	156162	518887	269963	241591	269963	105953	356120	18738	502244		2691655
2015	48702	240703	161261	498232	274802	299703	289405	52933	340008	55137	507613		2768500
Total	783541	1934964	3223704	5405876	4580787	3459129	4018944	489371	3927921	73876	5416676	259833	33574621

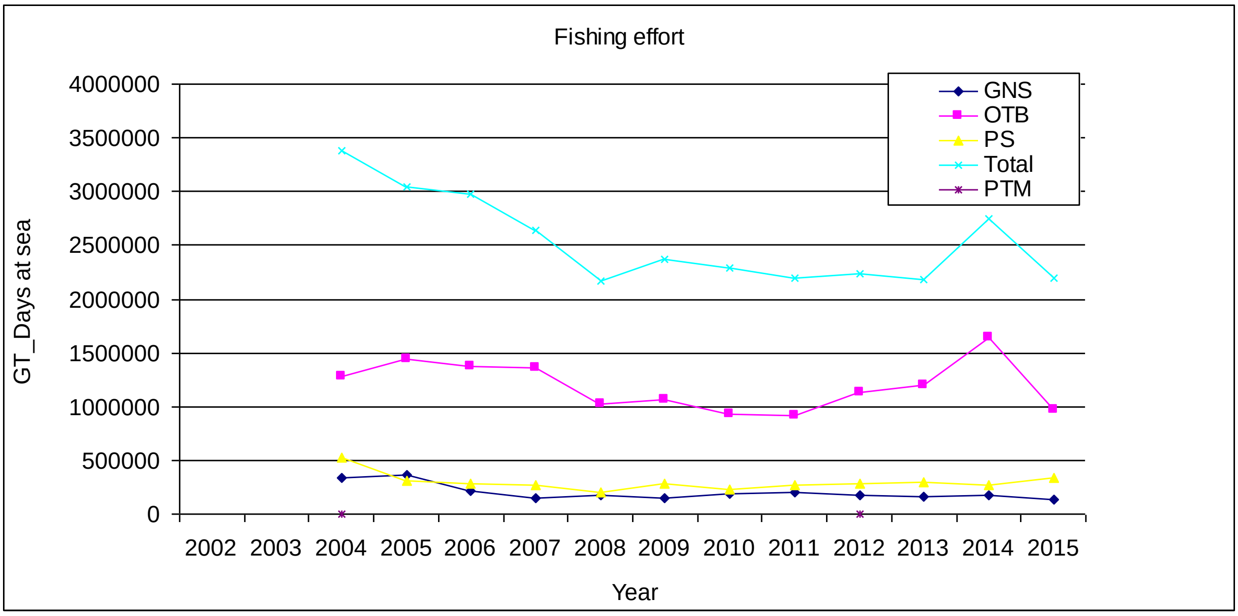


Figure 6.11.3.1. European Anchovy in GSA 10. Fishing effort data in GT*Days at sea.

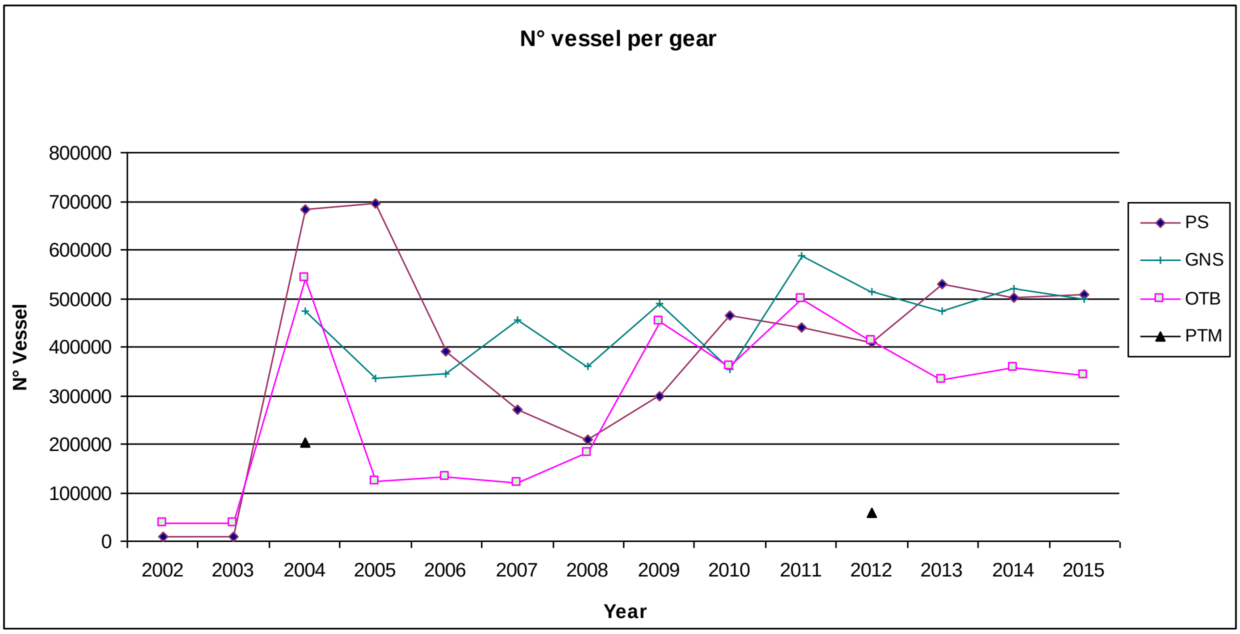


Figure 6.11.3.2. European Anchovy in GSA 10. Fishing effort data in Days at sea by fishing gear.

6.11.4. Survey Indices of abundance and biomass by year and size/age

Survey #1 (Extension of the MEDIAS in the GSAs 9 and 10)

The scientific survey used is an acoustic survey that has been conducted in summer of 2009 (17th August to 9th September), and in late the spring– early summer during 2011 (10th May to 10th June), 2013 (17th May to 9th June) and 2014 (8th – 25th June). The first two surveys were funded by the Italian National Research Council while the other two were carried out in the framework of the RITMARE project. A further acoustic survey, funded by the Italian Ministry of Agriculture, Food and Forestry (MIPAAF), was carried out in the period 1-27 August 2015. The five surveys follow the Mediterranean Acoustic Survey (MEDIAS) protocol.

Methods

The echo survey sampling strategy mainly adopted a parallel transects design in areas with wide continental shelf, and a zig-zag transects design on the continental shelf located in the southern part of GSA 10 (Fig. 1). The minimum sampling depth varied between 10 and 20 m, depending on the area. A Simrad EK60 scientific echo sounder, working with a split beam transducer at 38 kHz, was used for acquiring acoustic data; the system was calibrated according to standard techniques (Foote et al., 1987). Acoustic data were recorded along the transects at a speed of 8–10 knots; the post-processing was then performed using the Myriax Echoview software.

In each EDSU (Elementary Distance Sampling Unit = 1 nmi), the acoustic nautical area scattering coefficient (NASC; MacLennan et al., 2002) and density (t nmi-2) for anchovy and sardine were evaluated by associating trawl hauls and nearest trawl haul, irrespective of the echo traces (Petitgas et al., 2003).

Geographical distribution

A recent study on spatial distribution of anchovy and sardine in the Tyrrhenian Sea in the period 2009-2014 has been published (Bonanno et al., 2016). Below are the maps for Anchovy from this publication and the spatial distribution obtained during the survey in summer 2015.

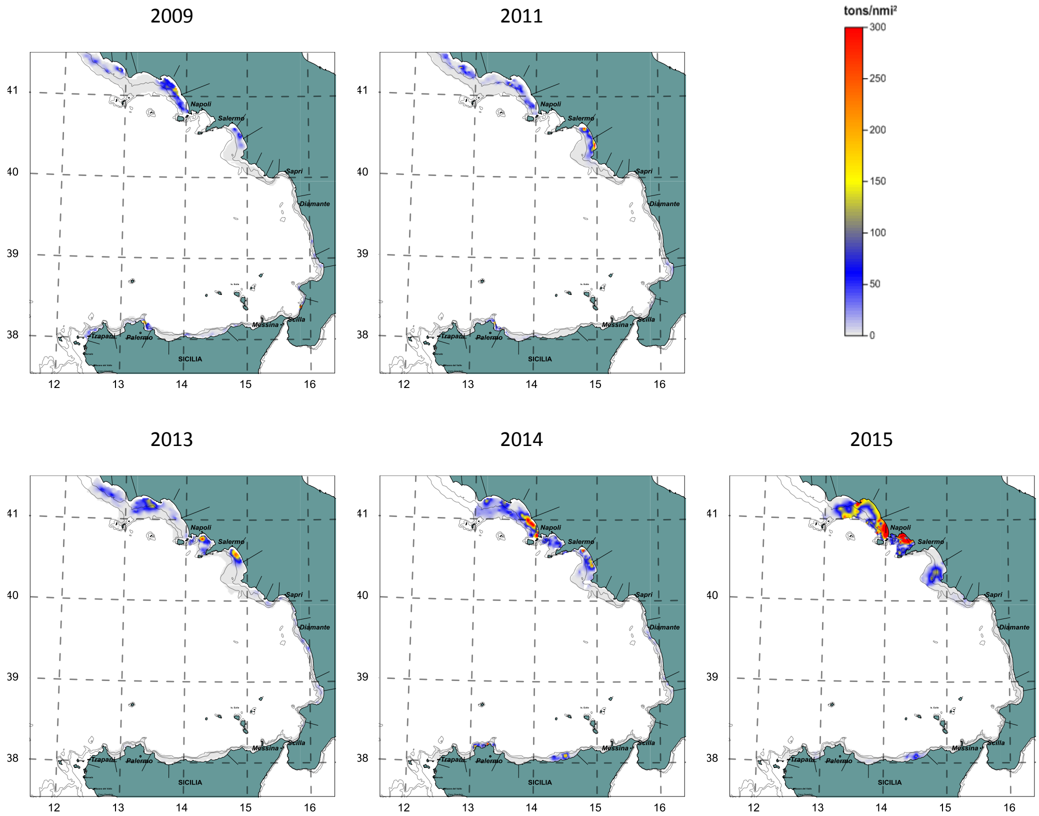


Figure 6.11.4.1. European Anchovy in GSA 10. Spatial distribution of anchovies from acoustic surveys (from Bonanno et al. (2016) and form the echo survey in summer 2015).

Trends in abundance and biomass

Abundance and biomass indexes for the survey carried out in summer 2015 were reported to STECF EWG 16-13 through DCF. The results of the four acoustic surveys, carried out in the period 2009-2014, were made available by a research group of the Italian National Council of the Researches (CNR-IAMC) during the meeting. European Anchovy time series of abundance and biomass indices from the five surveys are shown and described in the following figures.

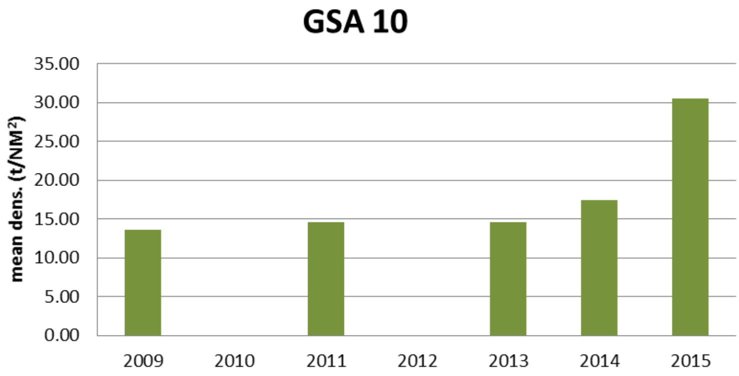


Figure 6.11.4.2.. European Anchovy in GSA 10. Biomass density estimated by direct acoustic method from echo survey.

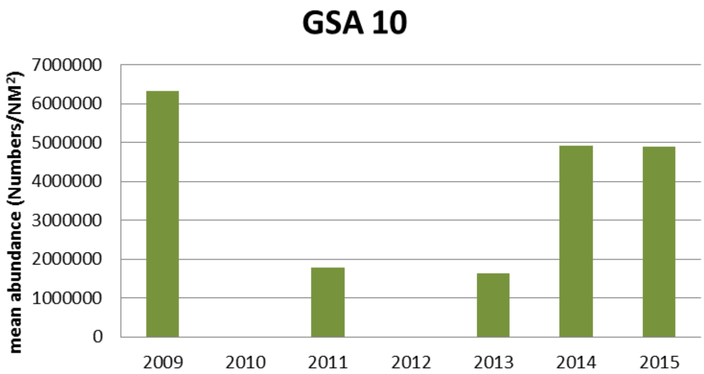


Figure 6.11.4.3. European Anchovy in GSA 10. Abundance density estimated by direct acoustic method from echo survey.

No data on biomass or abundance were collected in GSA 10 for the years 2010 and 2012.

Trends in biomass and abundance by length or age

European Anchovy time series of abundance and biomass indices from the five acoustic surveys are shown in the following figures.

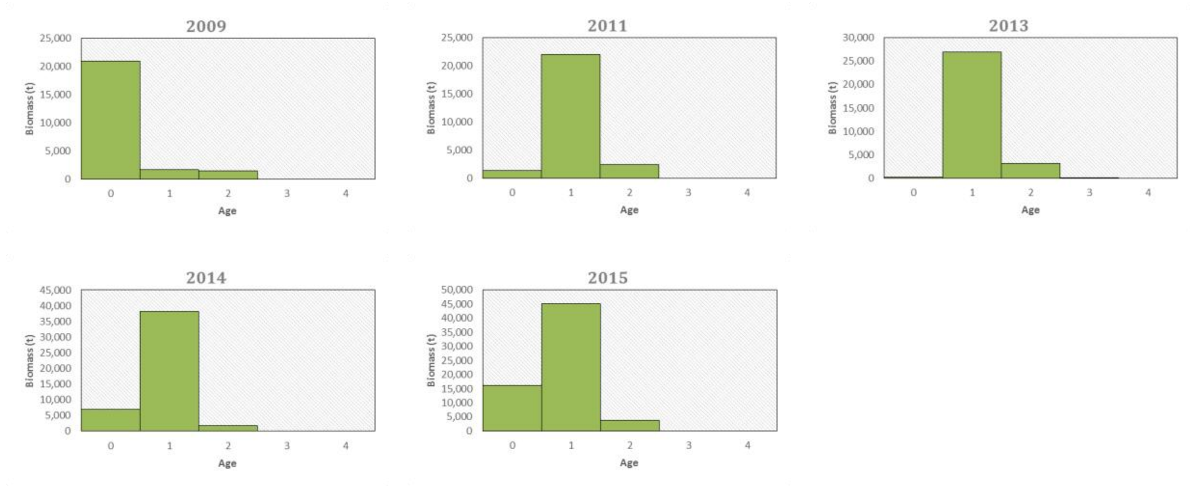


Figure 6.11.4.4. European Anchovy in GSA 10. Age structure of the Biomass index estimated by direct acoustic method.

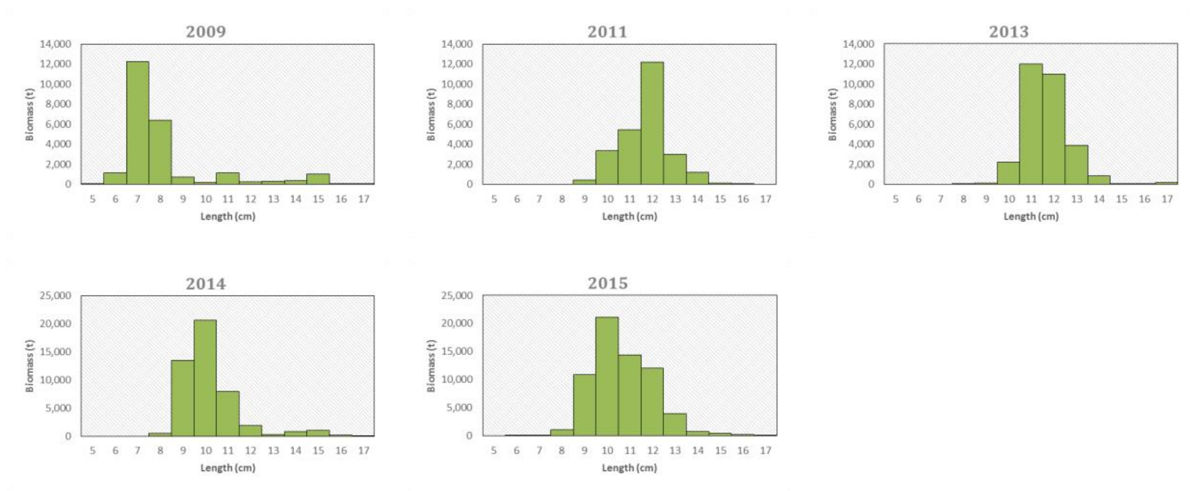


Figure 6.11.4.5. European Anchovy in GSA 10. Size structure of the Biomass index estimated by direct acoustic method.

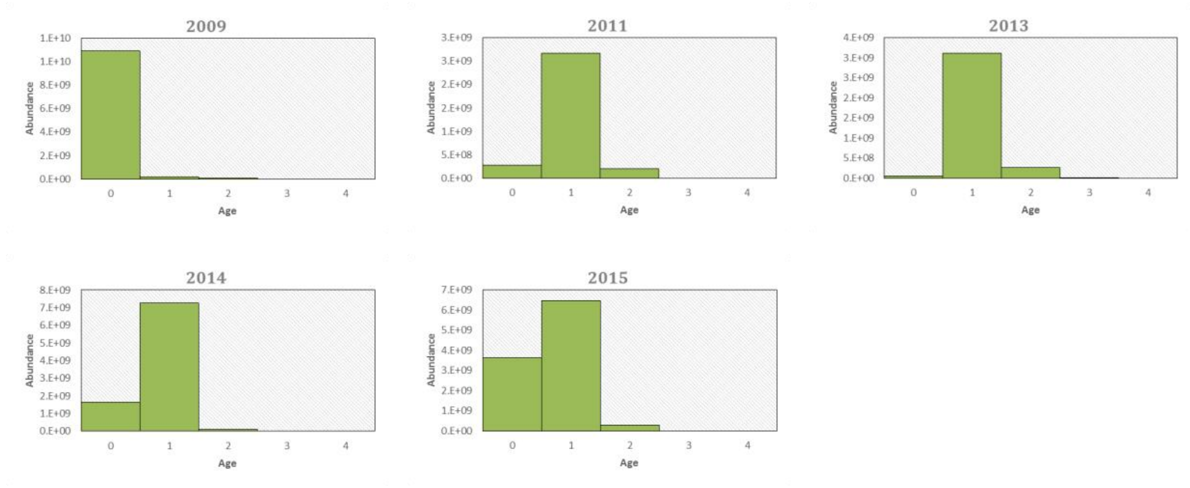


Figure 6.11.4.6. European Anchovy in GSA 10. Age structure of the Abundance index estimated by direct acoustic method.

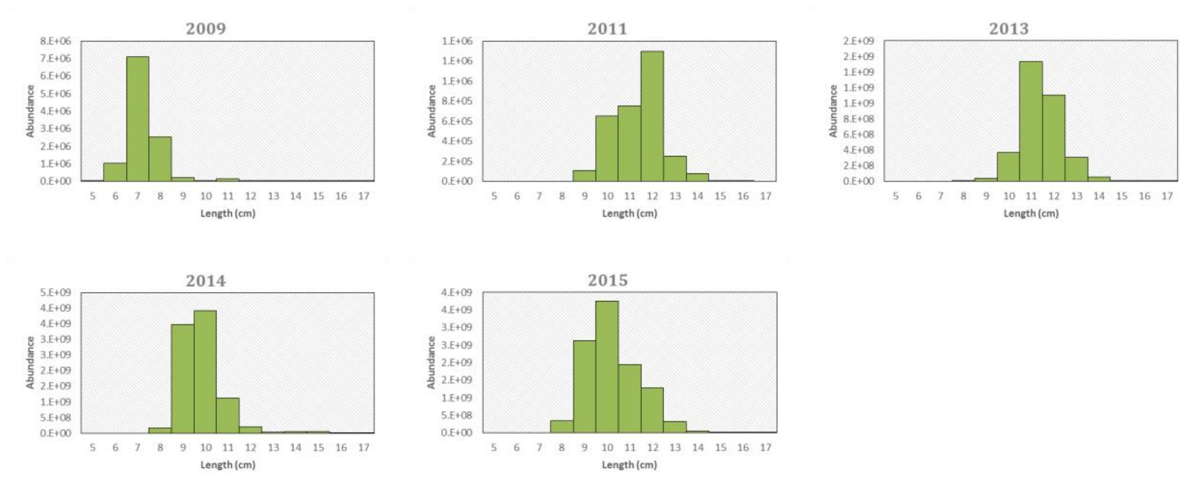


Figure 6.11.4.7. European Anchovy in GSA 10. Size structure of the Abundance index estimated by direct acoustic method.

6.12. DATA GATHERING OF SARDINE IN GSA 10

6.12.1. Stock Identity and biology

The assessment covers the entire GSA 10 area corresponding to the northern part of the Tyrrhenian Sea. However, the GSA 10 may not correspond to a Sardine single stock unit. Hydrological exchanges between the northern and southern part of Tyrrhenian Sea (GSA 9 and 10) for instance are well known, which should at least affect larval transport and then recruitment of juvenile sardine in both areas. Similarly, part of the young recruited sardine population may come from larval transport from spawners of the GSA 10. However, due to a lack of specific information about the stock structure of the sardine population in the western Mediterranean, this stock was assumed to be confined within the GSA 10 boundaries in this assessment.

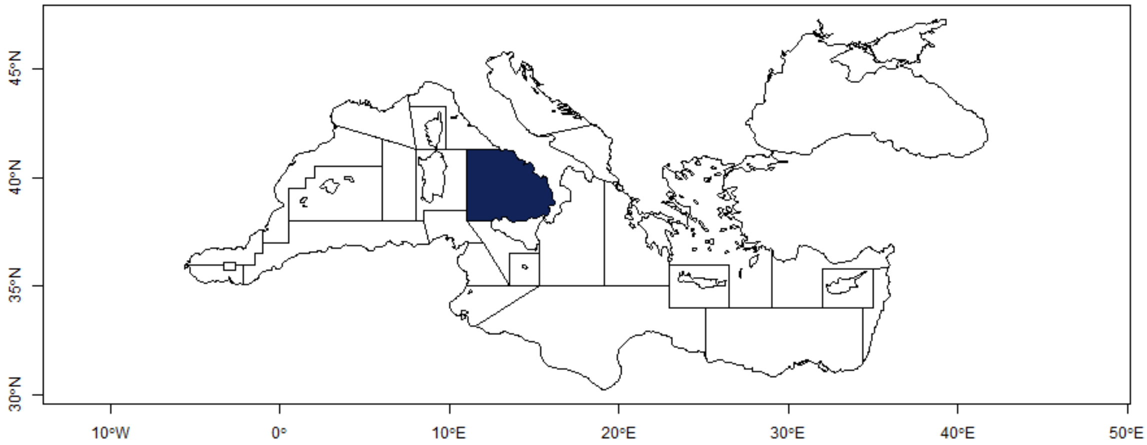


Figure 6.12.1.1. Geographical location of GSA 10.

Growth

Maturity

Maturity ogives were taken from DCF data in GSA 10.

Table 6.12.1.2. Sardine in GSA 10. Proportion of mature fish by age and sex.

Age	Female	Male	Mean
0	0.07	0.21	0.512
1	0.73	0.85	0.986
2	0.99	0.99	1
3	1	0.99	1

4	**1**	**1**	**1**

Natural mortality

6.12.2. Catches data

Data of catches at age were extracted from the repository of the *Data Collection Framework* for Sardine (*Sardine pilchardus*) to create data files for subsequent Stock assessment modelling. Data ranged from 2002 to 2015.

Unfortunately, no age structure from acoustic survey was ready to be used to compare age structure of Catch data. However, it seems that too many age classes were in the dataset ranging from 4 to 21 age classes that is quite unusual for short living species like sardine. Moreover, age data from the neighbouring GSA 9 are made by quite lower number of age classes (from 0 to 2 year old) suggesting that these data have to be revisited.

General description of the fisheries

The number of GNS was the higher among the different gear and it increased from 2009 to 2014. The other part of the fleet which is able to catch sardine in the GSA appeared quite stable in number among years. Pelagic trawlers were recorded only in 2004 and 2012 respectively with 28 and 19 vessel units.

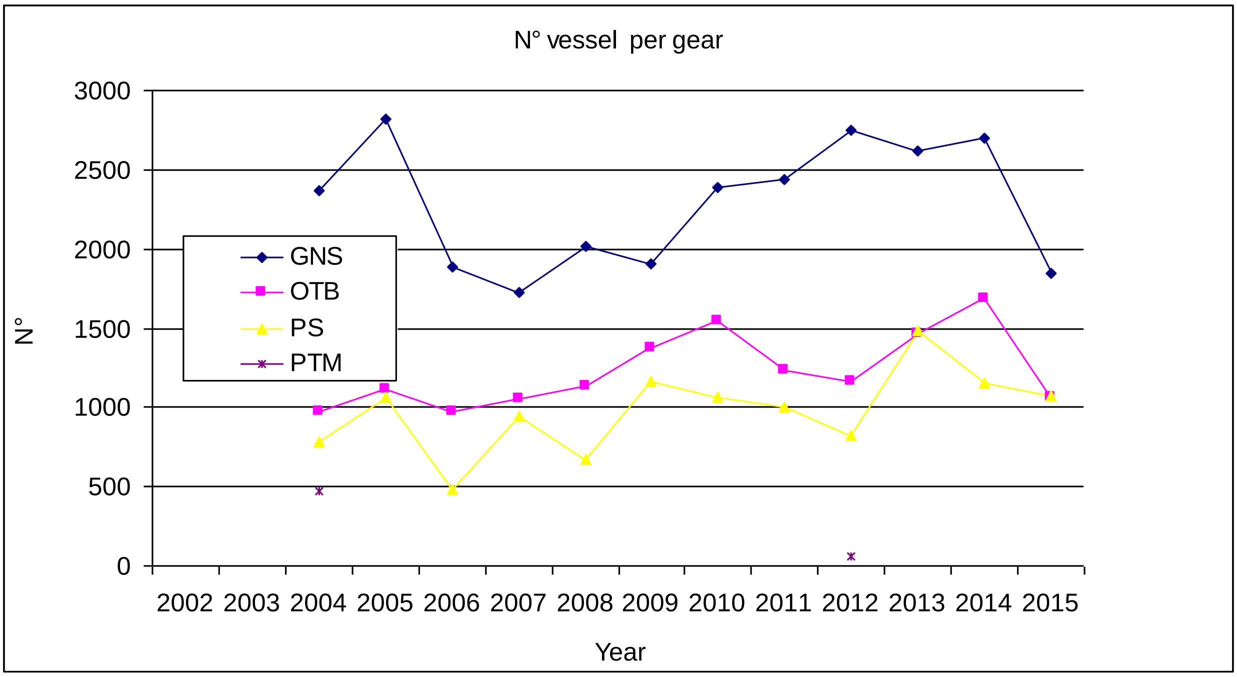


Figure 6.12.2.1. Sardine in GSA 10. Fleet data in numbers of vessel for fishing gear.

Landings

Landings data were reported to STECF EWG 16-13 through the DCF. In GSA 10 the landings come mainly from Purse Seiners, and by bottom trawls to lesser extent. The available Landings data from the DCF for the GSA 10 are presented in the following tables and figures.

Table 6.12.2..1. Sardine in GSA 10. Landings in tons by year and fishing gear.

Year	GND	GTR	OTB	PS	GNS
2002	-	225	43	1245	-
2003	-	62	-	1261	-
2004	-	-	22	3796	-
2005	-	14	12	1615	-
2006	84	2	6	1662	-
2007	64	-	4	1439	-
2008	17	-	13	1127	-
2009	14	-	27	3028	-
2010	21	-	23	2408	-
2011	9	-	44	1507	-
2012	-	-	31	559	-
2013	-	-	82	548	-
2014	-	-	38	808	1
2015	-	1	40	748	-
Total	208	303	385	21749	1

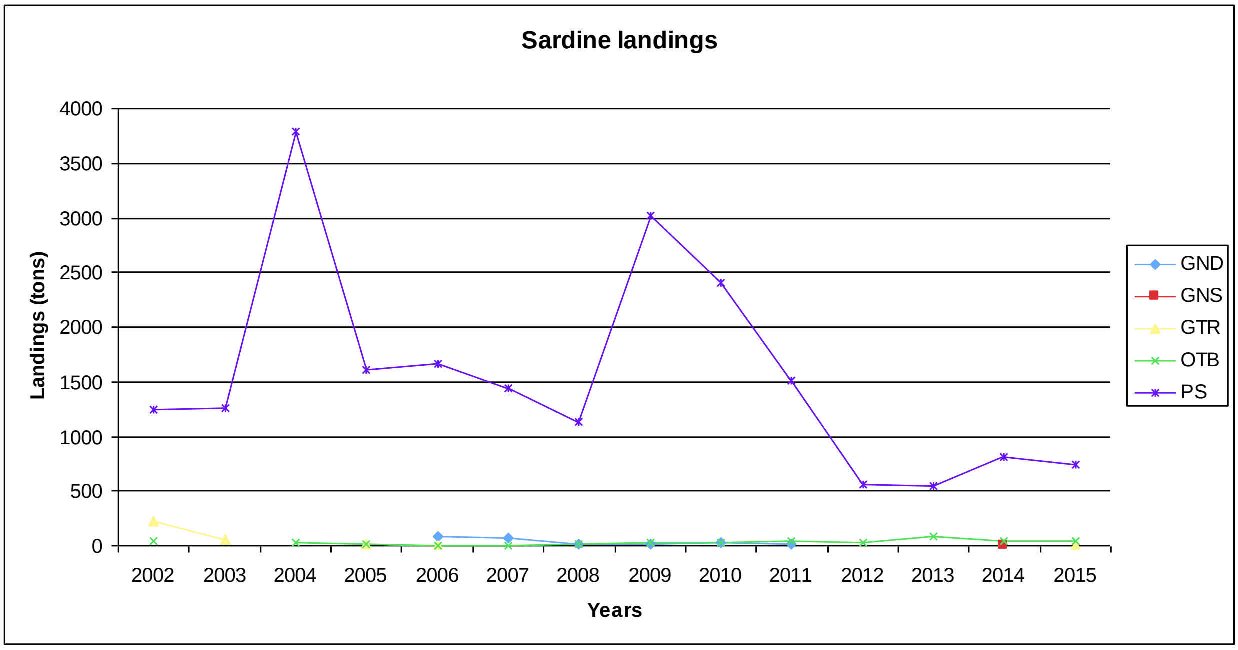
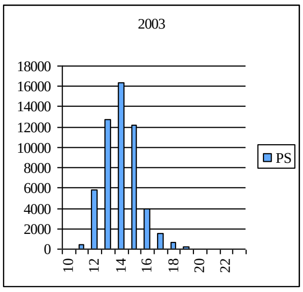
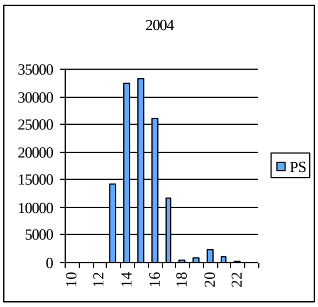
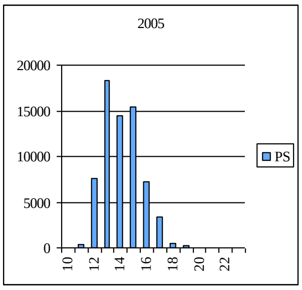


Figure 6.12.2.2. Sardine in GSA 10. Landings data in tons by fishing gear.

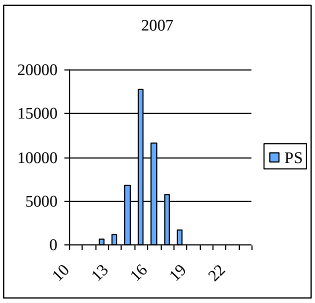
2002







2006



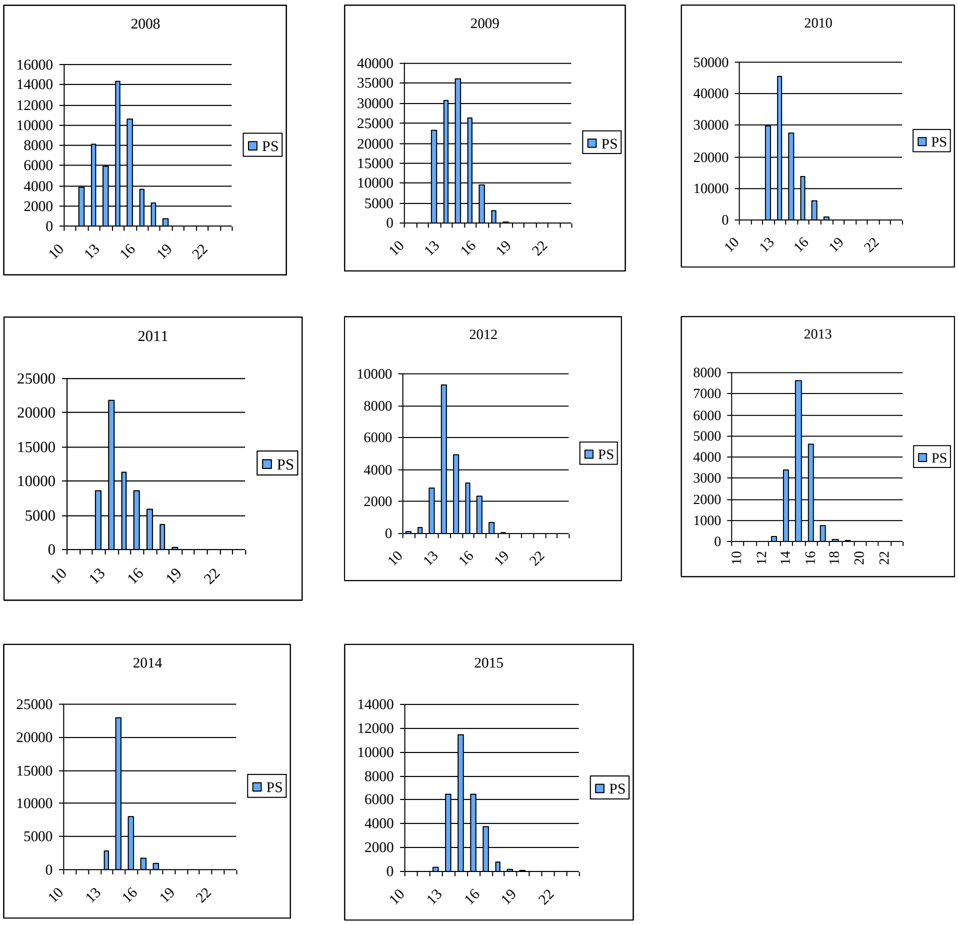
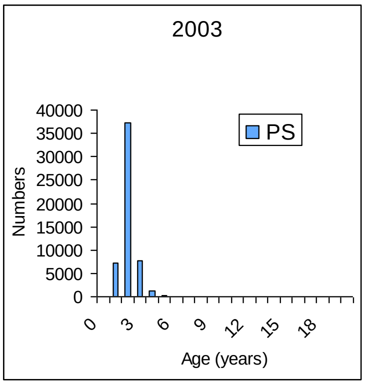
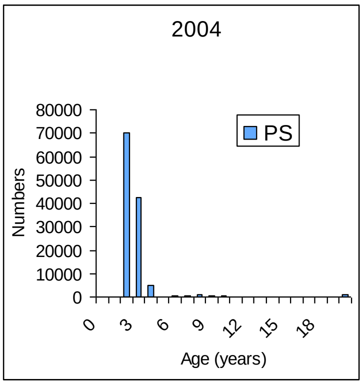


Figure 6.12.2.3. Sardine in GSA 10. Size structure of the landings data by fishing gear. Note that no length frequency data were recorded for others gears along the whole considered period.

2002


2003
Numbers
40000
35000
30000
25000
20000
15000
10000
5000
0
PS
0 3 6 9 12 15 18
Age (years)


2004
Numbers
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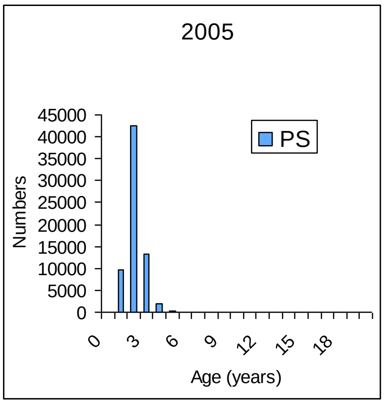
70000
60000
50000
40000
30000
20000
10000
0
PS
0 3 6 9 12 15 18
Age (years)


2005
Numbers
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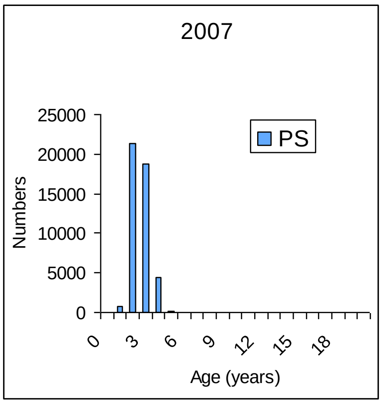
35000
30000
25000
20000
15000
10000
5000
0
PS
0 3 6 9 12 15 18
Age (years)

2006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Numbers
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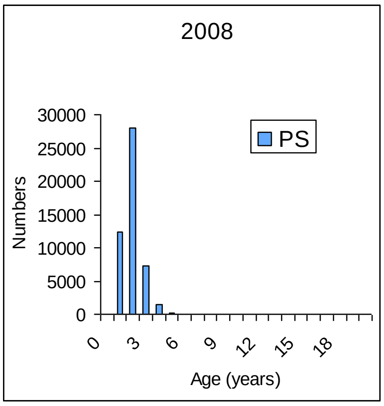
15000
10000
5000
0
PS
0 3 6 9 12 15 18
Age (years)


2008
Numbers
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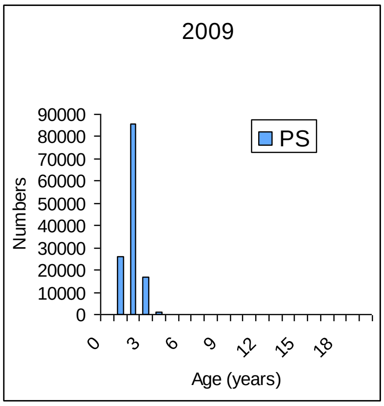
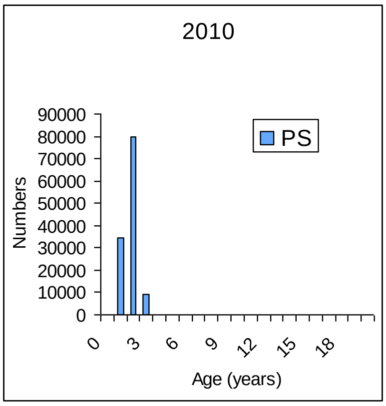
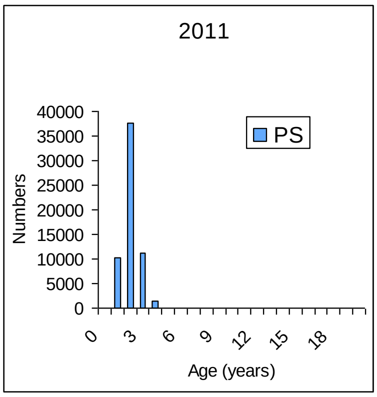
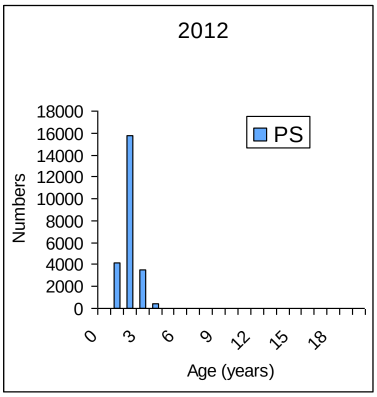
20000
15000
10000
5000
0
PS
0 3 6 9 12 15 18
Age (years)


2009
Numbers
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
PS
0 3 6 9 12 15 18
Age (years)


2010
Numbers
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
PS
0 3 6 9 12 15 18
Age (years)


2011
Numbers
40000
35000
30000
25000
20000
15000
10000
5000
0
PS
0 3 6 9 12 15 18
Age (years)


2012
Numbers
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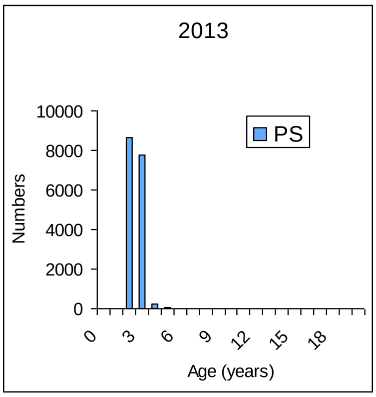
16000
14000
12000
10000
8000
6000
4000
2000
0
PS
0 3 6 9 12 15 18
Age (years)


2013
Numbers
10000
8000
6000
4000
2000
0
PS
0 3 6 9 12 15 18
Age (years)

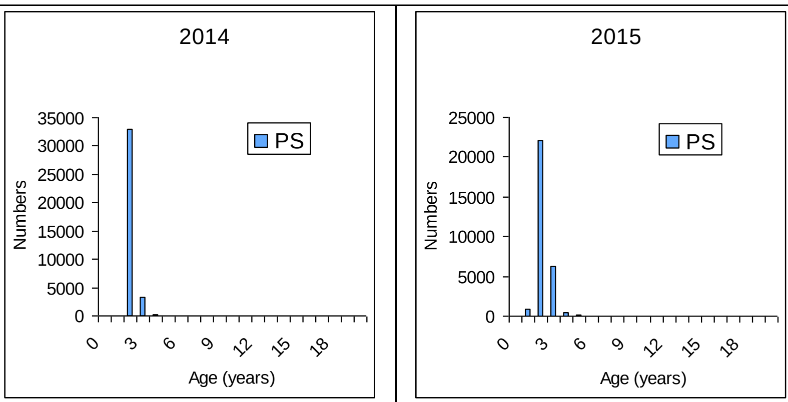


Figure 6.12.2.4. Sardine in GSA 10. Age structure of the landings data by fishing gear. Note that only PS samples were available in DCF data for age determination.

No landings have been reported for sardine pilchardus in 2002 and 2006, for GSA 10. Age structure of the landings derives from Purse Seines only (PS) other samples from other gear are not recorded for all the years. In Sardine landing sampling were recorded age classes from 1 to 20 while age 0 is missing during the whole period. Nothing similar was observed for Sardine in the adjacent GSA 9 where the oldest class recorded was the age 3.

Discards

Discards data were reported to STECF EWG 16-13 through the DCF. Discards for Sardine in GSA 10 was recorded only for Purse seine fleet (PS) starting from 2011. The size structure of the discarded sardine showed that the most abundant sardine discarded were between 10 and 16 cm.

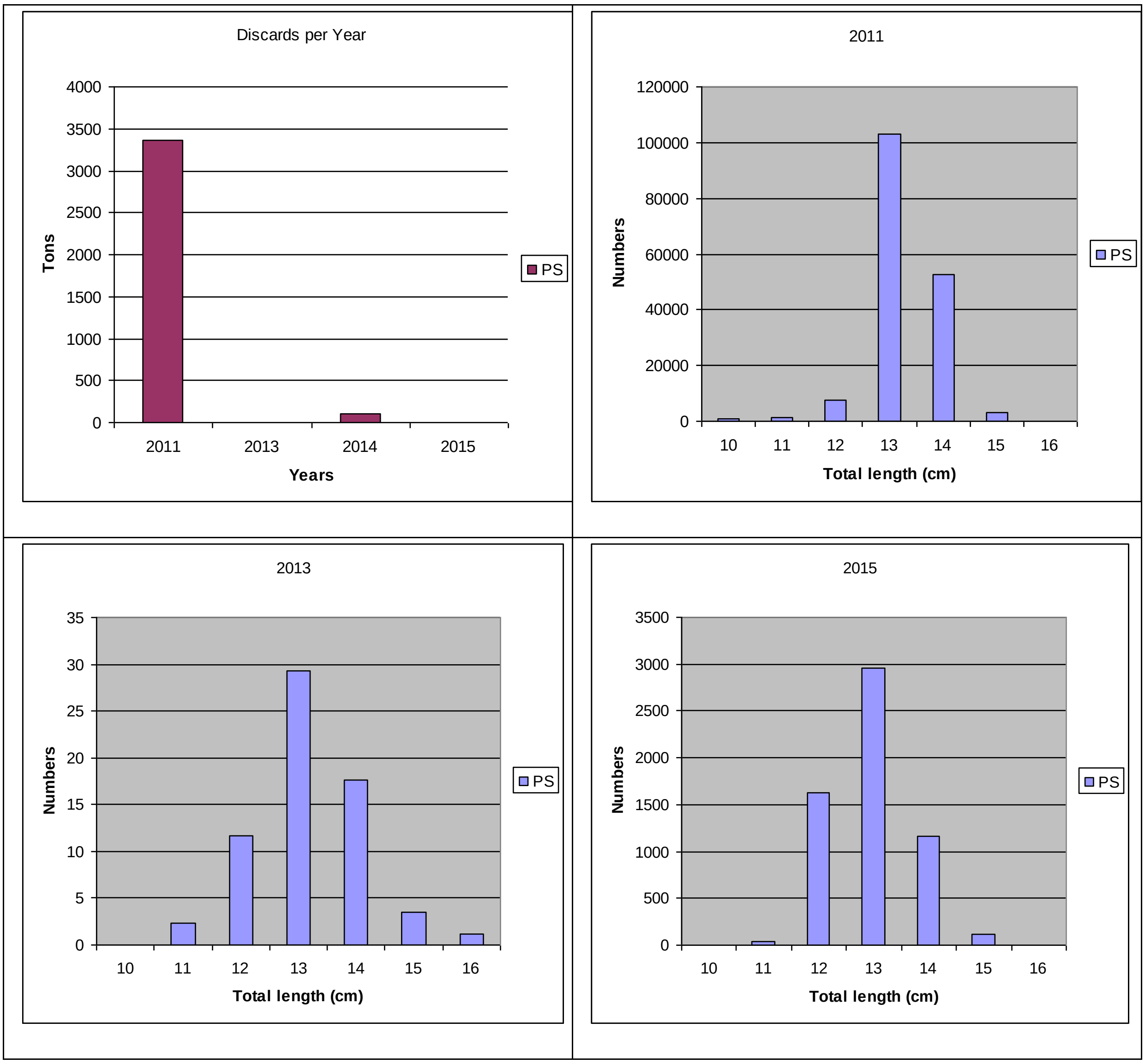


Figure 6.12.2.5.. Sardine in GSA 10. structure of the landings data by fishing gear. Note that only PS samples were available in DCF data as discarded samples.

6.12.3. Fishing effort data

Fishing effort data were reported to STECF EWG 16-13 through DCF. Fishing effort for GSA 10 was recorded for all the years except for GT_days at sea data in 2002 and 2003. Fishing effort data are presented in the following tables and figures.

Table 6.12.3.1. Fishing effort in GT*Days at sea by year and fishing in GSA 10. gear.

Year	DRB	FPO	GND	GNS	GTR	LLD	LLS	LTL	OTB	OTM	PS	PTM	Total
2002													
2003													
2004	7020	6050	23116	333949	264201	118528	204675	158	1274428		527621	475	3387109
2005	16261	26544	16308	365776	158576	77567	130253		1447582		303201		3048087
2006	18109	12407	49292	213574	377004	107859	128861		1370881		286612		2980738
2007	8939		39974	148766	327315	47486	96753		1354061		270975		2637172
2008	13553		36301	176750	235911	56463	115469		1017588		207179		2167164
2009	11184		33252	153684	195701	160627	80929		1065025		283823		2365065
2010	12210		10833	186442	203275	362818	90320		933293		232340		2285463
2011	11227	717	3684	204682	203044	281860	130835	789	911156		263106		2198502
2012	14678	6058	4389	177119	178421	224510	89885	174	1131380		287623	57	2231071
2013	5327	27149	510	158525	194817	121023	106365		1203248		298673		2179718
2014	7875	8647	2289	173614	176657	115173	221637	809	1639130	107419	262647		2750765
2015	9359	11027	984	132503	171185	262771	127997	196	966497	121444	335612		2199239

Table 6.12.3.2. Fishing effort in Days at sea by year and fishing gear in GSA 10.

Year	DRB	FPO	GND	GNS	GTR	LLD	LLS	LTL	OTB	OTM	PS	PTM	Total
2002	658				357895				37949		8258		404760
2003	205				311474				38134		9780		359593
2004	57588	389037	428503	474436	430026	446625	446625	187448	541461		682933	201588	4286270
2005	60292	335666	376122	335666	367704	395958	395958		124234		694631		3086231
2006	60829	248966	405704	344875	357634	245857	405704		133834		390431		2593836
2007	55580		345841	454246	363750	87754	363750		120326		271924		2063172
2008	52520		320569	361391	320569	288969	320569		182574		208394		2055556
2009	50004		339424	490533	339424	316867	339424		451327		297236		2624240
2010	48534		250301	354913	298834	268299	298834		359572		464102		2343391
2011	33571	86854	266283	586976	333836	326015	333836	98540	498102		438635		3002649

2012	230539	231682	158566	513041	293239	297261	293239	44497	411390		410746	58245	2942444
2013	41317	193223	14967	472679	261636	244230	261636		332890		529748		2352325
2014	43200	208832	156162	518887	269963	241591	269963	105953	356120	18738	502244		2691655
2015	48702	240703	161261	498232	274802	299703	289405	52933	340008	55137	507613		2768500
Total	783541	1934964	3223704	5405876	4580787	3459129	4018944	489371	3927921	73876	5416676	259833	33574621

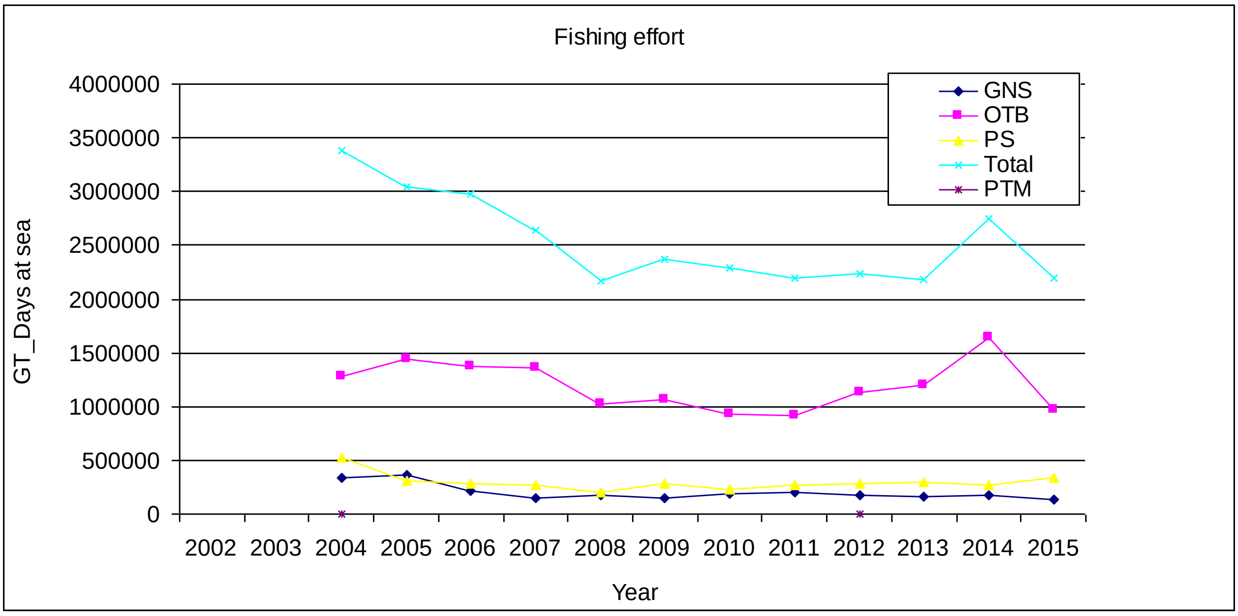


Figure 6.12.3.1. Fishing effort data in GT*Days at sea in GSA 10.

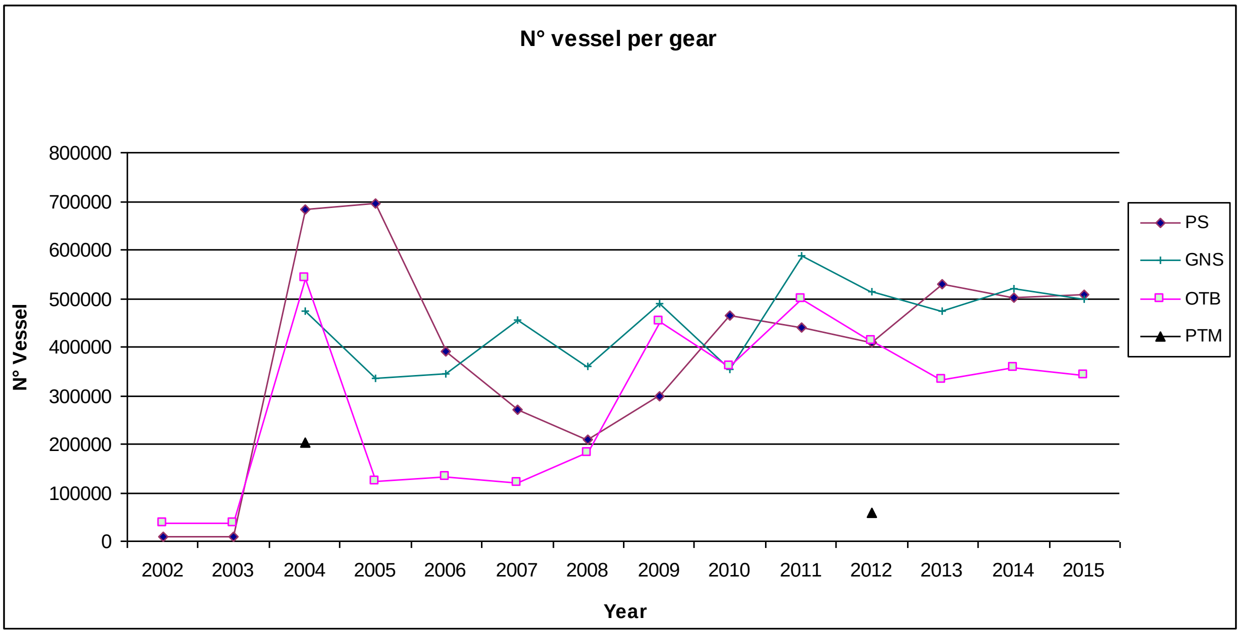


Figure 6.12.3.2. Fishing effort data in Days at sea by fishing gear in GSA 10.

6.12.4. Survey Indices of abundance and biomass by year and size/age

Survey #1 (Extension of the MEDIAS in the GSAs 9 and 10)

The scientific survey used is an acoustic survey that has been conducted in summer of 2009 (17th August to 9th September), and in late the spring– early summer during 2011 (10th May to 10th June), 2013 (17th May to 9th June) and 2014 (8th – 25th June). The first two surveys were funded by the Italian National Research Council while the other two were carried out in the framework of the RITMARE project. A further acoustic survey, funded by the Italian Ministry of Agriculture, Food and Forestry (MIPAAF), was carried out in the period 1-27 August 2015. The five surveys follow the Mediterranean Acoustic Survey (MEDIAS) protocol.

Methods

The echo survey sampling strategy mainly adopted a parallel transects design in areas with wide continental shelf, and a zig-zag transects design on the continental shelf located in the southern part of GSA 10 (Fig. 1). The minimum sampling depth varied between 10 and 20 m, depending on the area. A Simrad EK60 scientific echo sounder, working with a split beam transducer at 38 kHz, was used for acquiring acoustic data; the system was calibrated according to standard techniques (Foote et al., 1987). Acoustic data were recorded along the transects at a speed of 8–10 knots; the post-processing was then performed using the Myriax Echoview software.

In each EDSU (Elementary Distance Sampling Unit = 1 nmi), the acoustic nautical area scattering coefficient (NASC; MacLennan et al., 2002) and density (t nmi-2) for anchovy and sardine were evaluated by associating trawl hauls and nearest trawl haul, irrespective of the echo traces (Petitgas et al., 2003).

Geographical distribution

A recent study on spatial distribution of anchovy and sardine in the Tyrrhenian Sea in the period 2009-2014 has been published (Bonanno et al., 2016). Below are the maps for Sardine from this publication and the spatial distribution obtained during the survey in summer 2015.

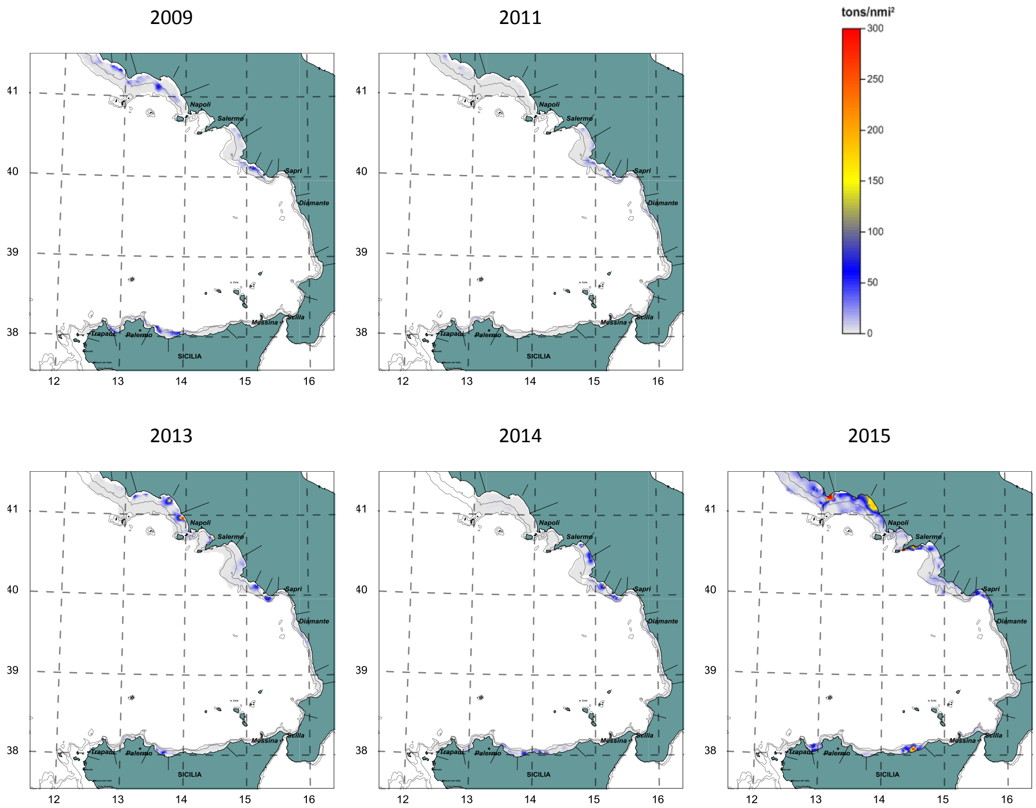


Figure 6.12.4.1. Sardine in GSA 10. Spatial distribution of anchovies from acoustic surveys (from Bonanno et al. (2016) and form the echo survey in summer 2015).

Trends in abundance and biomass

Abundance and biomass indexes for the survey carried out in summer 2015 were reported to STECF EWG 16-13 through DCF. The results of the four acoustic surveys, carried out in the period 2009-2014, were made available by a research group of the Italian National Council of the Researches (CNR-IAMC) during the meeting. European Sardine time series of abundance and biomass indices from the five surveys are shown and described in the following figures.

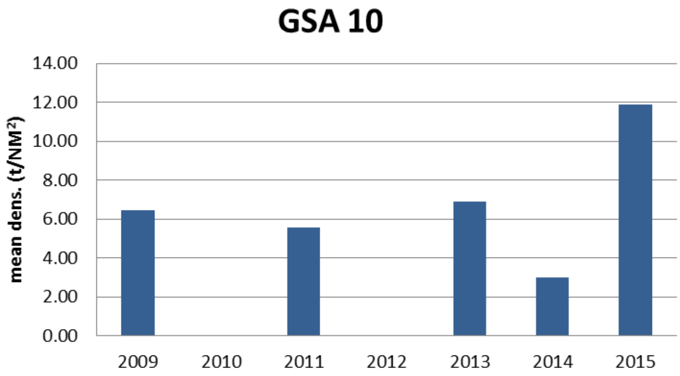


Figure 6.12.4.2. Sardine in GSA 10. Biomass density estimated by direct acoustic method from echo survey.

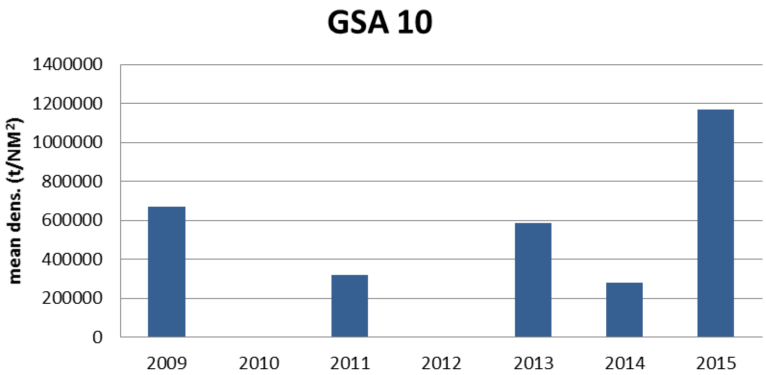


Figure. 6.12.4. 3. Sardine in GSA 10. Abundance density estimated by direct acoustic method from echo survey.

No data on biomass or abundance were collected in GSA 10 for the years 2010 and 2012.

Trends in biomass and abundance by length or age

Sardine time series of abundance and biomass indices from the five acoustic surveys are shown in the following figures.

Unfortunately, no age structure was available for acoustic data collected in summer 2009.

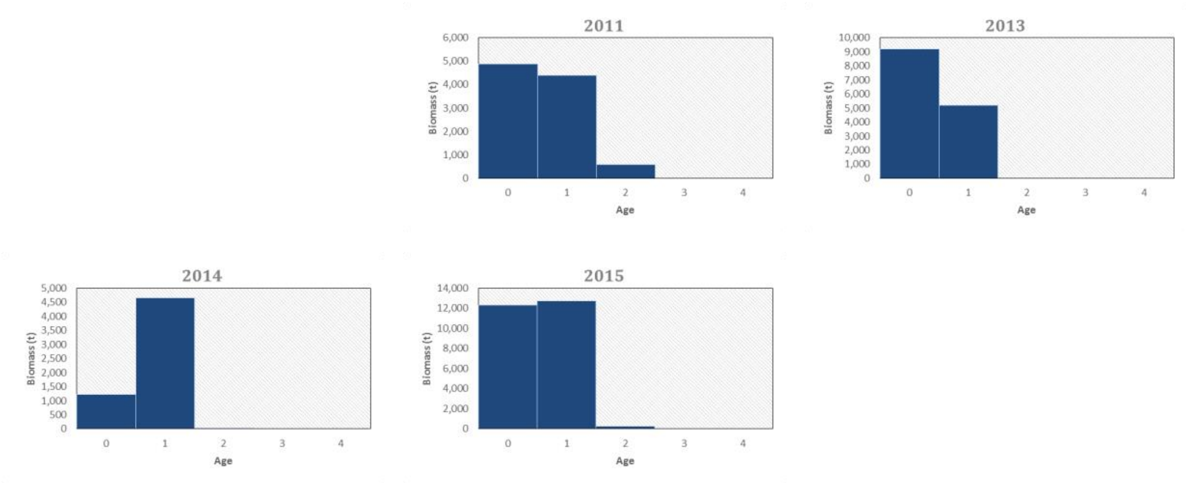


Figure 6.12.4.4. Sardine in GSA 10. Age structure of the Biomass index estimated by direct acoustic method.

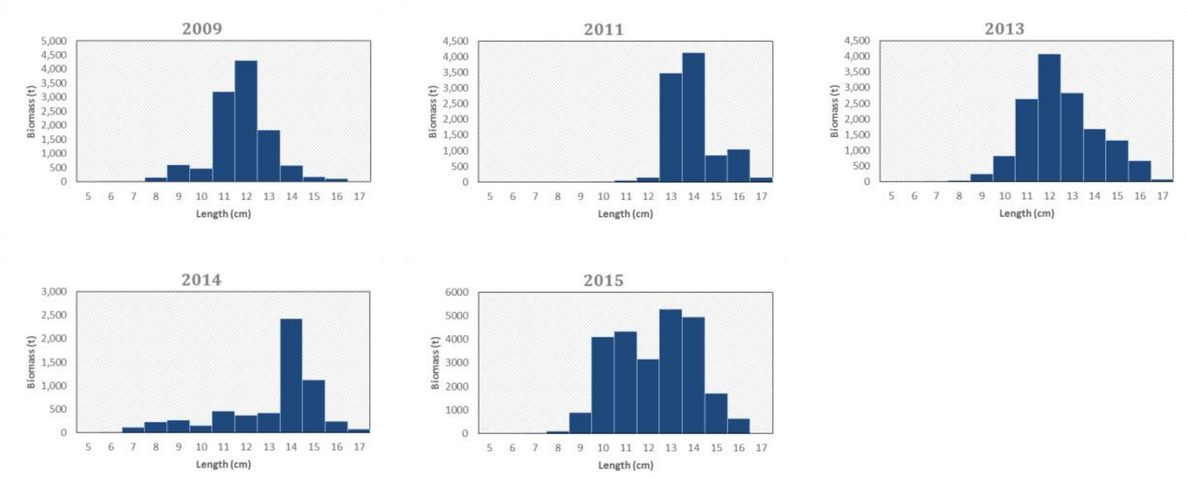


Figure 6.12.4.5. Sardine in GSA 10. Size structure of the Biomass index estimated by direct acoustic method.

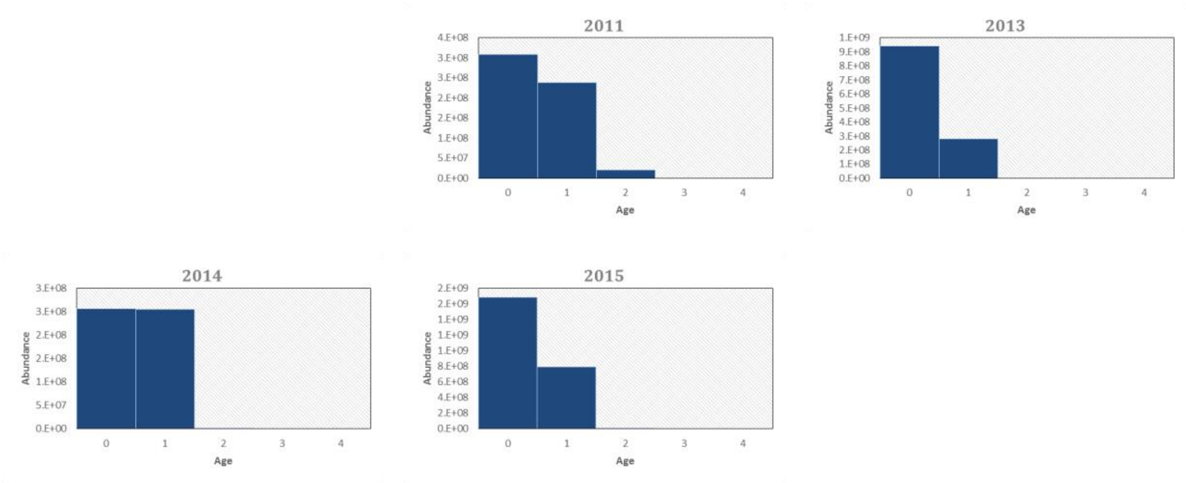


Figure 6.12.4.6 Sardine in GSA 10. Age structure of the Abundance index estimated by direct acoustic method.

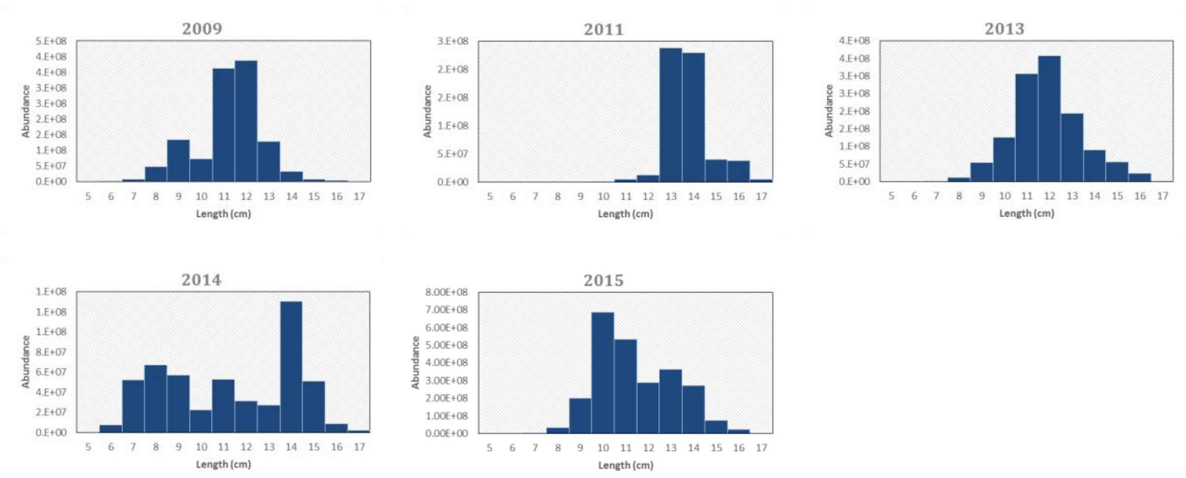


Figure 6.12.4.7. Sardine in GSA 10. Size structure of the Abundance index estimated by direct acoustic method.

6.13. DATA GATHERING ON SARDINE IN GSA5

6.13.1. Stock Identity and Biology

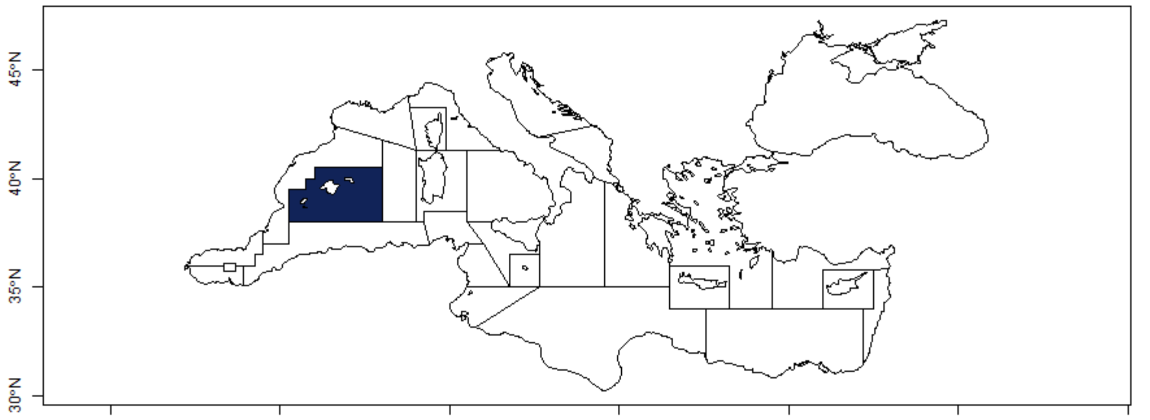


Figure 6.13.1.1. Geographical location of GSA 5.

There is limited information available on the stock of European pilchard (*Sardina pilchardus*) in GSA 5. The StockMed project results suggest the sardine population in GSA 5 belongs to the stock unit encompassing GSAs 1, 5, 6 and a part of GSA 7. However, the examined stock units are considered unreliable by the StockMed and further corroboration of this hypothesis in the future is suggested. (6.13.1.2, Fiorentino et al. 2014).

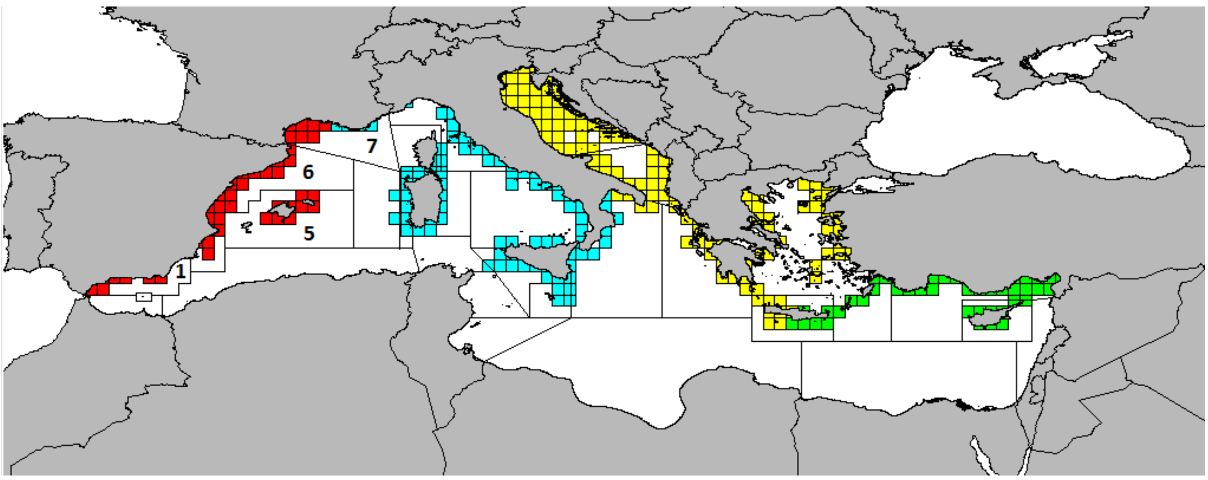


Figure 6.13.1.2. Stock unit identification for *Sardina pilchardus (source:* StockMed Data Viewer*).*

Age and growth

Maximum reported size for sardine according to FishBase is 27.5 cm TL, but this value varies extensively and has been estimated much lower for some Mediterranean GSAs.

The species can live up to 15 years, although a maximum age of 8 years is a more realistic estimate for the Mediterranean (Sinovčić, 2000).

There was no information on sardine growth parameters for GSA 5 in the DCF data base made available to STECF EWG 16-13. A number of growth parameter estimates are available in the literature for other GSAs (Sinovčić 2000, STECF reports, GFCM reports), however, their potential use for stock assessment of the above defined sardine stock unit needs prior verification since rapid changes in growth, condition, size and age of small pelagic fish in certain areas of the Mediterranean have been observed (Van Beveren et al. 2014).

Maturity

Sardine has a very fast initial growth, reaching sexual maturity at the end of the first year of life at a length of 12 – 15 cm (Sinovčić 1984, FishBase 2016, MedSudMed 2004). As most of the Clupeidae family, it is a batch-spawner: females emit groups of pelagic eggs asynchronously, with different ovulations during the breeding season (autumn-winter) (Ganias et al., 2004). In the Mediterranean the breeding season is between October and April (Muzinić, 1954; 1984, Morello and Arneri 2009) and the size of first sexual maturity is 12.5 cm (MedSudMed, 2004).

Reproduction occurs both in the open sea and close to shoreline and the hatching of eggs depends strongly on temperature. In the peak of the breeding season each female lays from 11337 to 12667 eggs (Sinovčić, 1983) with a diameter of 1.5 mm.

Feeding

A general pattern of diurnal feeding activity that extends until dusk was observed for sardine in the NW Mediterranean (Costalago & Palomera 2014). Larger sardines (7 cm SL and higher) primarily use filter feeding rather than particulate feeding (Costalago & Palomera 2014), although a shift to particulate feeding could also occur under specific environmental conditions. Sardine larvae are obligate particulate feeders, while juvenile and adult sardine are opportunistic feeders with a more heterogeneous diet. Results of several studies suggest that sardine is essentially non-selective filter-feeder and that its diet reflects the ambient plankton composition (Costalago & Palomera 2014).

Habitat

Sardines are known to distribute in various ecosystems within the temperate zone that largely differentiate in terms of oceanographic characteristics and productivity. Both adult and juvenile sardine prefer shallower and warmer coastal waters and seem to select less stratified, higher salinity waters or otherwise moderate upwelling conditions. In the Mediterranean sardines do not perform long migrations between feeding, spawning and juvenile grounds and the habitat distribution is largely driven by the local productivity patterns. (Bonanno et al. 2014, Giannoulaki et al. 2011, Tugores et al., 2010)

6.13.2. Catch data

Absolute catch values of sardine in GSA 5 are low - average landing of sardine in GSA 5 in the last 3 years is 182.83 tonnes.

Landings

The vast majority of sardine in GSA 5 is landed by the purse seine fleet. Because the landings from OTB are negligible, the total landing (blue) and landing from PS (dashed green) overlap almost completely (6.13.2.1).

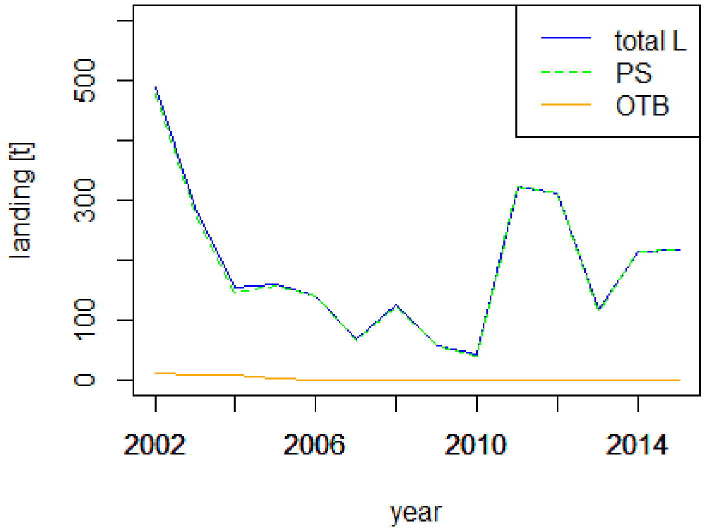


Figure 6.13.2.1 Sardine in GSA 5. : Landing by year and gear.

Table 6.13.2.1. Sardine in GSA 5. Landing and discard data by year and gear.

Year	Gear	Landings [t]	Discards [t]
2002	OTB	11.15	
2002	PS	476.85	
2003	OTB	8.68	
2003	PS	280.21	
2004	OTB	8.79	
2004	PS	146.09	
2005	OTB	3.79	
2005	PS	157.75	
2006	OTB	1.14	
2006	PS	139.09	
2007	OTB	1.22	

2007	**PS**	**67.61**	
2008	**OTB**	**1.12**	
2008	**PS**	**124.67**	
2009	**OTB**	**0.06**	
2009	**PS**	**58.4**	
2010	**OTB**	**0.17**	
2010	**PS**	**41.97**	
2011	**OTB**	**0.12**	
2011	**PS**	**323.71**	
2012	**OTB**	**0.07**	
2012	**PS**	**309.99**	
2013	**OTB**	**0.22**	**19.3**
2013	**PS**	**116.02**	
2014	**OTB**	**0.05**	**2.38**
2014	**PS**	**215.82**	
2015	**OTB**	**0.1**	
2015	**PS**	**216.28**	

There was no information on length or age structure for sardine in GSA 5 in the DCF data base made available to STECF EWG 16-13, so the size and age structure of the landings could not be presented.

Discards

There were only 2 instances of discard data for sardine in GSA 5 (6.13.2.1), so no figure was produced.

6.13.3. Fishing effort data

Fishing effort

Sardine in GSA 5 is caught almost exclusively by purse seiners (Figure 6.14.2.1. European Anchovy in GSA 5.), hence only effort for this gear is presented below. There is a declining trend in the number of vessels using purse seines in the area with an average of 26 vessels operating in the last 3 years, down from 76 vessels in 2004. This trend is also reflected in the declining trend of effort for purse seines.

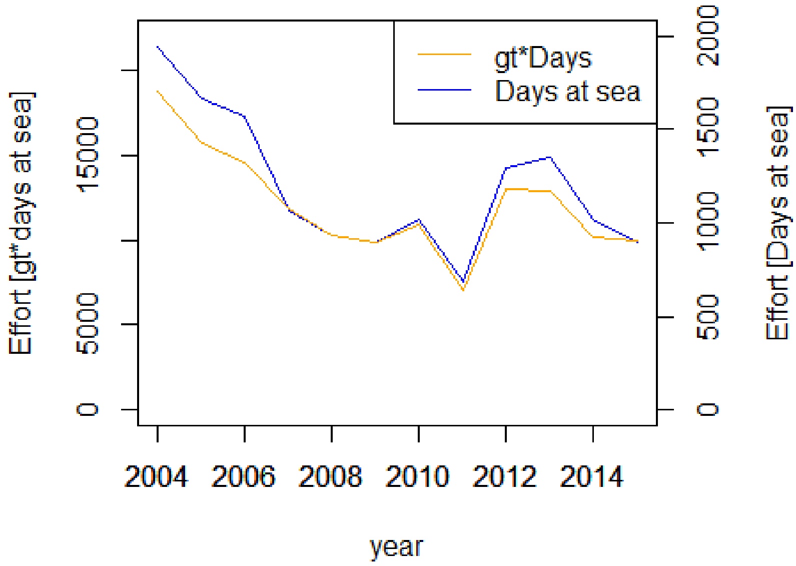


Figure 6.13.3.1. *Effort for PS in GSA 5 by year.*

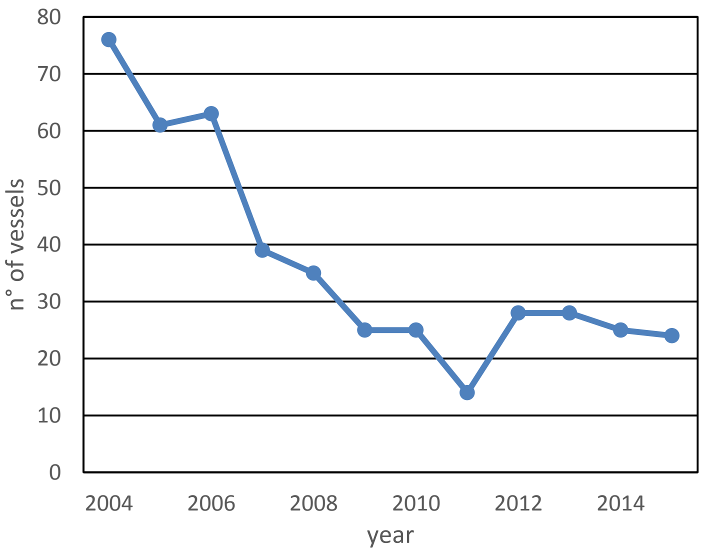


Figure 6.13.3.2. Number of vessels using purse seine in GSA 5 by year.

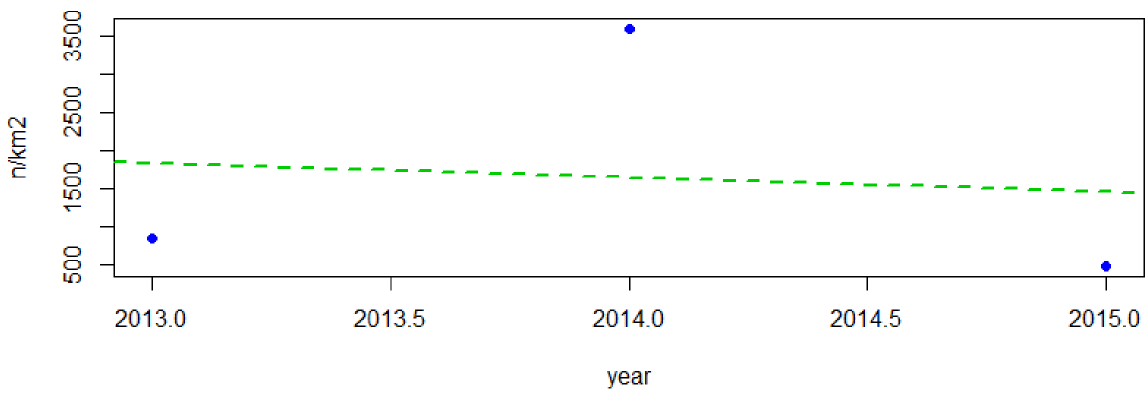
Table 6.13.3.1. **Effort for PS in GSA 5 by year.**

Year	Total effort [Gt*days at sea]	Total effort [Days at sea]
2004	**21359.3**	**1704**
2005	**18273**	**1424**
2006	**17310.29**	**1323**
2007	**11709.62**	**1076**
2008	**10240.52**	**933**
2009	**9873.28**	**892**
2010	**11163.94**	**988**
2011	**7574.7**	**641**
2012	**14254.6**	**1177**
2013	**14839.96**	**1173**
2014	**11225.88**	**921**
2015	**9840.95**	**903**

6.13.4. Survey Indices of abundance and biomass by year and size/age

There were no data available from acoustic surveys for sardine in GSA 5.

Data from MEDITS survey for sardine in GSA 5 were only available from 2013 onwards and the trends for this time series are presented below (Fig. 6.13.4.1-3).. However, it should be noted that MEDITS survey is not targeted at small pelagic species and the time series is too short, so the trend should not be taken as indicative of stock status.



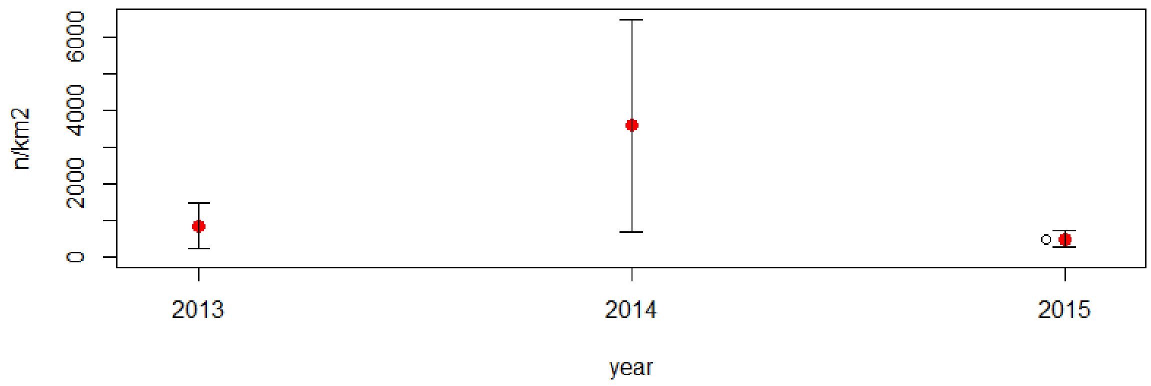
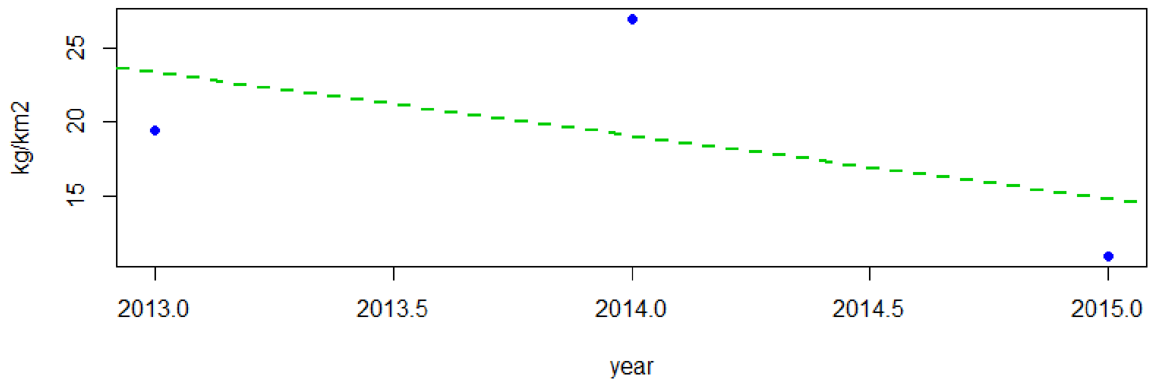


Figure 6.13.4.1. Sardine in GSA5. Total density index by year from MEDITS survey.



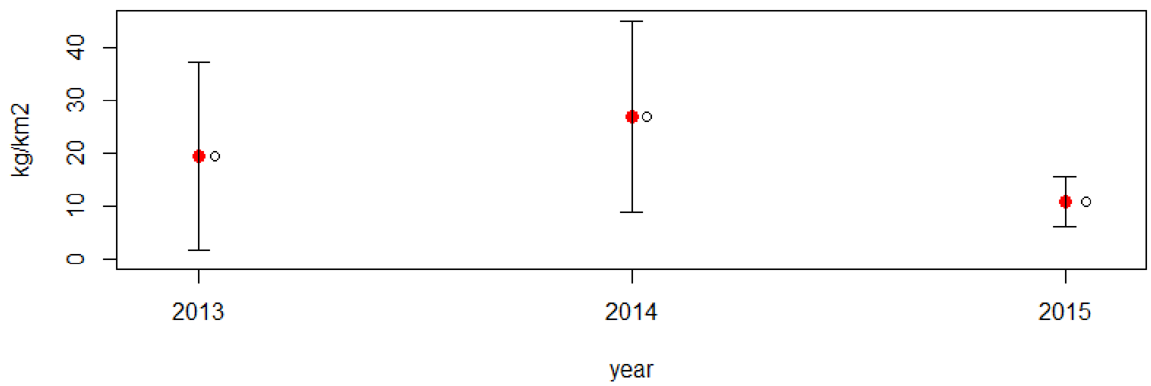


Figure 6.13.4.2. Sardine in GSA5. Total biomass index by year from MEDITS survey.

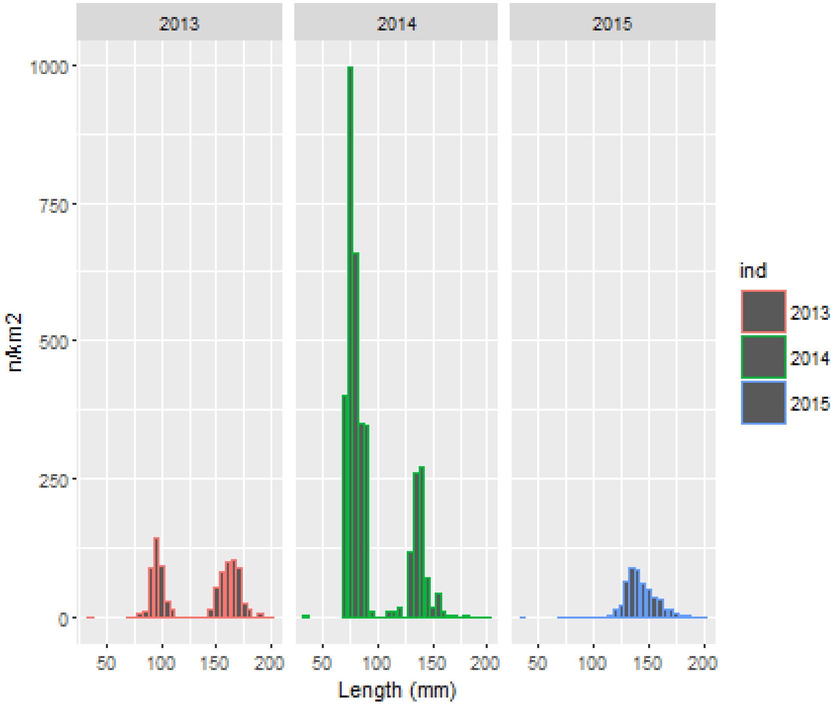


Figure 6.13.4.3. Sardine in GSA5. Length-frequency distribution by year from MEDITS survey.

6.14. DATA GATHERING IN EUROPEAN ANCHOVY IN GSA 5

6.14.1. Stock Identity and Biology

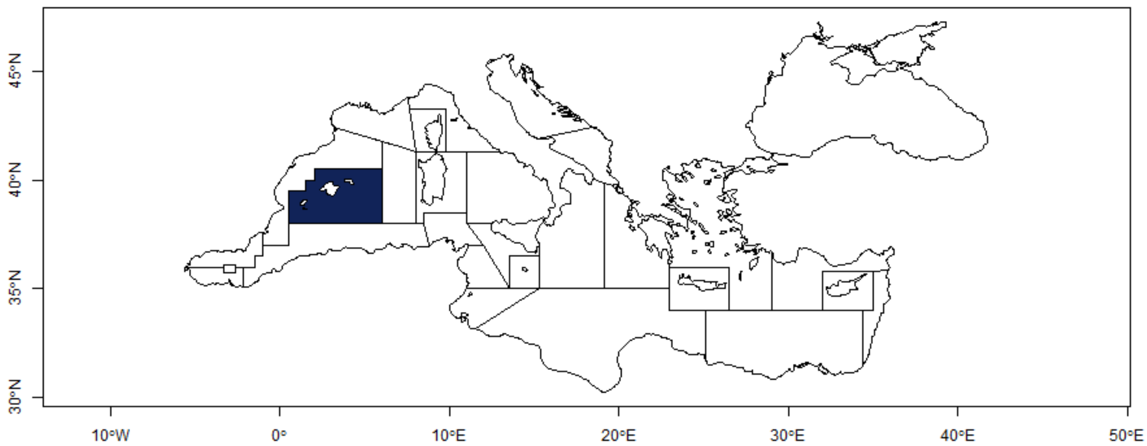


Figure 6.14.1.1 Geographical location of GSA 5

There is limited information available on the stock of European anchovy (*Engraulis encrasicolus*) in GSA 5. The fairly reliable StockMed project results suggest the anchovy population in GSA 5 belongs to the stock unit encompassing GSAs 1, 5, 6, 7, 9 and even a part of GSA 10 (Figure 6.14.1.2., Fiorentino et al. 2014).

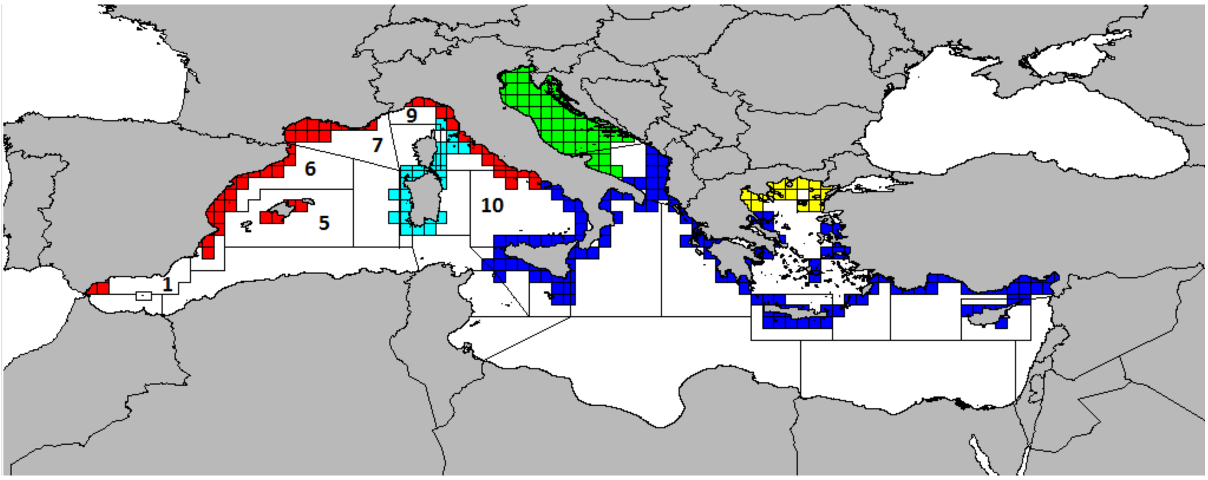


Figure 6.14.1.2. Stock unit identification for *Engraulis encrasicolus* (source: StockMed Data Viewer).

There was no information on age structure, growth, maturity or natural mortality for anchovy in GSA 5 in the DCF data base made available to STECF EWG 16-13.

Feeding

Adult anchovy tend to use particulate feeding when food concentration is relatively scarce, but shift to filter feeding under higher food concentrations (Bulgakova 1996). However, juvenile anchovy keep feeding predominantly on zooplankton rather than phytoplankton regardless the planktonic composition and food concentration in the environment. The predatory behaviour observed in anchovy, preying on relatively large and abundant plankton (Copepods) supports the theory that anchovy juveniles are particle feeders rather than filter feeders. At least during winter anchovy juveniles prey only on zooplankton. (Costalago & Palomera 2014b)

Habitat

Anchovy mostly occurs in depths of up to 100 m. It prefers areas with lower salinity values typically influenced by deep water masses and/or riverine outflows. Anchovy is most abundant in less stratified waters associated with moderate upwelling and downwelling processes. The shallow waters over the continental shelf meet suitable conditions for high photosynthesis levels; such areas coincide with different circulation patterns that enhance productivity and subsequently food availability for anchovy. (Bonanno et al. 2014)

6.14.2. Catch data

Landings

The vast majority of anchovy in GSA 5 is landed by the purse seine fleet. Because the landings from OTB are negligible, the total landing (blue) and landing from PS (dashed green) overlap almost completely (Fig. 6.14.2.1).

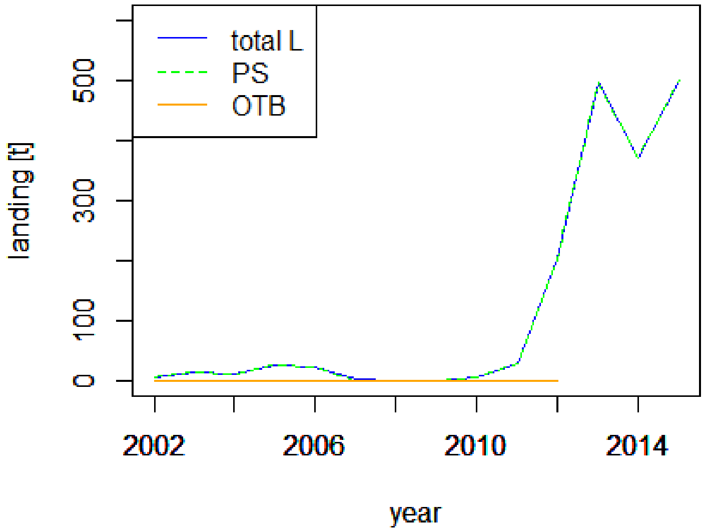


Figure 6.14.2.1. European Anchovy in GSA 5. : Landing by year and gear.

Table 6.14.2.1. European Anchovy in GSA 5. Landing by year and gear.

Year	Gear	Landings [t]
2002	OTB	0.11
2002	PS	6.12
2003	OTB	0.01
2003	PS	13.83
2004	OTB	0.1
2004	PS	13.16
2005	OTB	0.1
2005	PS	25.34
2006	OTB	0.12
2006	PS	22.46
2007	OTB	0.72

2007	**PS**	**1.5**
2008	**OTB**	**0.04**
2008	**PS**	**0.86**
2009	**OTB**	**0**
2009	**PS**	**0.67**
2010	**OTB**	**0**
2010	**PS**	**6.14**
2011	**PS**	**30.17**
2012	**OTB**	**0.01**
2012	**PS**	**204.03**
2013	**PS**	**495.62**
2014	**PS**	**370.13**
2015	**PS**	**500.61**

There was no information on length or age structure for anchovy in GSA 5 in the DCF data base made available to STECF EWG 16-13, so the size and age structure of the landings could not be presented.

Discards

There were no discard data for anchovy in GSA 5 in the DCF data base made available to STECF EWG 16-13.

6.14.3. Fishing effort data

Fishing effort

Anchovy in GSA 5 is caught almost exclusively by purse seiners (Figure 6.14.2.1. European Anchovy in GSA 5.), hence only effort for this gear is presented below.

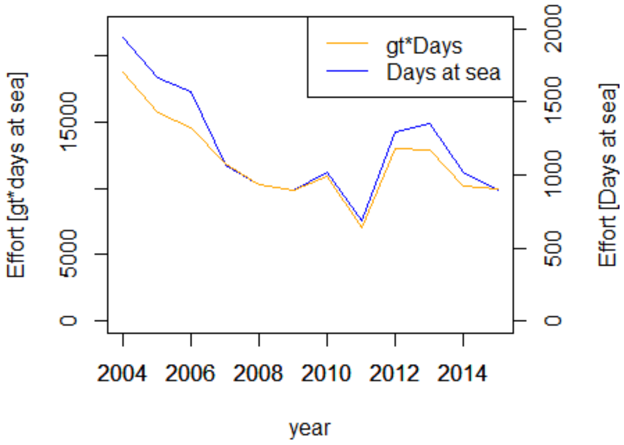


Figure 6.14.3.1 Effort for PS in GSA 5 by year.

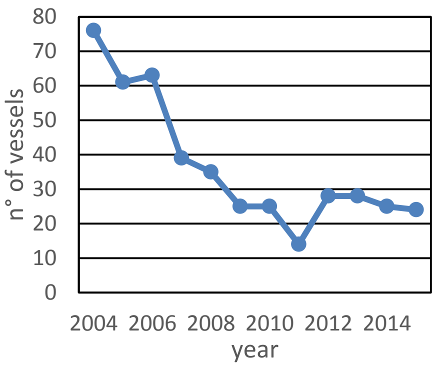


Figure 6.14.3.2. Number of vessels using purse seine by year

Table 6.14.3.1 Effort for PS in GSA by year

Year	Total effort [Gt*days at sea]	Total effort [Days at sea]
2004	21359.3	1704
2005	18273	1424
2006	17310.29	1323
2007	11709.62	1076
2008	10240.52	933
2009	9873.28	892

2010	**11163.94**	**988**
2011	**7574.7**	**641**
2012	**14254.6**	**1177**
2013	**14839.96**	**1173**
2014	**11225.88**	**921**
2015	**9840.95**	**903**

6.14.4. Survey Indices of abundance and biomass by year and size/age

There were no data available from acoustic surveys for anchovy in GSA 5.

Data from MEDITS survey for anchovy in GSA 5 were only available from 2012 onwards and the trends for this time series are presented below (Fig. 6.14.4.1-3). However, it should be noted that MEDITS survey is not targeted at small pelagic species and the time series is too short, so the trend should not be taken as indicative of stock status.

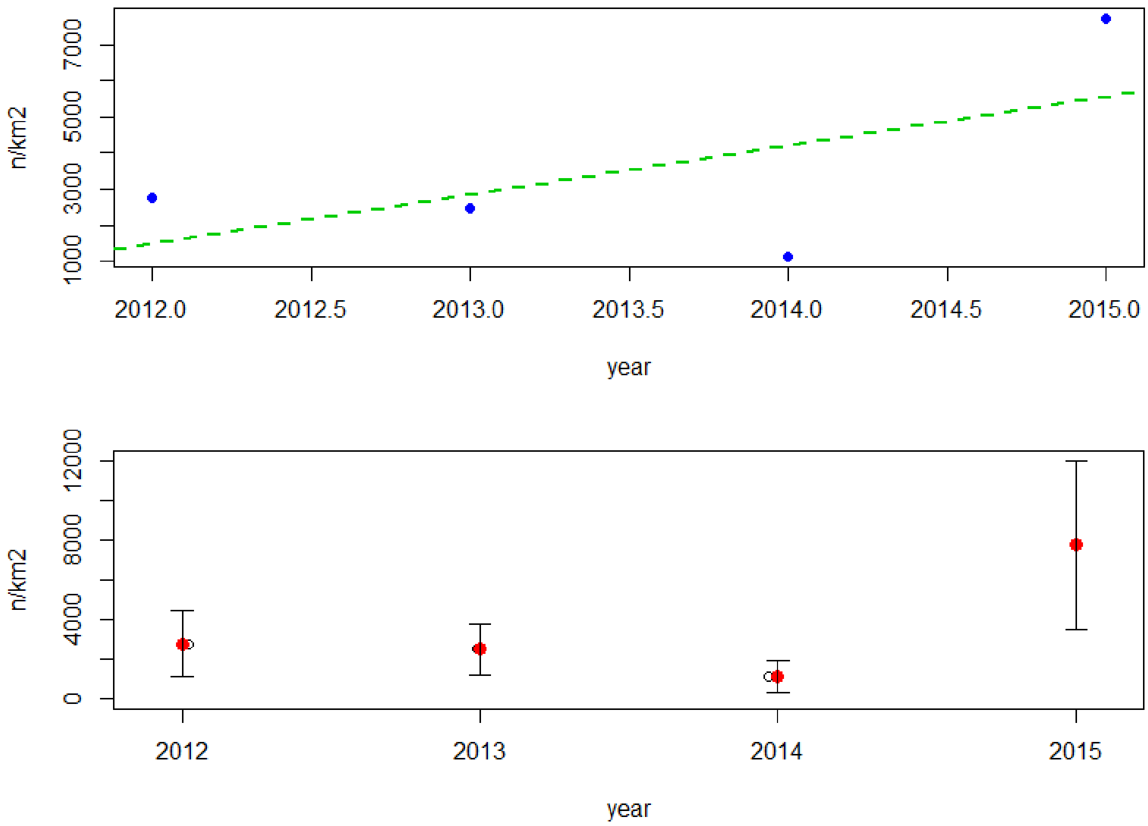


Figure 6.14.4.1. European Anchovy in GSA5.Total density index by year from MEDITS survey.

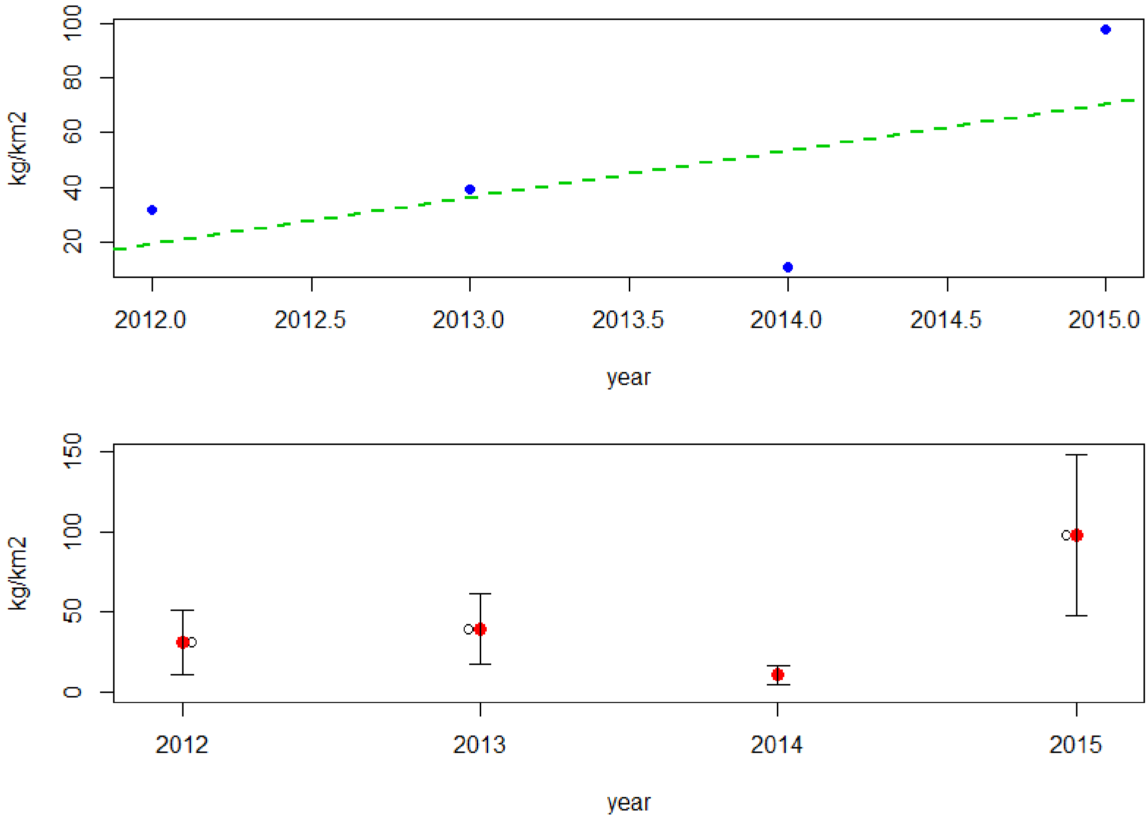


Figure 6.14.4.2. European Anchovy in GSA5.Total biomass index by year from MEDITS survey.

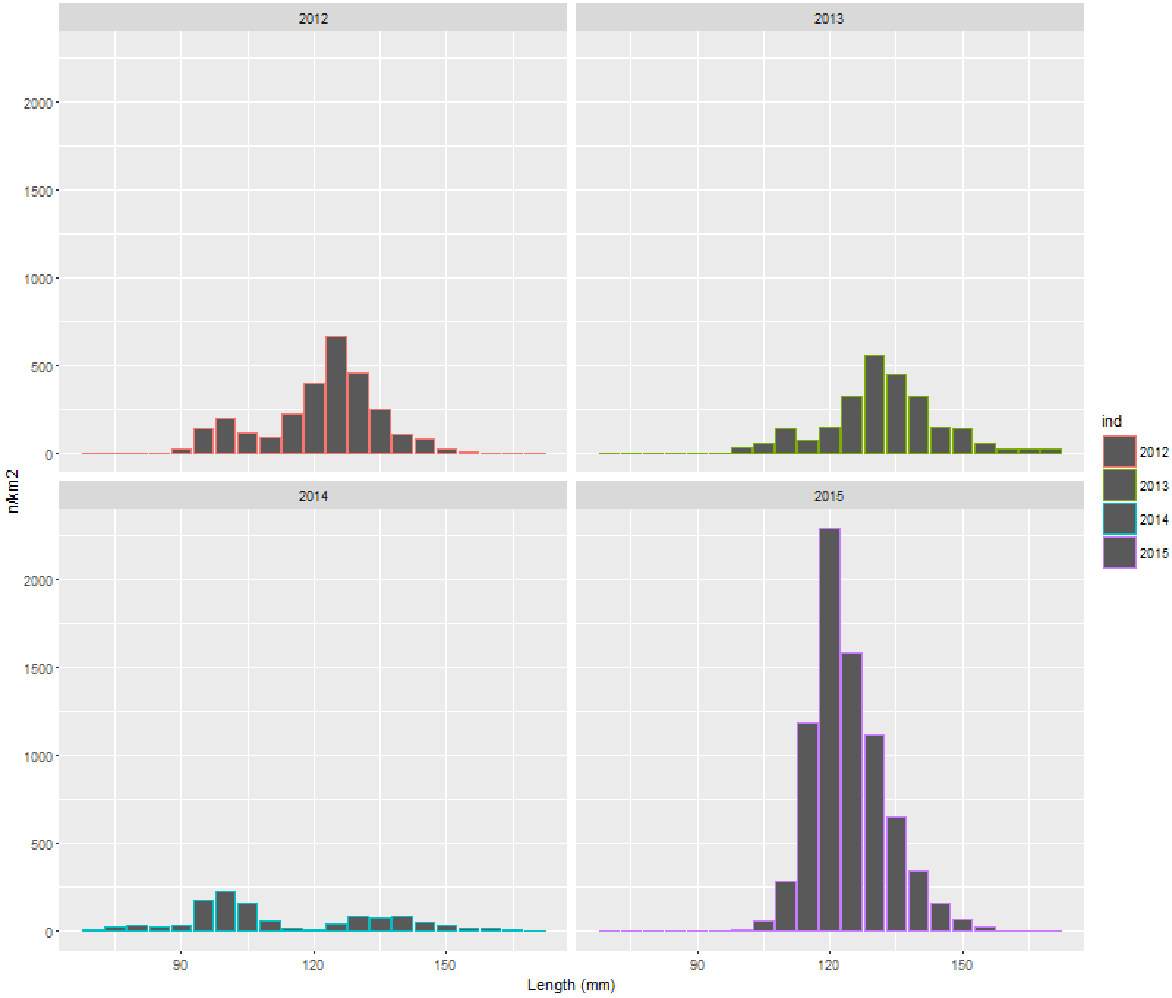


Figure 6.14.4.3. European Anchovy in GSA 5. Length-frequency distribution from MEDITS survey.

6.15. DATA GATHERING OF SARDINE IN GSA 11

6.15.1. Stock Identity and Biology

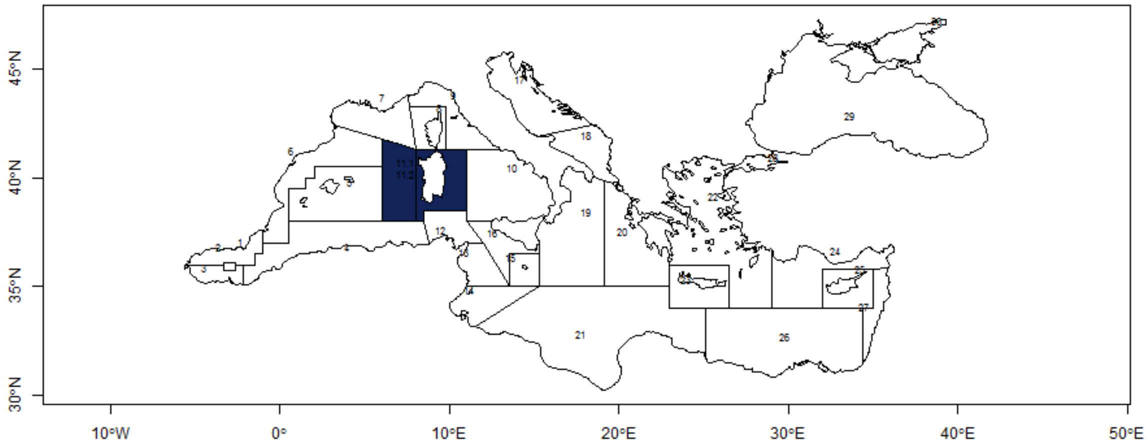


Figure 6.15.1.1. Geographical location of GSA 11

There is limited information available on the stock of European pilchard (*Sardina pilchardus*) in GSA 11. The StockMed project results suggest the sardine population in GSA 11 belongs to the stock unit encompassing GSAs 8 - 11, 15, 16, majority of GSA 19 and a part of GSA 7. However, the examined stock units are considered unreliable by the StockMed and further corroboration of this hypothesis in the future is suggested. (Fig. 6.15.1.2, Fiorentino et al. 2014)

On the other hand, known hydrological exchanges between the Gulf of Lions and the Catalan Sea probably affect larval transport and recruitment of juvenile sardine in both areas. Similarly, part of the young recruited in the Gulf of Lions sardine population may come from larval transport from spawners in the Ligurian Sea. Furthermore, preliminary genetic analyses have shown no differences between Spanish and French stocks of sardines in the North-Western Mediterranean Sea. Finally, the stock is shared between French (trawlers and purse seines) and Spanish (purse seines) fleets. (STECF EWG 13-19)

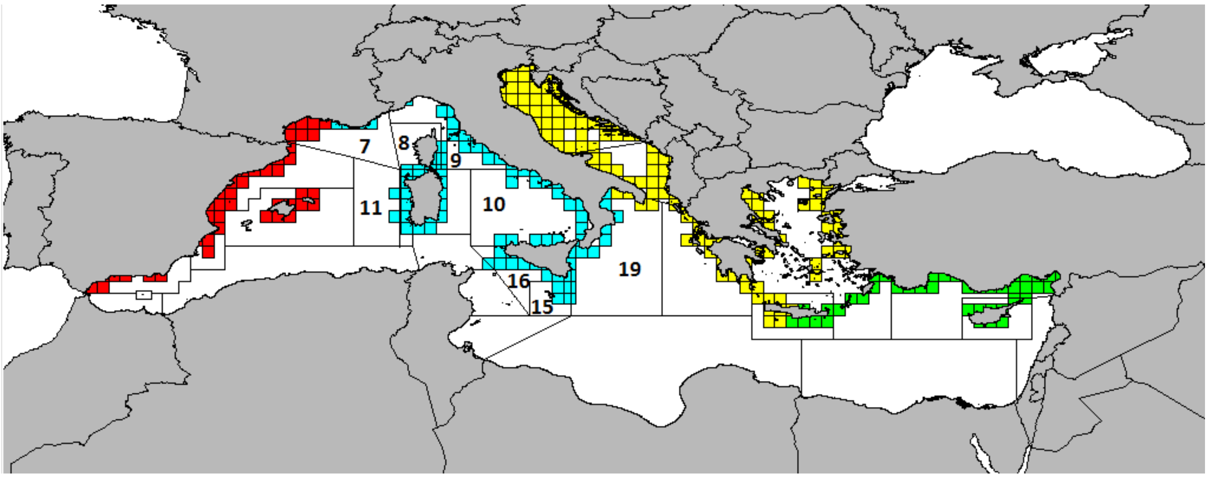


Figure 6.15.1.2Stock unit identification for *Sardina pilchardus* (source: StockMed Data Viewer).

Age and growth

Maximum reported size for sardine according to FishBase is 27.5 cm TL, but this value varies extensively and has been estimated much lower for some Mediterranean GSAs. The species can live up to 15 years, although a maximum age of 8 years is a more realistic estimate for the Mediterranean (Sinovčić, 2000).

There was no information on sardine age or growth parameters for GSA 10 in the DCF data base made available to STECF EWG 16-13. A number of growth parameter estimates are available in the literature for other GSAs (Sinovčić 2000, STECF reports, GFCM reports), however, their potential use for stock assessment of the above defined sardine stock unit needs prior verification since rapid changes in growth, condition, size and age of small pelagic fish in certain areas of the Mediterranean have been observed (Van Beveren et al. 2014).

Maturity

There was no information on sardine maturity for GSA 10 in the DCF data base made available to STECF EWG 16-13.

Sardine has a very fast initial growth, reaching sexual maturity at the end of the first year of life at a length of 12 – 15 cm (Sinovčić 1984, FishBase 2016, MedSudMed 2004). As most of the Clupeidae family, it is a batch-spawner: females emit groups of pelagic eggs asynchronously, with different ovulations during the breeding season (autumn-winter) (Ganias et al., 2004). In the Mediterranean the breeding season is between October and April (Muzinić, 1954; 1984, Morello and Arneri 2009) and the size of first sexual maturity is 12.5 cm (MedSudMed, 2004).

Reproduction occurs both in the open sea and close to shoreline and the hatching of eggs depends strongly on temperature. In the peak of the breeding season each female lays from 11337 to 12667 eggs (Sinovčić, 1983) with a diameter of 1.5 mm.

Feeding

A general pattern of diurnal feeding activity that extends until dusk was observed for sardine in the NW Mediterranean (Costalago & Palomera 2014). Larger sardines (7 cm SL and higher) primarily use filter feeding rather than particulate feeding (Costalago & Palomera 2014), although a shift to particulate feeding could also occur under specific environmental conditions. Sardine larvae are obligate particulate feeders, while juvenile and adult sardine are opportunistic feeders with a more heterogeneous diet. Results of several studies suggest that sardine is essentially non-selective filter-feeder and that its diet reflects the ambient plankton composition (Costalago & Palomera 2014).

Habitat

Sardines are known to distribute in various ecosystems within the temperate zone that largely differentiate in terms of oceanographic characteristics and productivity. Both adult and juvenile sardine prefer shallower and warmer coastal waters and seem to select less stratified, higher salinity waters or otherwise moderate upwelling conditions. In the Mediterranean sardines do not perform long migrations between feeding, spawning and juvenile grounds and the habitat distribution is largely driven by the local productivity patterns. (Bonanno et al. 2014, Giannoulaki et al. 2011, Tugores et al., 2010)

6.15.2. Catch data

Landings and Discards

There are only 2 years of records for the catch of sardine in GSA 11 showing negligible amounts are caught only by bottom trawlers (OTB).

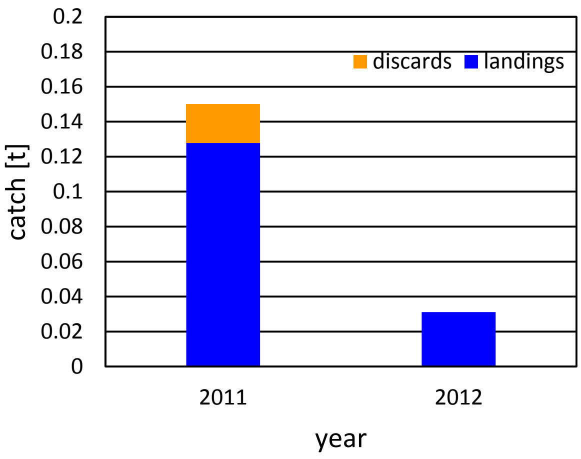
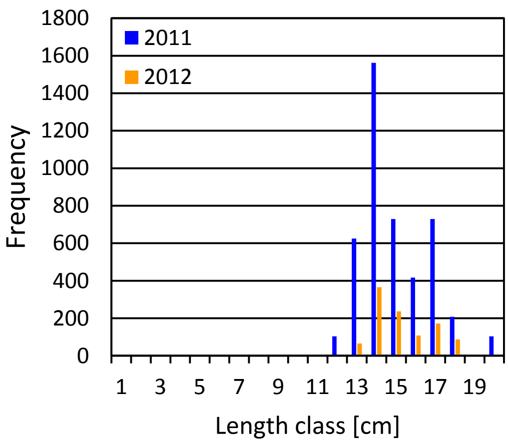


Figure 6.15.2.1Sardine in GSA 11. Available catch (landing, discard) data

Table 6.15.2.1. *Sardine in GSA 11.* Available catch (landing, discard) data.

Year	Gear	Landings [t]	Discards [t]
2011	**OTB**	**0.127831**	**0.022144**
2012	**OTB**	**0.031119**	**0**

Landings at length and catch at age data for sardine in GSA 11 were only available for 2 years and they are presented below (Fig. 6.15.2.2).



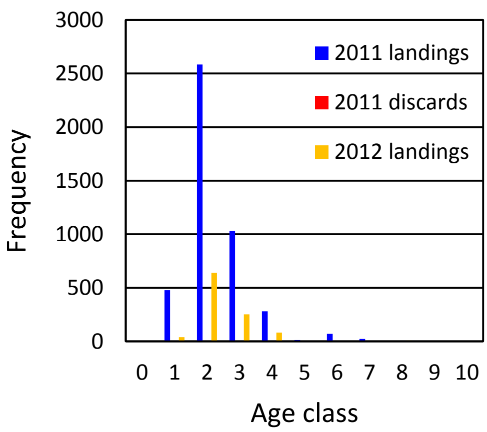


Figure 6.15.2.2. *Sardine in GSA 11.* Available landing at length (left) and catch at age (right) data.

6.15.3. Fishing effort data.

Sardine is only caught by bottom otter trawls (OTB) in GSA 11. Since sardine is by-catch species for this fishing gear and the amounts caught are negligible, the fishing effort data is not expected to reveal any relevant information on the status of this stock.

6.15.4. Survey Indices of abundance and biomass by year and size/age

There were no data available from acoustic surveys for sardine in GSA 11.

The MEDITS survey time series for sardine in GSA 11 was available from 1994 onwards and the trends for this time series are presented below (Fig. 6.15.4.1-3). Even though MEDITS survey is not targeted at small pelagic species, it has been suggested in some GSAs that MEDITS indices could be indicative of trends in small pelagic stocks. However, further analysis is needed to confirm this hypothesis for the stock unit in question.

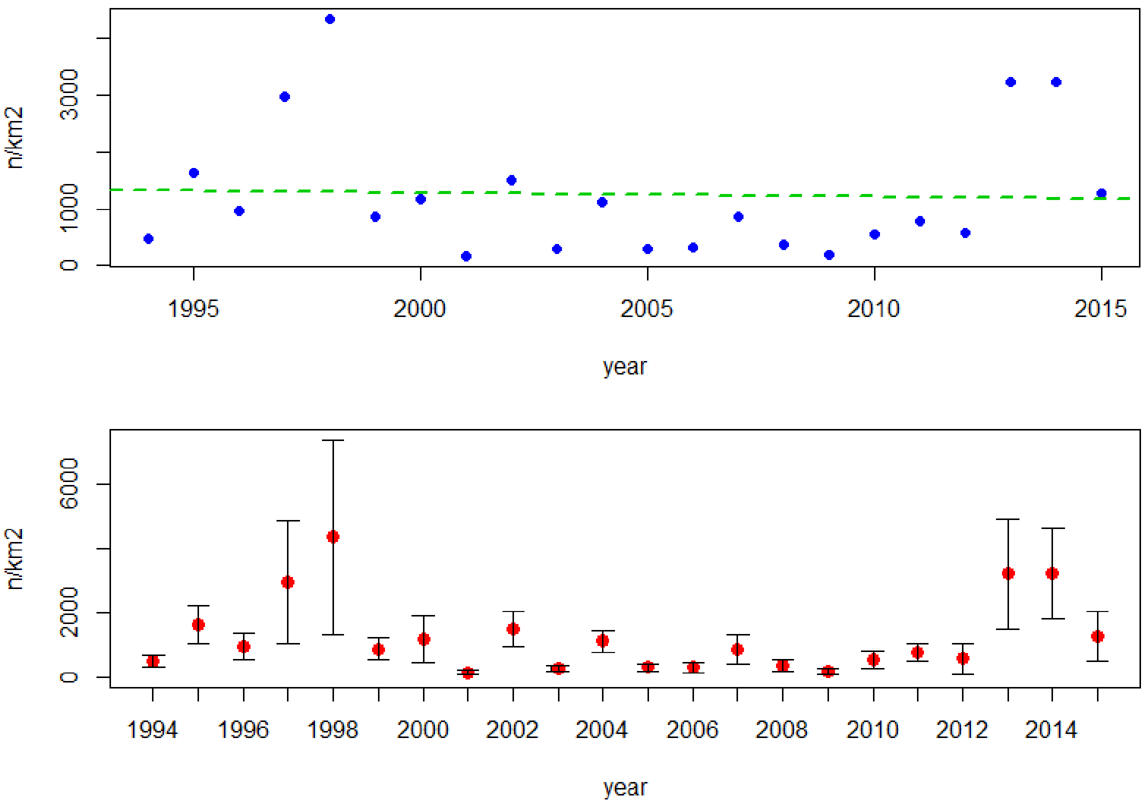


Figure 6.15.4.1. Sardine in GSA 11. MEDITS density index by year.

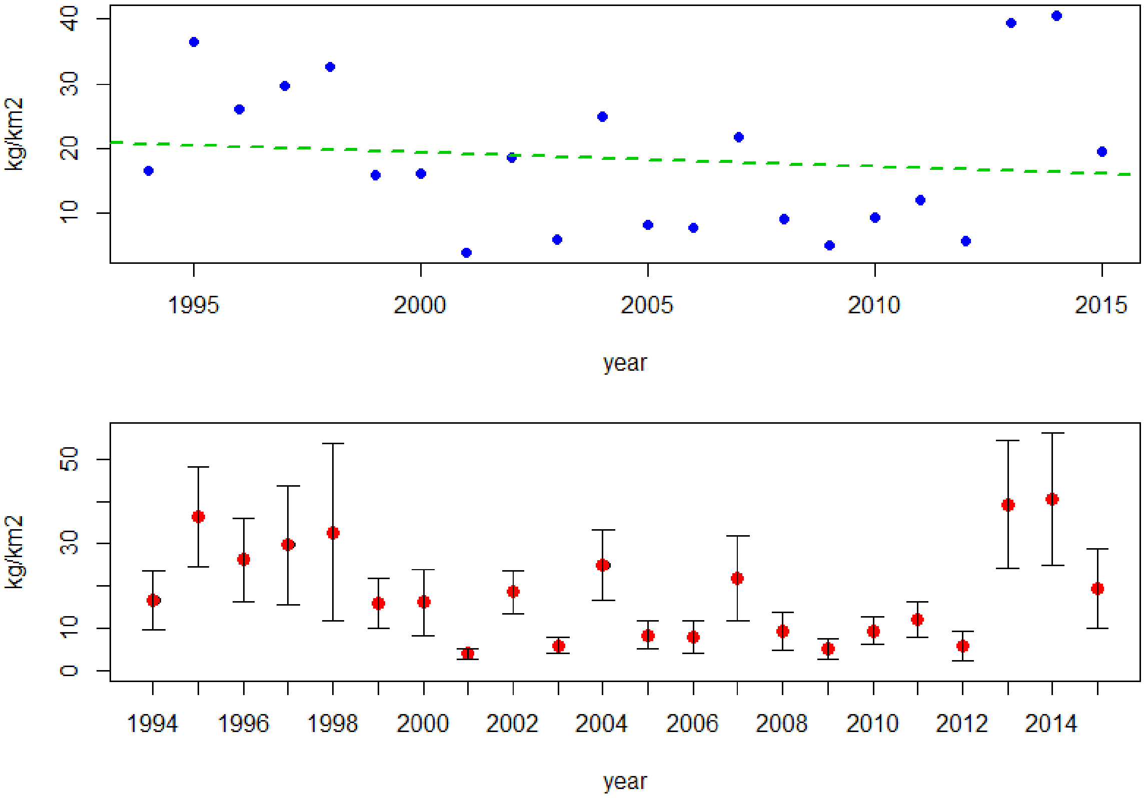


Figure 6.15.4.2. Sardine in GSA 11. MEDITS biomass index by year.

The length-frequency data from MEDITS survey for sardine in GSA 11 was only available since 2012 (Fig. 6.15.4.3).

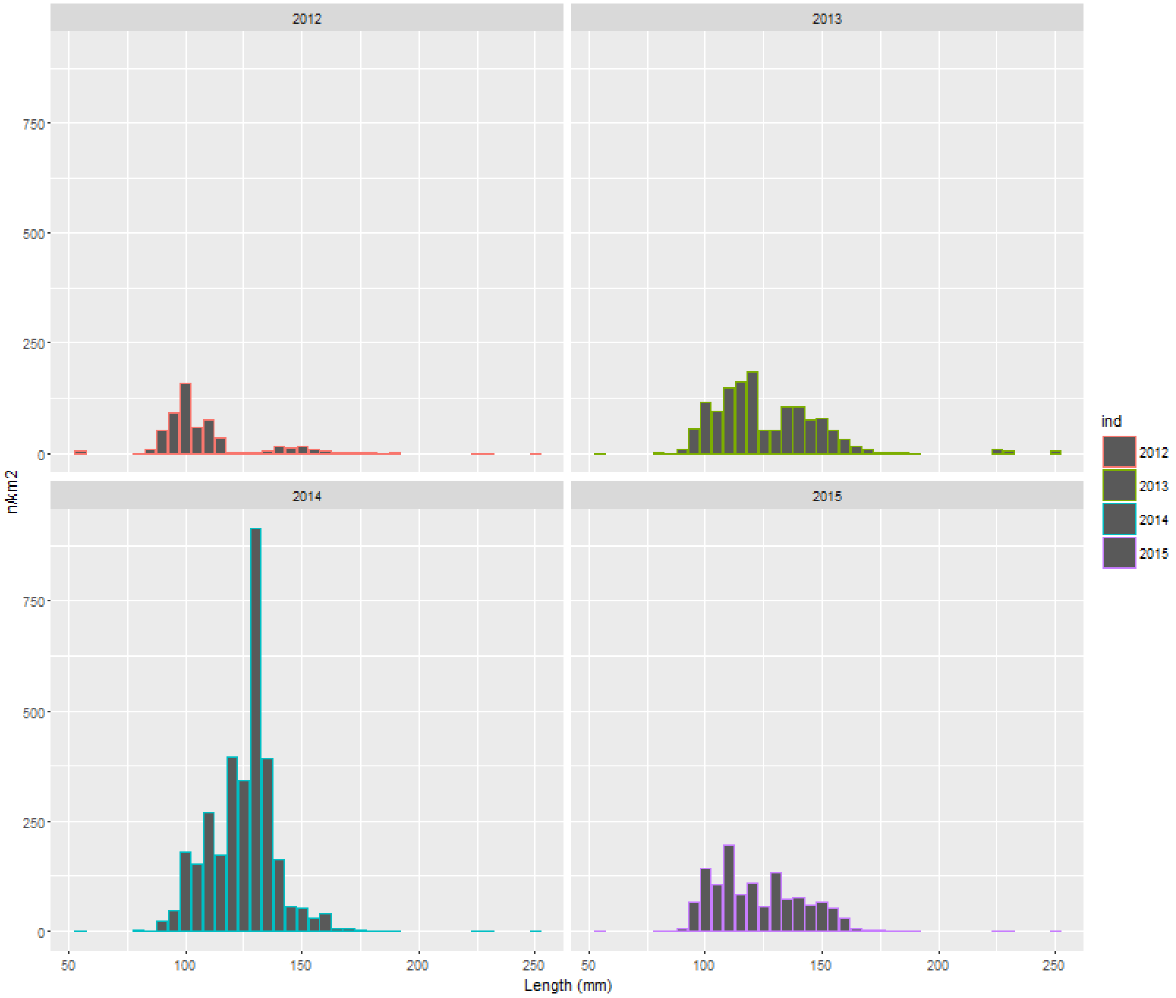


Fig. 6.15.4.3 Sardine in GSA 11. MEDITS abundance index size structure by year for sardine in GSA 11.

6.16. DATA GATHERING OF EUROPEAN ANCHOVY IN GSA 11

6.16.1. Stock Identity and Biology

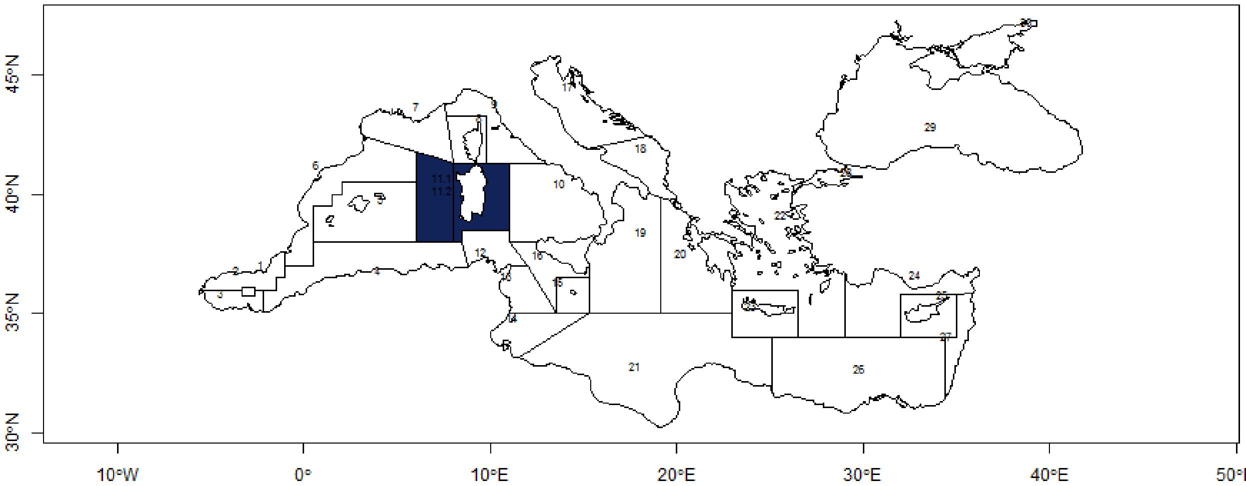


Figure 6.16.1.1. Geographical location of GSA 11

There is limited information available on the stock of European anchovy (*Engraulis encrasicolus*) in GSA 11. The fairly reliable StockMed project results suggest the local anchovy stock is confined to GSA 11 and a small part of GSA 9 (Fig 6.16.1.2, Fiorentino et al. 2014).

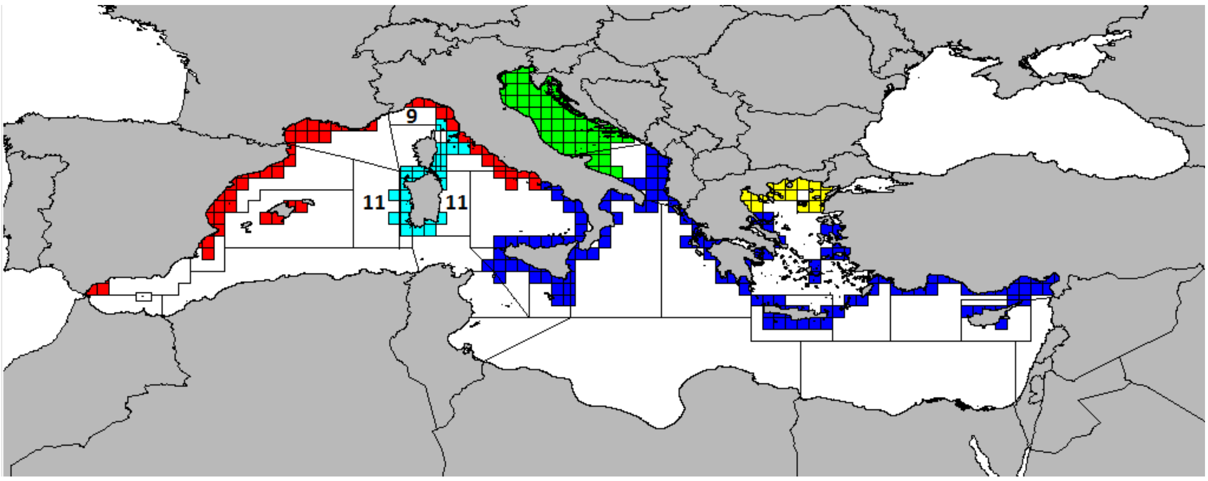


Figure 6.16.1.2. Stock unit identification for *Engraulis encrasicolus* (source: StockMed Data Viewer).

There was no information on age structure, growth, maturity or natural mortality for anchovy in GSA 11 in the DCF data base made available to STECF EWG 16-13.

Feeding

Adult anchovy tend to use particulate feeding when food concentration is relatively scarce, but shift to filter feeding under higher food concentrations (Bulgakova 1996). However, juvenile anchovy keep feeding predominantly on zooplankton rather than phytoplankton regardless the planktonic composition and food concentration in the environment. The predatory behaviour observed in anchovy, preying on relatively large and abundant plankton (Copepods) supports the theory that anchovy juveniles are particle feeders rather than filter feeders. At least during winter anchovy juveniles prey only on zooplankton. (Costalago & Palomera 2014b)

Habitat

Anchovy mostly occurs in depths of up to 100 m. It prefers areas with lower salinity values typically influenced by deep water masses and/or riverine outflows. Anchovy is most abundant in less stratified waters associated with moderate upwelling and downwelling processes. The shallow waters over the continental shelf meet suitable conditions for high photosynthesis levels; such areas coincide with different circulation patterns that enhance productivity and subsequently food availability for anchovy. (Bonanno et al. 2014)

6.16.2. Catch data

There were no catch data for anchovy in GSA 11 in the DCF data base made available to STECF EWG 16-13, hence no data could be presented.

6.16.3. Fishing effort data.

Since there was no catch data for anchovy in GSA 11, it was also not possible to present relevant effort data.

6.16.4. Survey Indices of abundance and biomass by year and size/age

There were no data available from acoustic surveys for anchovy in GSA 11.

The MEDITS survey time series for anchovy in GSA 11 was available from 1994 onwards and the trends for this time series are presented below (Fig. 6.16.4.1-3). Even though MEDITS survey is not targeted at small pelagic species, it has been suggested in some GSAs that MEDITS indices could be indicative of trends in small pelagic stocks. However, further analysis is needed to confirm this hypothesis for the stock unit in question.

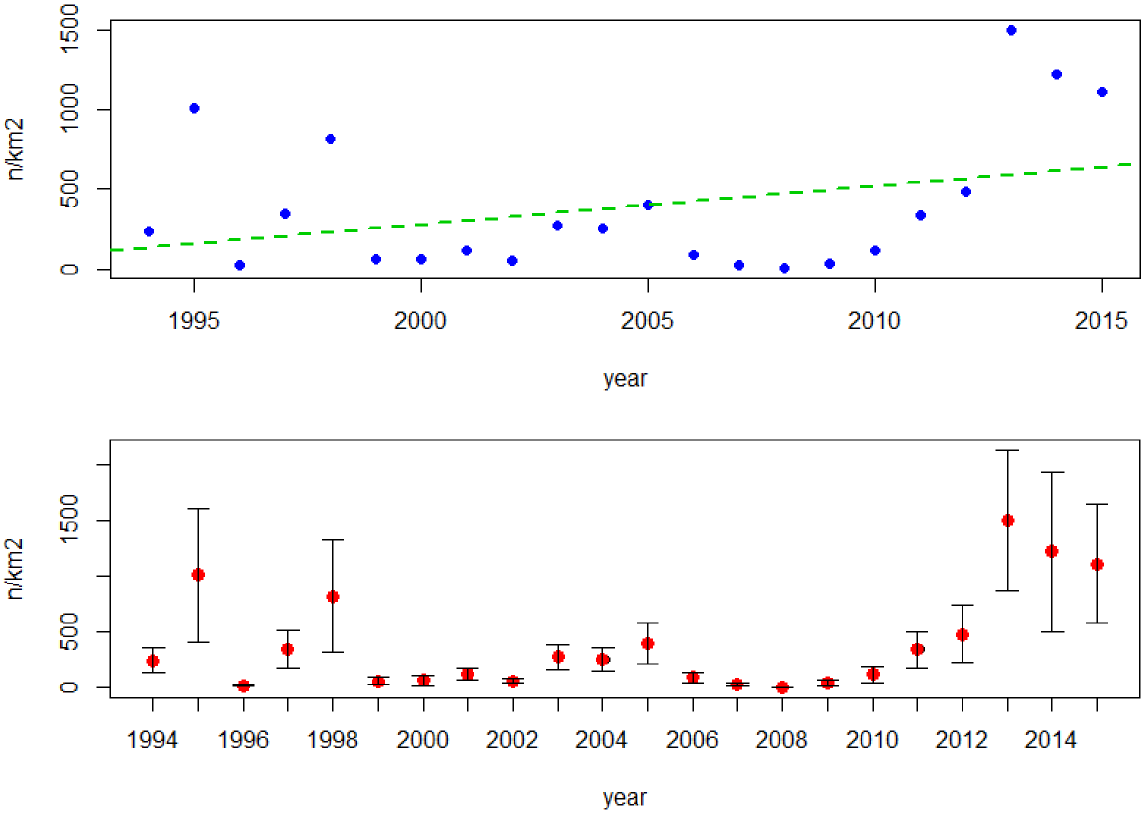


Figure 6.16.4.1 European Anchovy in GSA 11. MEDITS density index by year.

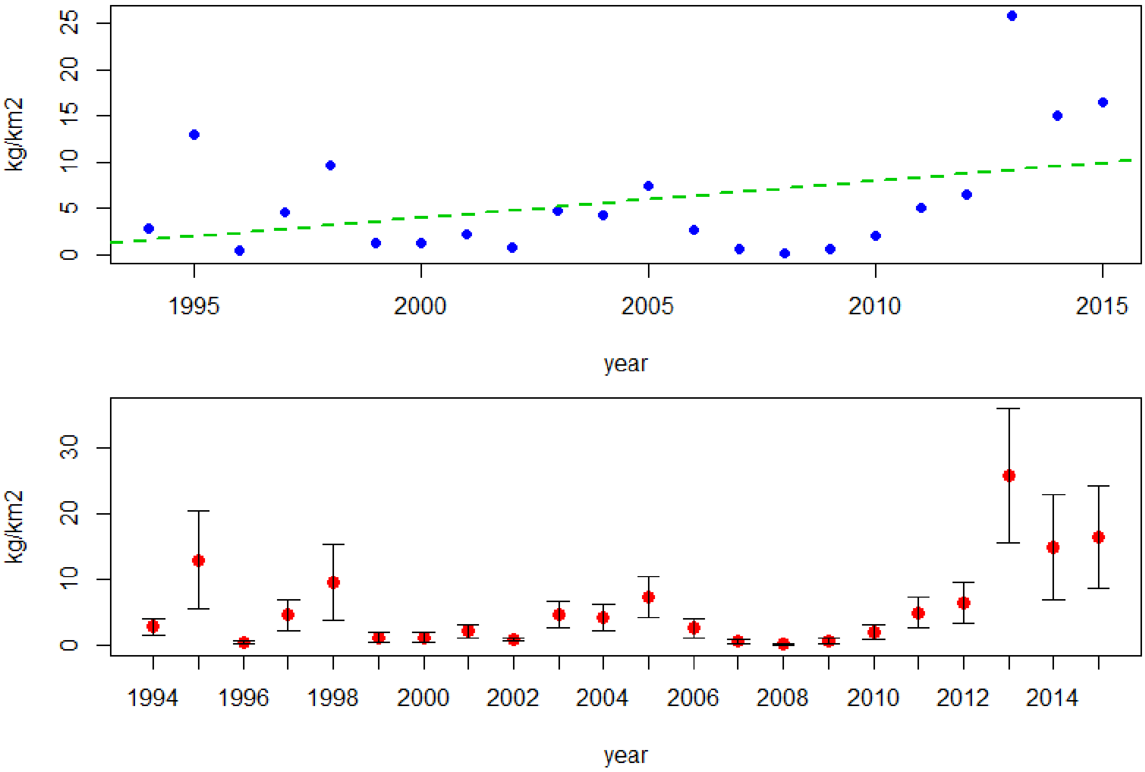


Figure 6.16.4.2. European Anchovy in GSA 11. MEDITS biomass index by year.

There were 4 years of length-frequency distribution data from MEDITS survey available for anchovy in GSA 11 (Fig. 6.16.4.3).

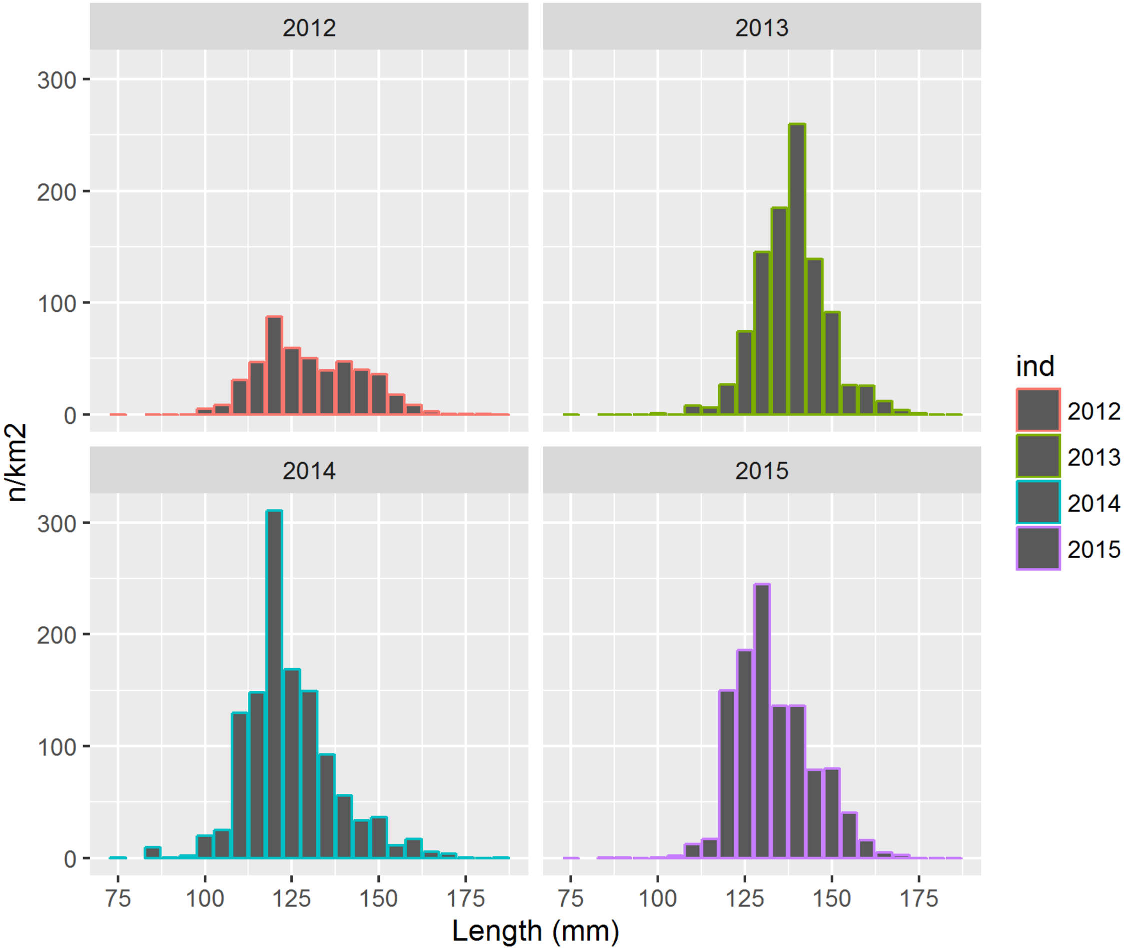


Figure 6.16.4.3. European Anchovy in GSA 11Length-frequency distribution from MEDITS survey by year.

6.17. DATA GATHERING ON SCOMBER SPP. IN GSAs 1, 5, 6 and 7

6.17.1. Stock Identity and Biology

Scomber scombrus (MAC) was examined together with *Scomber japonicus* (MAS) because the majority of catch data available in the DCF referred to the genus level (*Scomber* spp. - MAZ).

Examination of the population genetic structures of *S. scombrus* and *S. japonicus* by Zardoya et al. (2004) suggested an extensive gene flow between the Mediterranean Sea and Atlantic Ocean populations of *S. japonicus*, which are organized into a larger panmictic unit. By contrast, Mediterranean Sea populations of *S. scombrus* showed some degree of genetic differentiation between the eastern and western Mediterranean, with specimens from GSAs 13, 17, 18, 19 and

22 being clearly separated from specimens from GSA 6, the latter forming a panmictic unit with eastern Atlantic Ocean populations.

Here the *Scomber* spp. stocks in GSAs 1, 5, 6 and 7 were examined (Fig. 6.17.1.1)

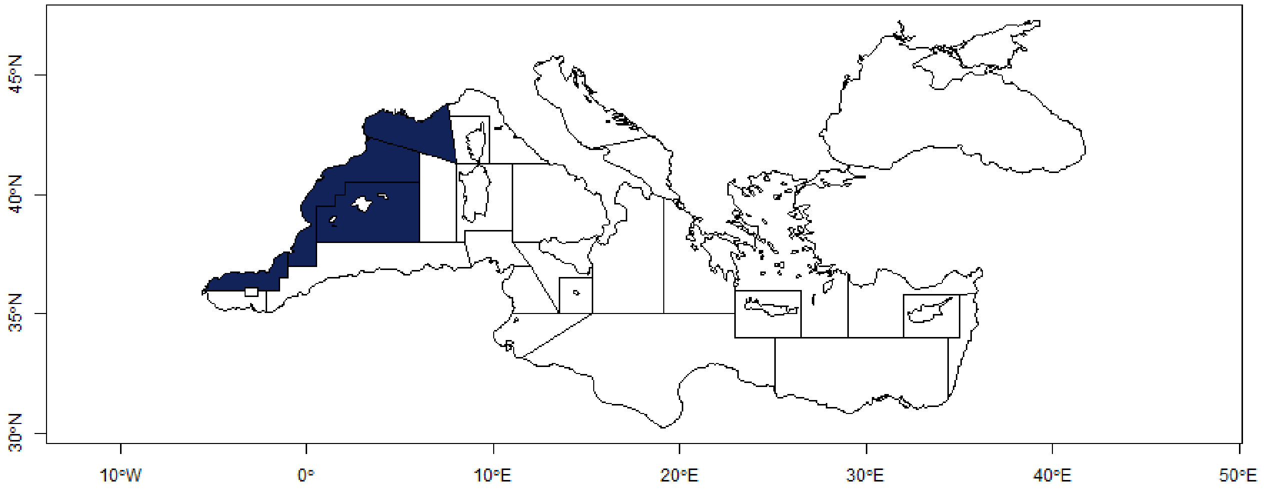


Figure 6.17.1.1. Geographical location of GSAS 1,5,6,7.

Age and growth

According to the DCF, the von Bertalanffy growth parameters for *Scomber* spp. are Linf = 40 cm, K = 0.28 y^{-1}, and t = -0.2 y. These values have been estimated for GSA 6 in 2013. No growth parameters are available for the other Mediterranean GSAs.

Maturity

Proportions of mature fish (Scomber spp.) per age-class were available for GSA 6 in 2013 as following:

Age (y)	**0**	**1**	**2**	**3**	**4**	**5**
Proportion mature	**0.051**	**0.227**	**0.617**	**0.899**	**0.98**	**0.996**

Feeding & habitat

S. scombrus and *S. japonicus* are pelagic, migratory and schooling species. They are mainly diurnal, feeding on zooplankton and small fish (Collette et al. 2016). Both Scomber species occupy a key position in the trophic chain of the Mediterranean Sea ecosystems, as they are an important element of the diet of larger pelagic fish (e.g. tuna, swordfish, and sharks) and sea mammals (e.g. dolphins and seals) (Zardoya et al. 2004).

6.17.2. Catch data

Landings

The majority of *Scomber* spp. landings in the western Mediterranean Sea come from GSAs 1 and 6 (Fig. 6.17.2.1, Table 6.17.2.1). In the period 2002-2015 there was a peak in landings in 2005 which was followed by a decreasing trend. The majority of the landings came from purse seines (PS), followed by bottom otter trawls (OTB) (Fig. 6.17.2.2; Table 6.17.2.2)

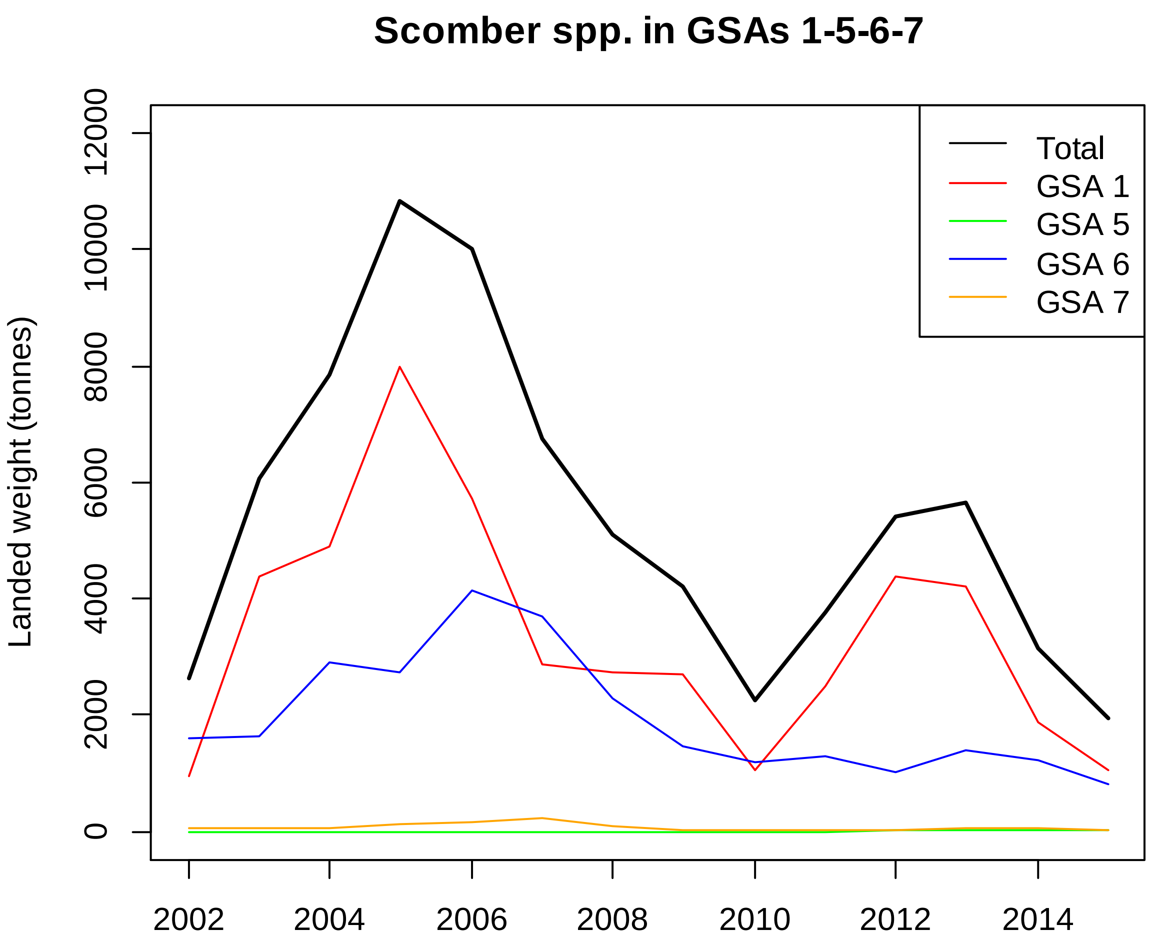


Figure 6.17.2.1. Scomber spp. In GSAS 1,5,6,7. Landings in 2002-2015

Table 6.17.2.1 Scomber spp. In GSAS 1,5,6,7. Landings in 2002-2015.

Year	Area	Landings weight (tonnes)	Total landings weight (tonnes)
2002	GSA 1	965.11	2617.5
	GSA 5	0	
	GSA 6	1587.34	
	GSA 7	65.05	
2003	GSA 1	4385.24	6073.04
	GSA 5	0	
	GSA 6	1634.21	
	GSA 7	53.59	
2004	GSA 1	4909.95	7853.38
	GSA 5	0	
	GSA 6	2895.22	
	GSA 7	48.21	
2005	GSA 1	7993.36	10834.59
	GSA 5	0	
	GSA 6	2733.64	
	GSA 7	107.59	
2006	GSA 1	5736.36	10030.57
	GSA 5	0	
	GSA 6	4128.32	
	GSA 7	165.89	
2007	GSA 1	2855.74	6755.82
	GSA 5	0	
	GSA 6	3682.47	

	GSA 7	217.61	
2008	GSA 1	2751.05	5120.74
	GSA 5	0	
	GSA 6	2277.95	
	GSA 7	91.74	
2009	GSA 1	2715.73	4214.06
	GSA 5	0	
	GSA 6	1474.35	
	GSA 7	23.98	
2010	GSA 1	1039.25	2251.24
	GSA 5	0	
	GSA 6	1198.59	
	GSA 7	13.4	
2011	GSA 1	2480.8	3771.15
	GSA 5	0	
	GSA 6	1278.27	
	GSA 7	12.08	
2012	GSA 1	4372.87	5425.79
	GSA 5	12.36	
	GSA 6	1012.33	
	GSA 7	28.23	
2013	GSA 1	4199.73	5641.25
	GSA 5	23.42	
	GSA 6	1378.45	
	GSA 7	39.65	
2014	GSA 1	1874.9	3284.82
	GSA 5	17.95	
	GSA 6	1218.97	
	GSA 7	173	
2015	GSA 1	1051.52	2023.55
	GSA 5	34.1	
	GSA 6	826.73	

GSA 7	**111.20**

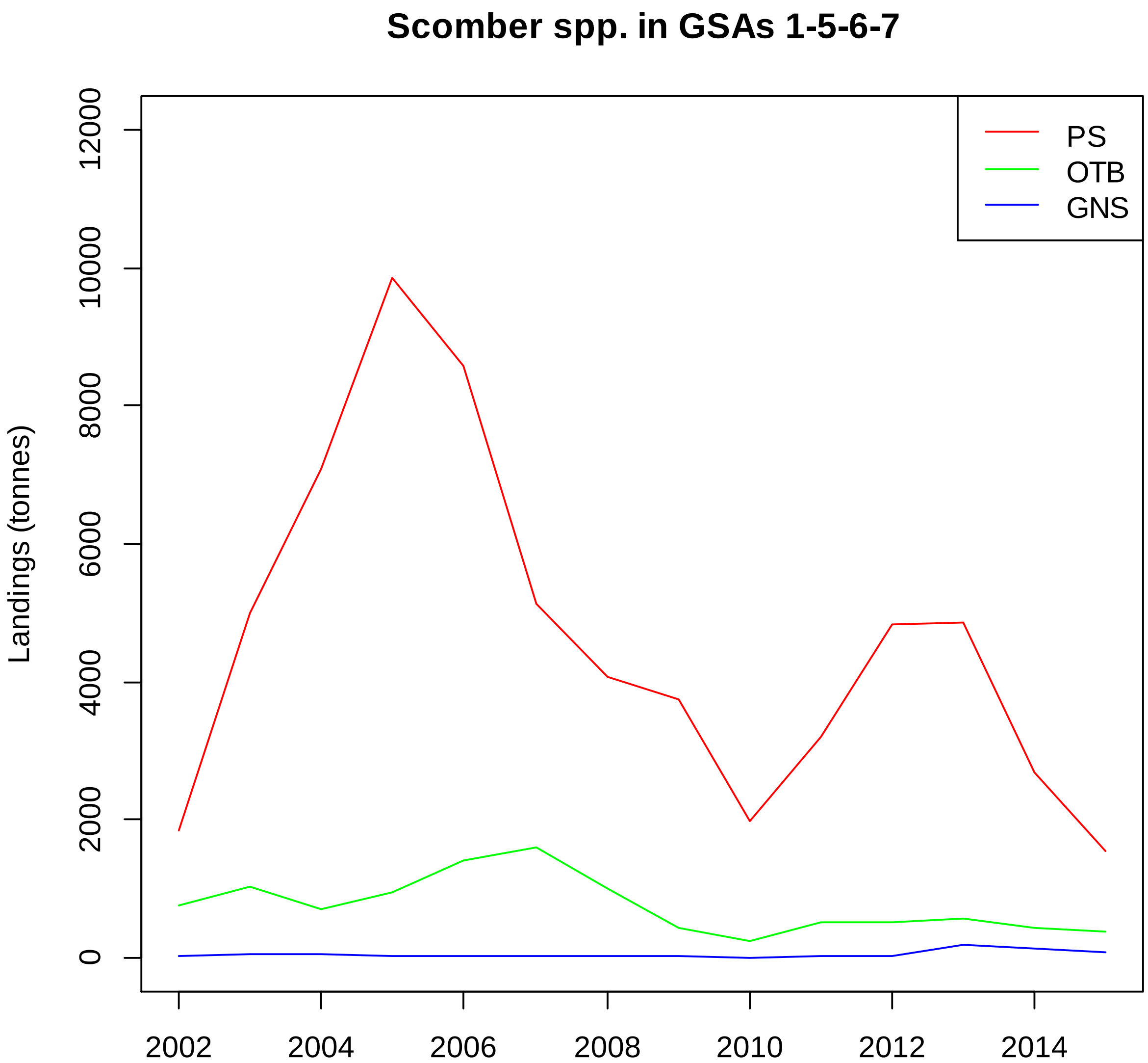


Figure 6.17.2.2. Scomber spp. In GSAS 1,5,6,7. Landings by fishing gear. The first three gears in terms of landings volume are shown. PS: Purse seine; OTB: Bottom otter trawl; GNS: Set gillnet

Table 6.17.2.2. Scomber spp. In GSAS 1,5,6,7 Landings by fishing gear.

Year	Gear	Landings weight (tonnes)	Total landings weight (tonnes)
2002	**PS**	**1833.15**	**2617.5**
	OTB	**761.62**	

	GTR	**3.78**	
	GNS	**18.95**	
2003	**PS**	**4990.55**	**6073.04**
	OTB	**1025.79**	
	GTR	**7.89**	
	GNS	**48.81**	
2004	**PS**	**7095.9**	**7853.38**
	OTB	**705.77**	
	GTR	**11.43**	
	GNS	**40.28**	
2005	**PS**	**9842.31**	**10834.59**
	OTB	**954.49**	
	GTR	**11.41**	
	GNS	**26.38**	
2006	**PS**	**8566.31**	**10030.57**
	OTB	**1415.84**	
	GTR	**11.84**	
	GNS	**36.58**	
2007	**PS**	**5132.21**	**6755.82**
	OTB	**1597.2**	
	GTR	**11.15**	
	GNS	**15.26**	
2008	**PS**	**4077.43**	**5120.74**
	OTB	**1014.52**	
	GTR	**13.43**	
	GNS	**15.36**	
2009	**PS**	**3738.15**	**4214.06**
	OTB	**442.38**	
	GTR	**10.43**	
	GNS	**22.52**	
	LLS	**0.58**	
2010	**PS**	**1992.48**	**2251.24**

	OTB	240.83	
	GTR	6.8	
	GNS	6.65	
	LLS	4.48	
	PS	3192.85	
	OTB	526.55	
2011	GTR	13.48	3771.15
	GNS	32.84	
	LLS	5.43	
	PS	4827.72	
	OTB	499.69	
	GTR	19.23	
2012	GNS	32.11	5425.79
	LLS	3.4	
	FPN	43.64	
	PS	4863.14	
	OTB	568.37	
	GTR	16.72	
2013	GNS	180.85	5641.25
	LLS	4.32	
	FPN	7.85	
	PS	2682.79	
	OTB	434.724	
	LLS	8.64	
2014	GTR	19.98	3284.82
	GNS	138.268	
	FPO	0.423	
	PS	1554.324	
	OTB	371.42	
2015	LLS	3.43	2023.55
	LHP	0.026	
	GTR	24.232	

GNS	**68.611**
GND	**0.015**
FPO	**0.016**
NK	**1.479**

Length frequency distribution of *Scomber* spp. landings from PS suggested the occurrence of smaller fish in GSA 6 compared to GSA 1 in most years (Fig. 6.17.2.3). *Scomber* spp. landings from OTB in GSA 6 (Fig. 6.17.2.4) exhibited generally larger individuals than PS. Length frequency distributions from other GSAs and gears were absent or inconsistent.

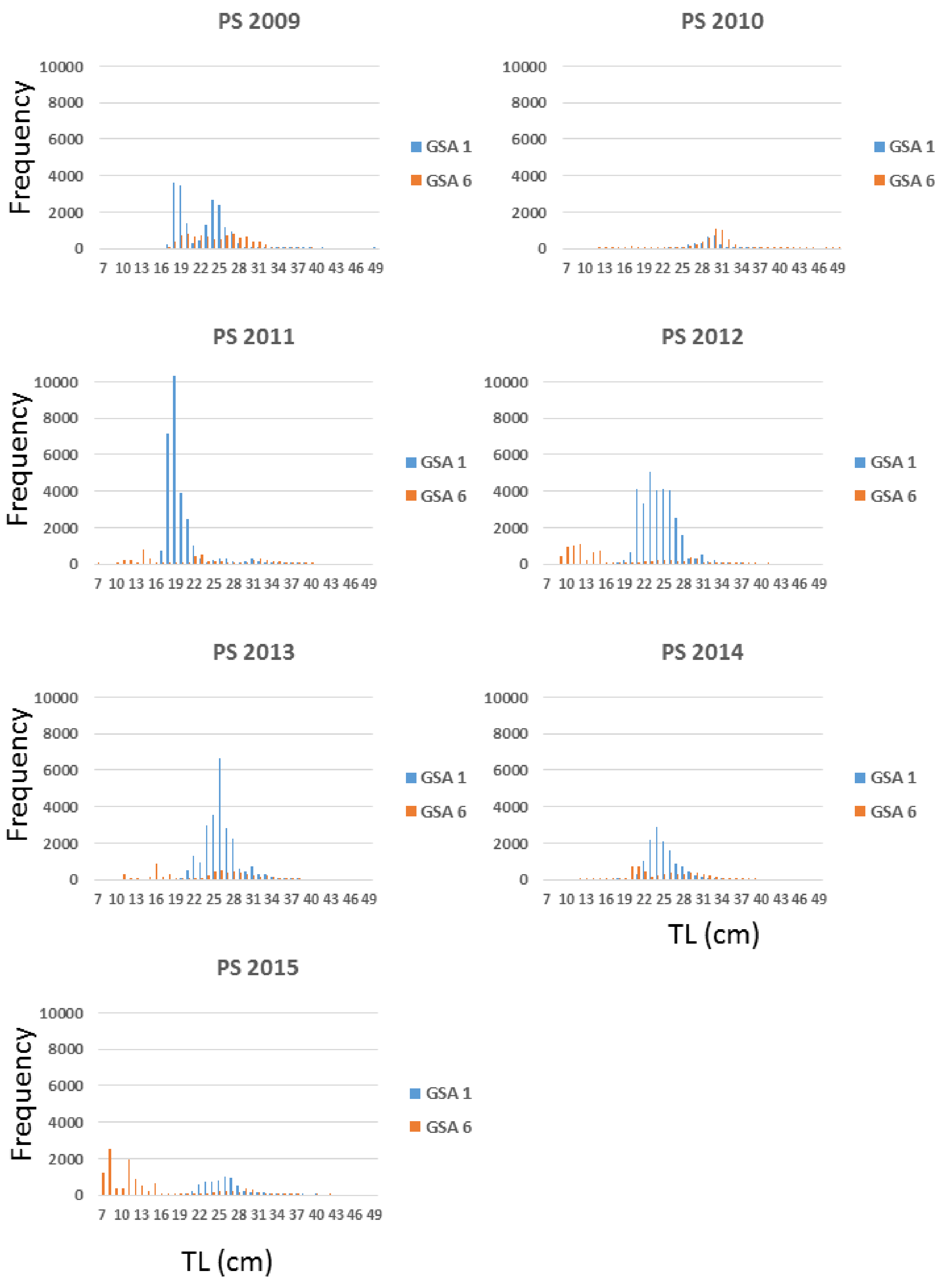


Figure 6.17.2.3. Scomber spp. In GSAS 1,5,6,7 Length frequency distribution (in thousands) of landings from purse seine (PS) in GSAs 1 and 6 in 2009-2015

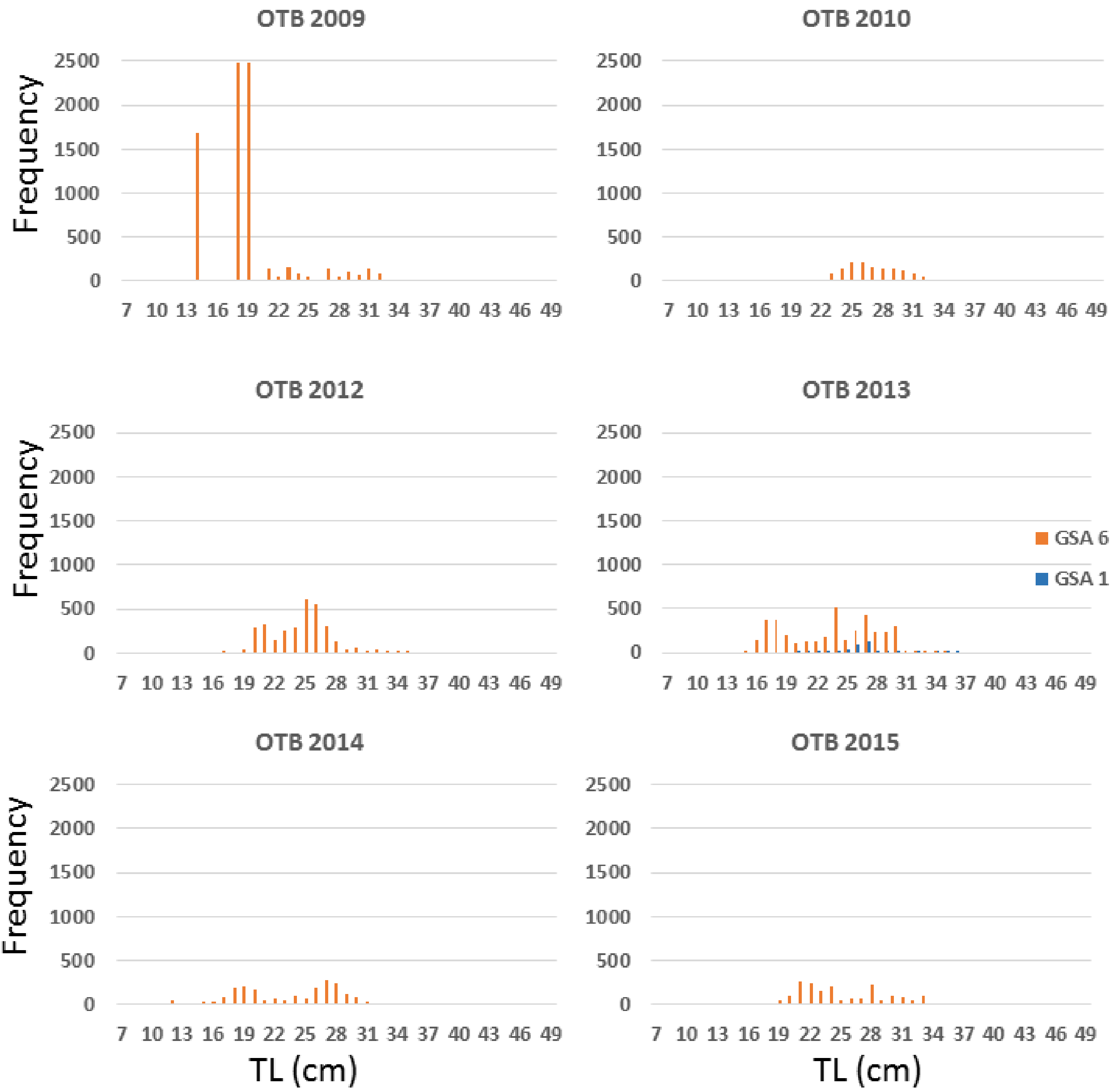


Figure 6.17.2.4. Scomber spp. In GSAS 1,5,6,7 Length frequency distribution (in thousands) of landings from bottom otter trawl (OTB) in GSAs 1 and 6 in 2009-2015. The respective data from GSA 1 were available only for 2013.

The age composition of the landings suggests that the majority of the landed fish caught by PS came from age-class 1 in both GSAs 1 and 6, and in most of the years examined (Fig. 6.17.2.5). Age-class 0 also had a significant contribution to the landings, especially in GSA 6. Landings at age from OTB were generally similar to those from PS in GSA 6 (Fig. 6.17.2.5). Comparing these results with the maturity ogive of *Scomber* spp. (6.17.1) indicates that the landings of *Scomber* spp. are dominated by juveniles.

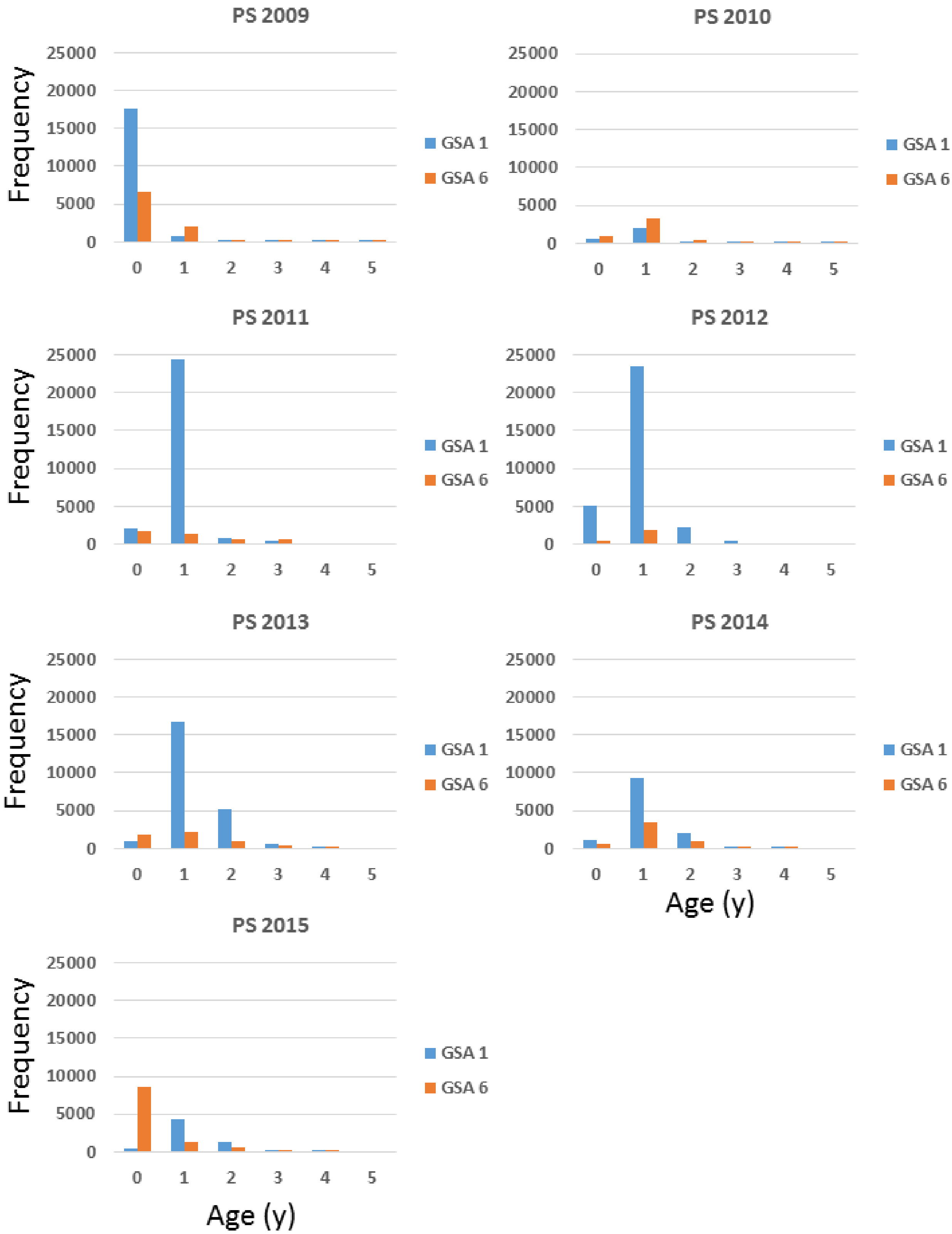


Figure 6.17.2.5. Scomber spp. In GSAS 1,5,6,7 Landings at age (in thousands) from purse seine (PS) in GSAs 1 and 6 in 2009-2015.

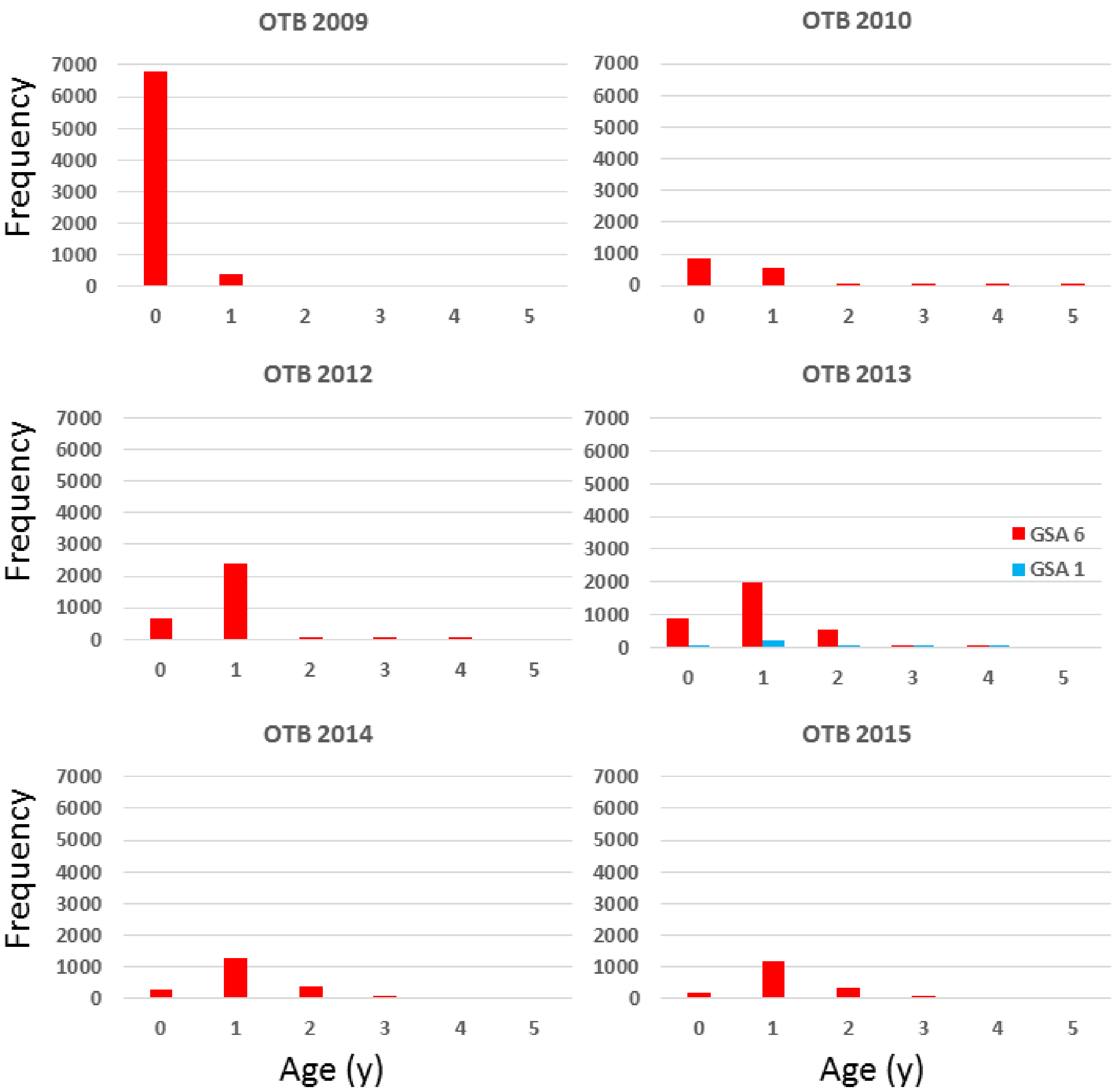


Figure 6.17.2.6. Scomber spp. In GSAS 1,5,6,7. Landings at age (in thousands) from bottom otter trawl (OTB) in GSA 6 in 2009-2015. Relevant data from GSA 1 were only available for 2013.

Discards

Discard data were available for 2009-2015. Same as landings, the majority of discards were reported in GSAs 1 and 6 (Fig. 6.17.2.7, Table 6.17.2.3) and from PS and OTB (Fig. 6.17.2.8, Table 6.17.2.4).

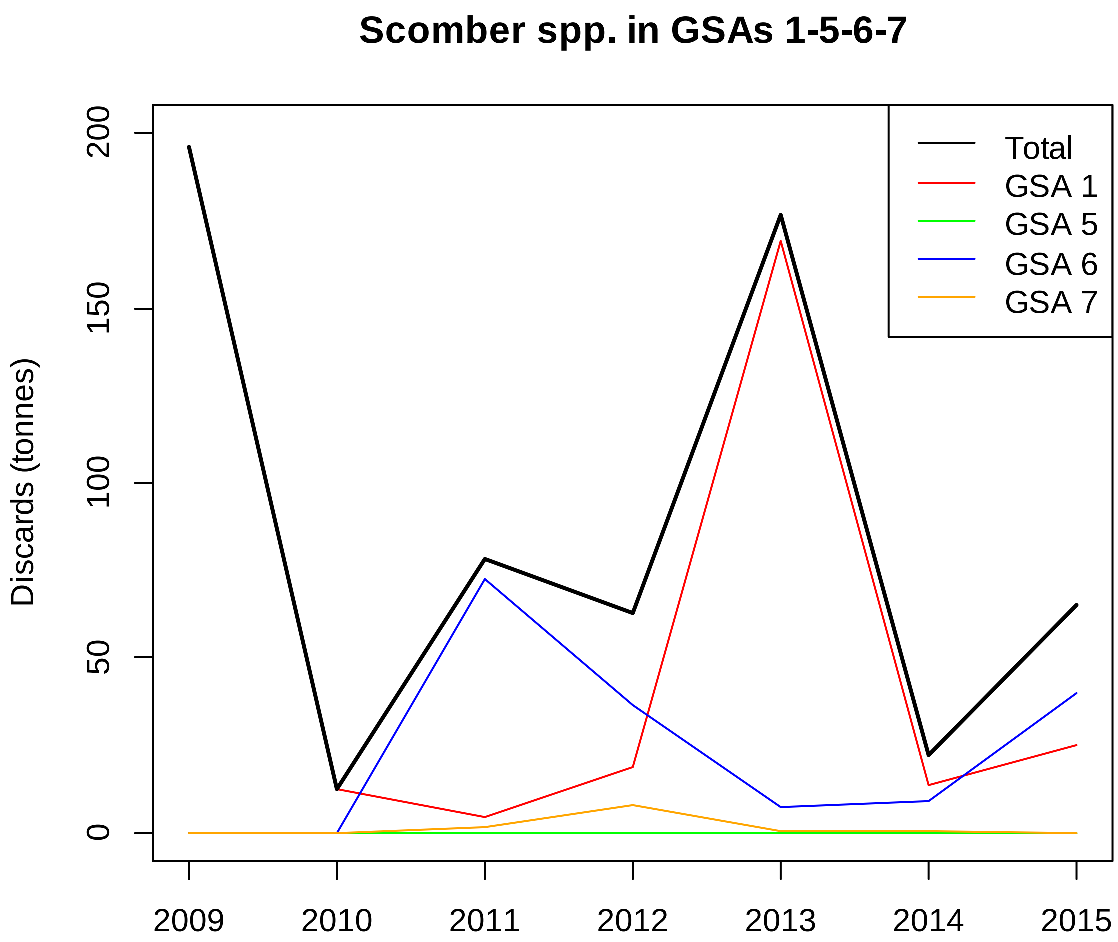


Figure 6.17.2.7. Scomber spp. In GSAS 1,5,6,7. Discards in 2009-2015

Table 6.17.2.3. Scomber spp. In GSAS 1,5,6,7. Discards in 2009-2015

Year	Area	Discards weight (tonnes)	Total discards weight (tonnes)
2009	GSA 1	196.05	196.06
	GSA 5	0	
	GSA 6	0.01	
	GSA 7	0	
2010	GSA 1	12.58	12.59
	GSA 5	0	
	GSA 6	0.01	
	GSA 7	0	
2011	GSA 1	4.07	78.03
	GSA 5	0	

	GSA 6	**72.74**	
	GSA 7	**1.22**	
2012	**GSA 1**	**18.8**	**63.01**
	GSA 5	**0**	
	GSA 6	**36.19**	
	GSA 7	**8.02**	
2013	**GSA 1**	**169.23**	**176.39**
	GSA 5	**0**	
	GSA 6	**6.95**	
	GSA 7	**0.21**	
2014	**GSA 1**	**13.5**	**22.28**
	GSA 5	**0**	
	GSA 6	**8.65**	
	GSA 7	**0.13**	
2015	**GSA 1**	**25.17**	**64.77**
	GSA 5	**0**	
	GSA 6	**39.6**	
	GSA 7	**0**	

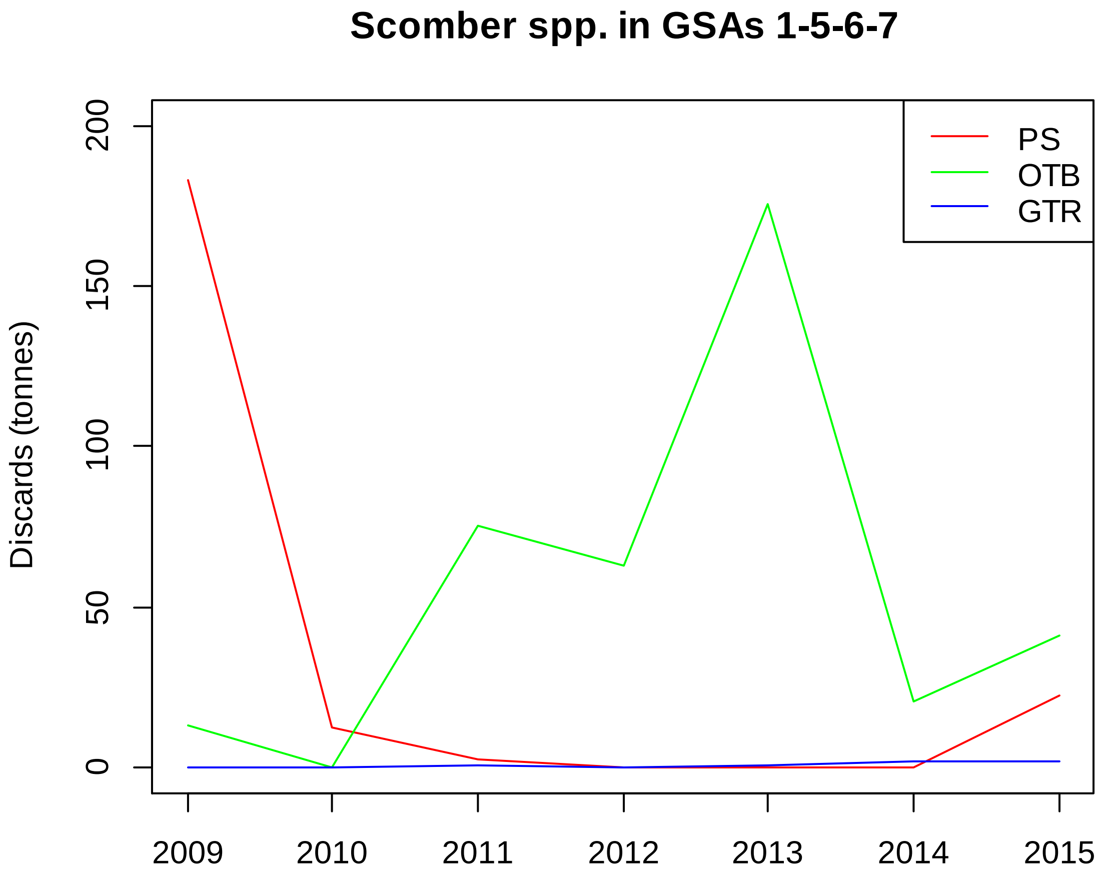


Figure 6.17.2.8. Scomber spp. In GSAS 1,5,6,7 Discards by fishing gear in 2009-2015. The first three gears in terms of discards volume are shown. PS: Purse seine; OTB: Bottom otter trawl; GTR: trammel net

Table 6.17.2.4. Scomber spp. In GSAS 1,5,6,7. Discards by fishing gear in 2009-2015.

Year	Gear	Discards weight (tonnes)	Total discards weight (tonnes)
	GTR	0	
2009	OTB	12.72	196.06
	PS	183.34	
	GTR	0	
2010	OTB	0.01	12.59
	PS	12.58	
	GTR	0.57	
2011	OTB	75.3	78.03
	PS	2.16	
2012	GTR	0.13	63.01

	OTB	**62.88**	
	PS	**0**	
	GTR	**0.72**	
2013	**OTB**	**175.67**	**176.39**
	PS	**0**	
	GTR	**1.55**	
2014	**OTB**	**20.73**	**22.28**
	PS	**0**	
	GTR	**1.41**	
2015	**OTB**	**41.24**	**64.77**
	PS	**22.12**	

6.17.3. Fishing effort data.

Effort of PS, which is the main gear catching *Scomber* spp. in GSAs 1, 5, 6 and 7, remained relatively stable in 2004-2015, while effort of OTB exhibited a slight decrease during the same period (Fig. 6.17.3.1, 6.17.3.2; Table 6.17.3.1). The majority of PS effort was allocated to GSAs 1 and 6 (Fig. 6.17.3.3; Table 6.17.3.2)

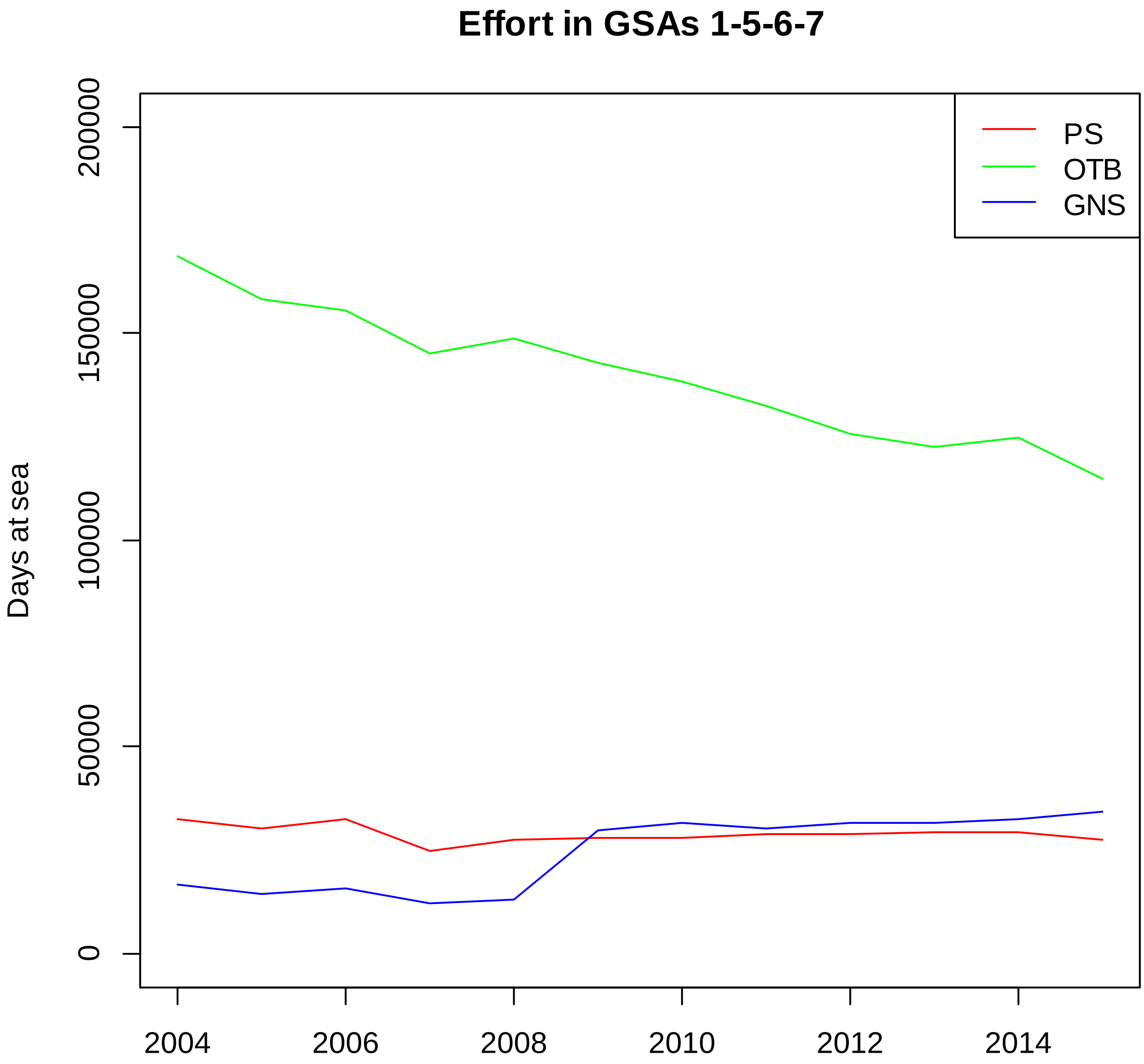


Figure 6.17.3.1. Scomber spp. In GSAS 1,5,6,7. Effort (in days at sea) of the main gears of the Spanish fleet catching *Scomber* spp. in GSAs 1, 5, 6 and 7 in 2004-2015. French effort data were available only for 2015 and were omitted.

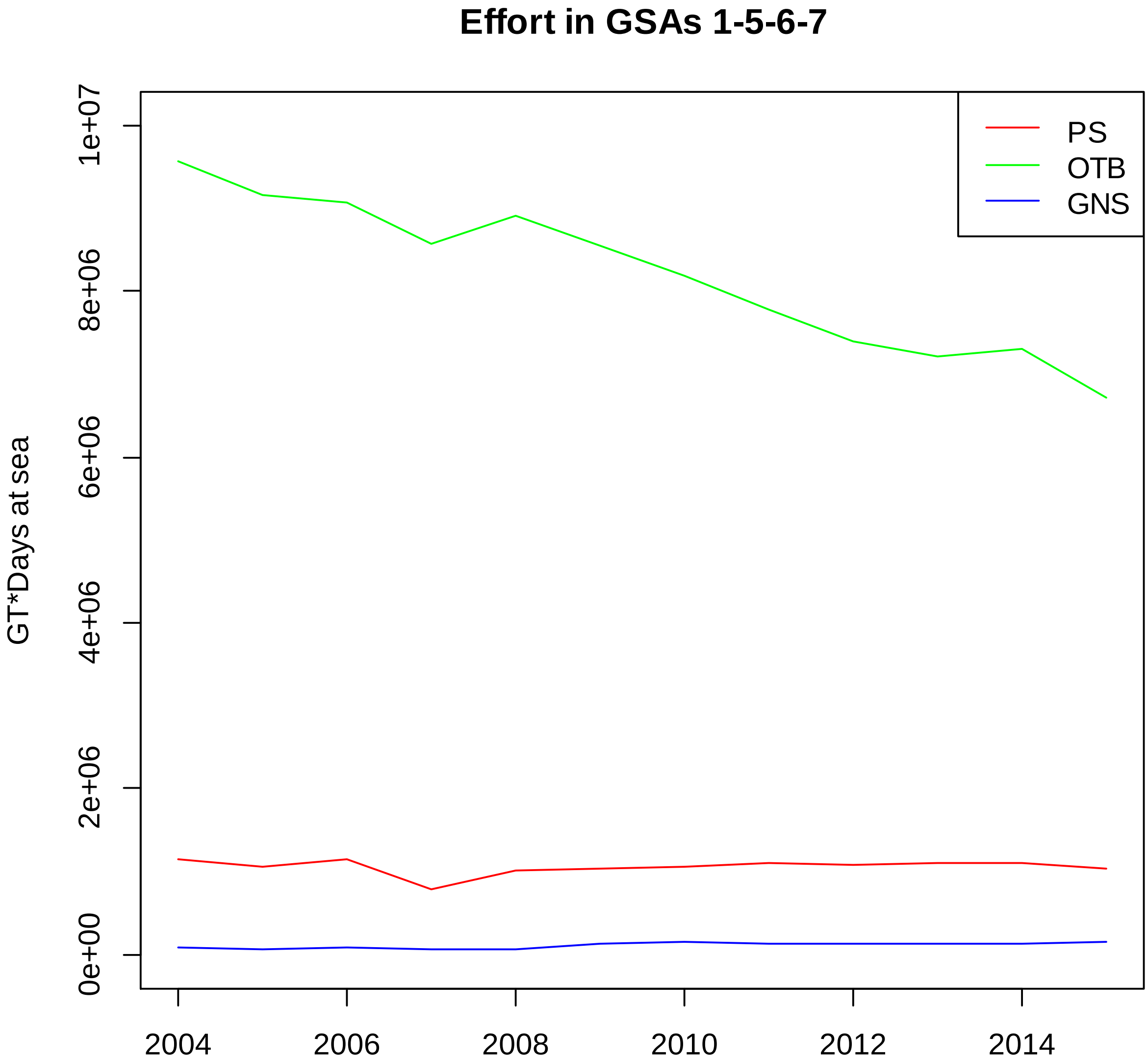


Figure 6.17.3.2. Scomber spp. In GSAS 1,5,6,7. Effort (in GT*days at sea) of the main gears of the Spanish fleet catching *Scomber* spp. in GSAs 1, 5, 6 and 7 in 2004-2015. French effort data were available only for 2015 and were omitted.

Table 6.17.3.1. Scomber spp. In GSAS 1,5,6,7. Effort of the main gears of the Spanish fleet catching *Scomber* spp. in GSAs 1, 5, 6 and 7 in 2004-2015. French effort data were available only for 2015 and were omitted.

Year	Gear	GT*Days at sea	Days at sea
2004	GNS	80364.11	16835
	OTB	9557032	168753
	PS	1141078	32400
2005	GNS	72835.06	14377
	OTB	9157386	158375

	PS	**1069000**	**30339**
	GNS	**79908.01**	**15682**
2006	**OTB**	**9060096**	**155508**
	PS	**1161202**	**32430**
	GNS	**60746.08**	**12364**
2007	**OTB**	**8570525**	**145015**
	PS	**796640.3**	**24831**
	GNS	**64675.37**	**13268**
2008	**OTB**	**8918841**	**148988**
	PS	**1010172**	**27695**
	GNS	**141403.3**	**29637**
2009	**OTB**	**8546535**	**142964**
	PS	**1048601**	**27848**
	GNS	**147632.2**	**31816**
2010	**OTB**	**8189138**	**138250**
	PS	**1067217**	**28048**
	GNS	**131565.7**	**30419**
2011	**OTB**	**7777756**	**132624**
	PS	**1115211**	**29138**
	GNS	**139920.4**	**31680**
2012	**OTB**	**7404322**	**125972**
	PS	**1092198**	**29135**
	GNS	**135987.6**	**31561**
2013	**OTB**	**7206494**	**122776**
	PS	**1098309**	**29543**
	GNS	**142589.9**	**32527**
2014	**OTB**	**7314162**	**124825**
	PS	**1103694**	**29572**
	GNS	**3088453**	**70671.06**
2015	**OTB**	**7676698**	**124725.3**
	PS	**1147357**	**28630.39**

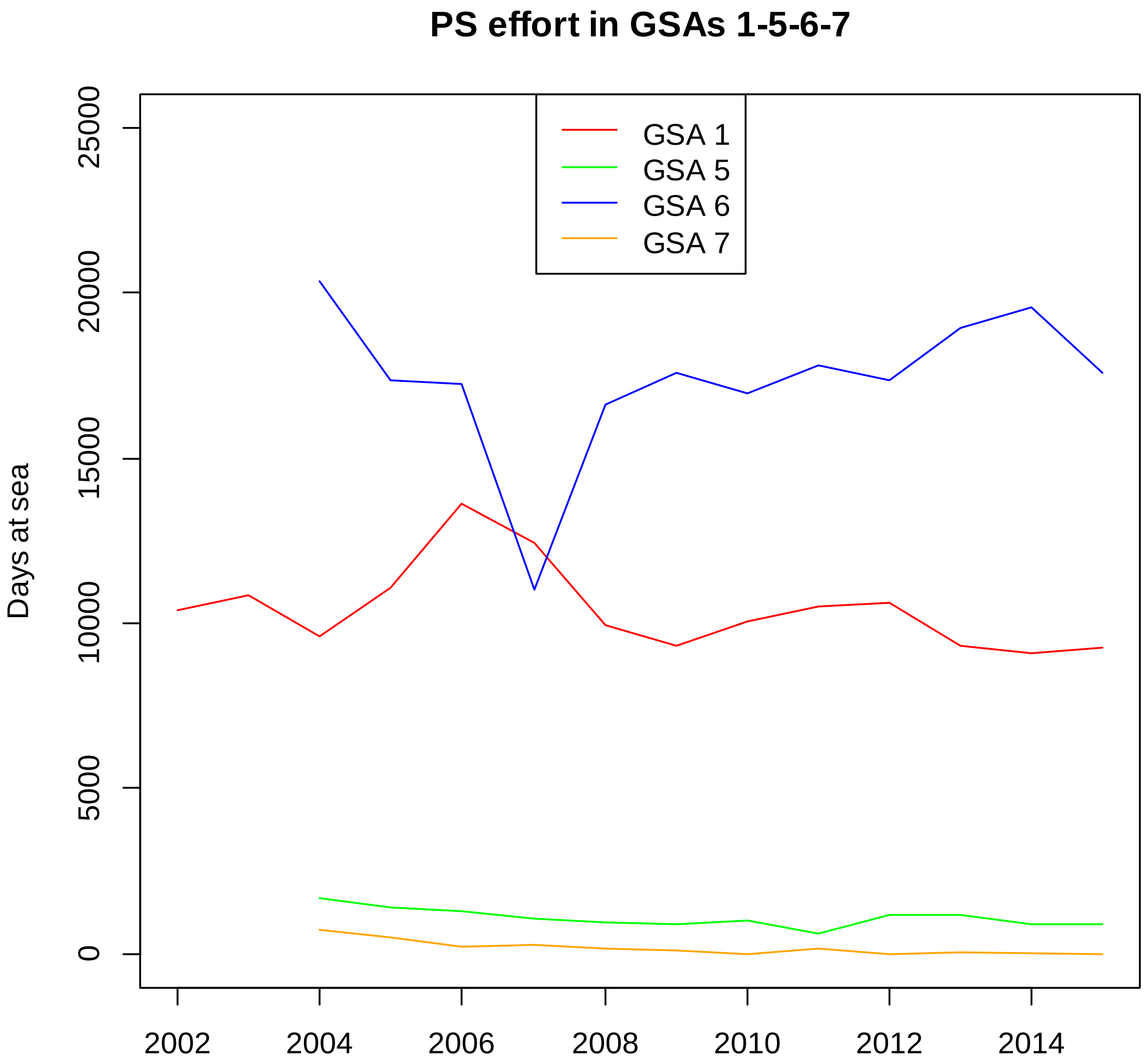


Figure 6.17.3.3. Scomber spp. In GSAS 1,5,6,7. Purse seine (PS) effort (in days at sea) per GSA of the Spanish fleet in 2004-2015. French effort data were available only for 2015 and were omitted.

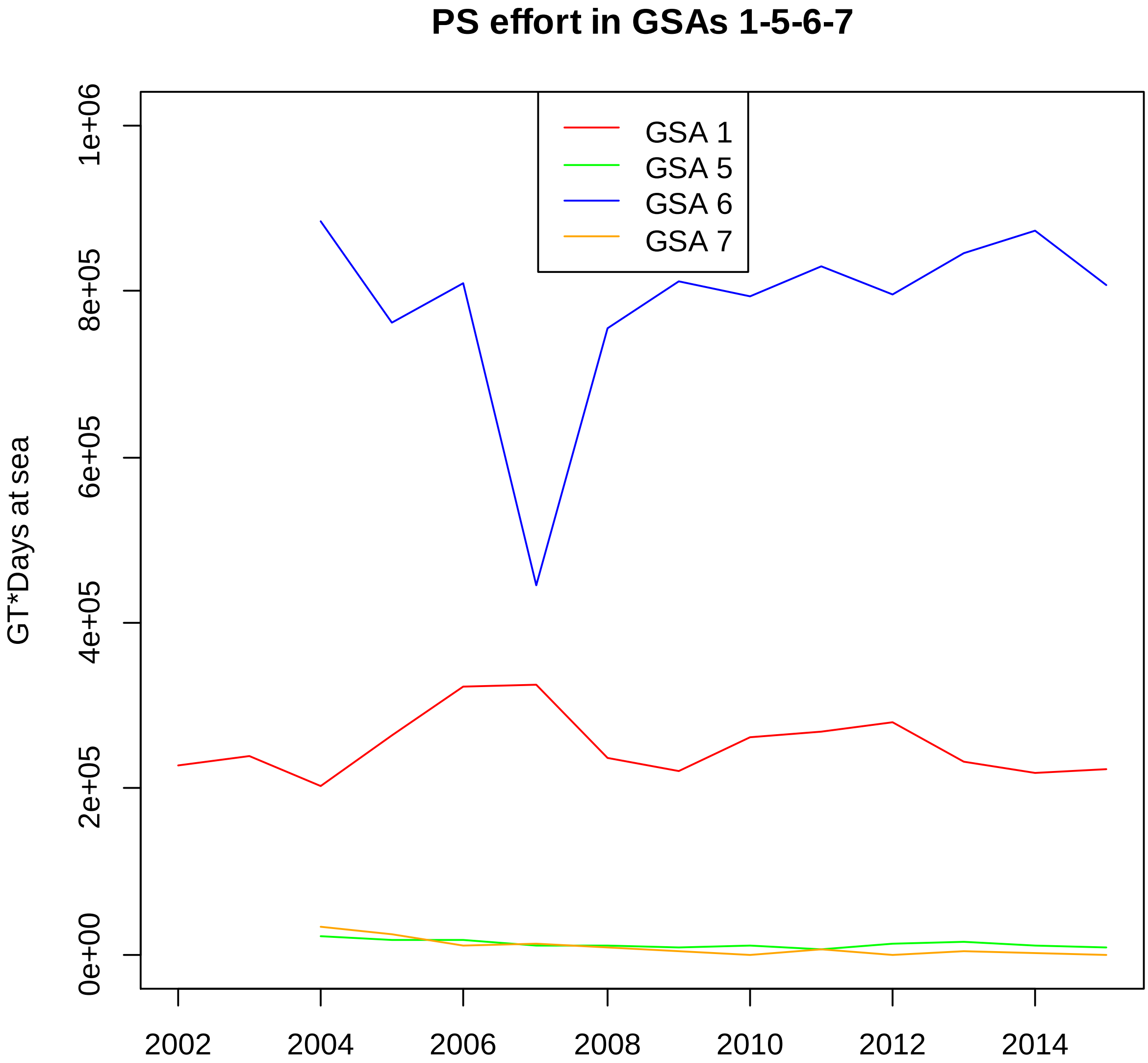


Figure 6.17.3.4. Scomber spp. In GSAS 1,5,6,7. Purse seine (PS) effort (in days at sea) per GSA of the Spanish fleet in 2004-2015. French effort data were available only for 2015 and were omitted.

Table 6.17.3.2. Scomber spp. In GSAS 1,5,6,7. Purse seine (PS) effort per GSA of the Spanish fleet in 2004-2015. French effort data were available only for 2015 and were omitted.

Year	Area	GT*days at sea	Days at sea
2002	**GSA 1**	**228616.7**	**10402**
2003	**GSA 1**	**240521.1**	**10882**
2004	**GSA 1**	**202617.1**	**9582**
	GSA 5	**21359.3**	**1704**

	GSA 6	883665.6	20359
	GSA 7	33436.37	755
2005	GSA 1	264253.2	11055
	GSA 5	18273	1424
	GSA 6	762915.5	17345
	GSA 7	23558.67	515
2006	GSA 1	322437.3	13617
	GSA 5	17310.29	1323
	GSA 6	810575.1	17243
	GSA 7	10879	247
2007	GSA 1	326381	12431
	GSA 5	11709.62	1076
	GSA 6	445302.7	11031
	GSA 7	13247.05	293
2008	GSA 1	237009	9935
	GSA 5	10240.52	933
	GSA 6	754749.3	16643
	GSA 7	8173.63	184
2009	GSA 1	221607.6	9299
	GSA 5	9873.28	892
	GSA 6	813051.2	17563
	GSA 7	4068.53	94
2010	GSA 1	261213	10071
	GSA 5	11163.94	988
	GSA 6	794730.8	16985
	GSA 7	108.84	4
2011	GSA 1	269401.2	10498
	GSA 5	7574.7	641
	GSA 6	830777.8	17832
	GSA 7	7457.15	167
2012	GSA 1	281256.6	10604
	GSA 5	14254.6	1177

	GSA 6	**796035.1**	**17339**
	GSA 7	**652.13**	**15**
2013	**GSA 1**	**233648.9**	**9350**
	GSA 5	**14839.96**	**1173**
	GSA 6	**846402.3**	**18968**
	GSA 7	**3418.05**	**52**
2014	**GSA 1**	**218479.8**	**9095**
	GSA 5	**11225.88**	**921**
	GSA 6	**873988.6**	**19556**
2015	**GSA 1**	**223457.7**	**9253**
	GSA 5	**9840.95**	**903**
	GSA 6	**808240.9**	**17589**
	GSA 7	**33.14**	**2**

6.17.4. Survey Indices of abundance and biomass by year and size/age

MEDITS data were used to derive abundance and biomass indices for *Scomber* spp. in GSAs 1 and 6 where the majority of catches is taken. MEDITS data for *Scomber* spp. and *S. scombrus* were combined to ensure consistency with the landings data. In GSA 1 the indices were calculated for years 2013-2015 (Fig. 6.17.4.1, 6.17.4.2), while in GSA 6 the indices were calculated for years 1996-2015 (Fig. 6.17.4.3, 6.17.4.4). No strong overall trends were observed in the MEDITS-derived indices.

MEDITS-derived length frequency distribution of *Scomber* spp. suggested the existence of generally larger fish in GSA 1 (Fig. 6.17.4.5) compared to GSA 6 (Fig. 6.17.4.6).

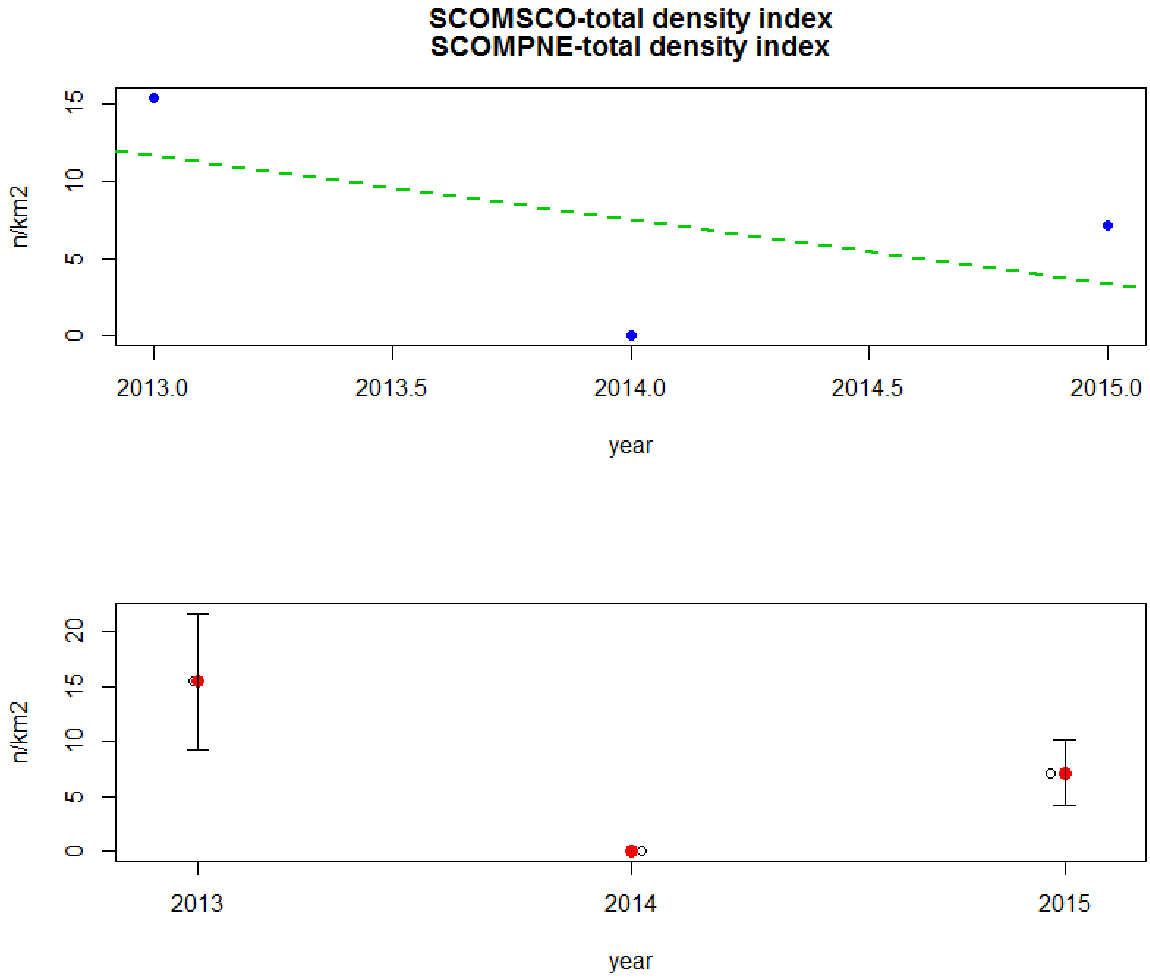


Figure 6.17.4.1. Scomber spp. In GSAS 1,5,6,7. MEDITS-derived abundance index (n/km2) for *Scomber* spp. in GSA 1 in 2013-2015

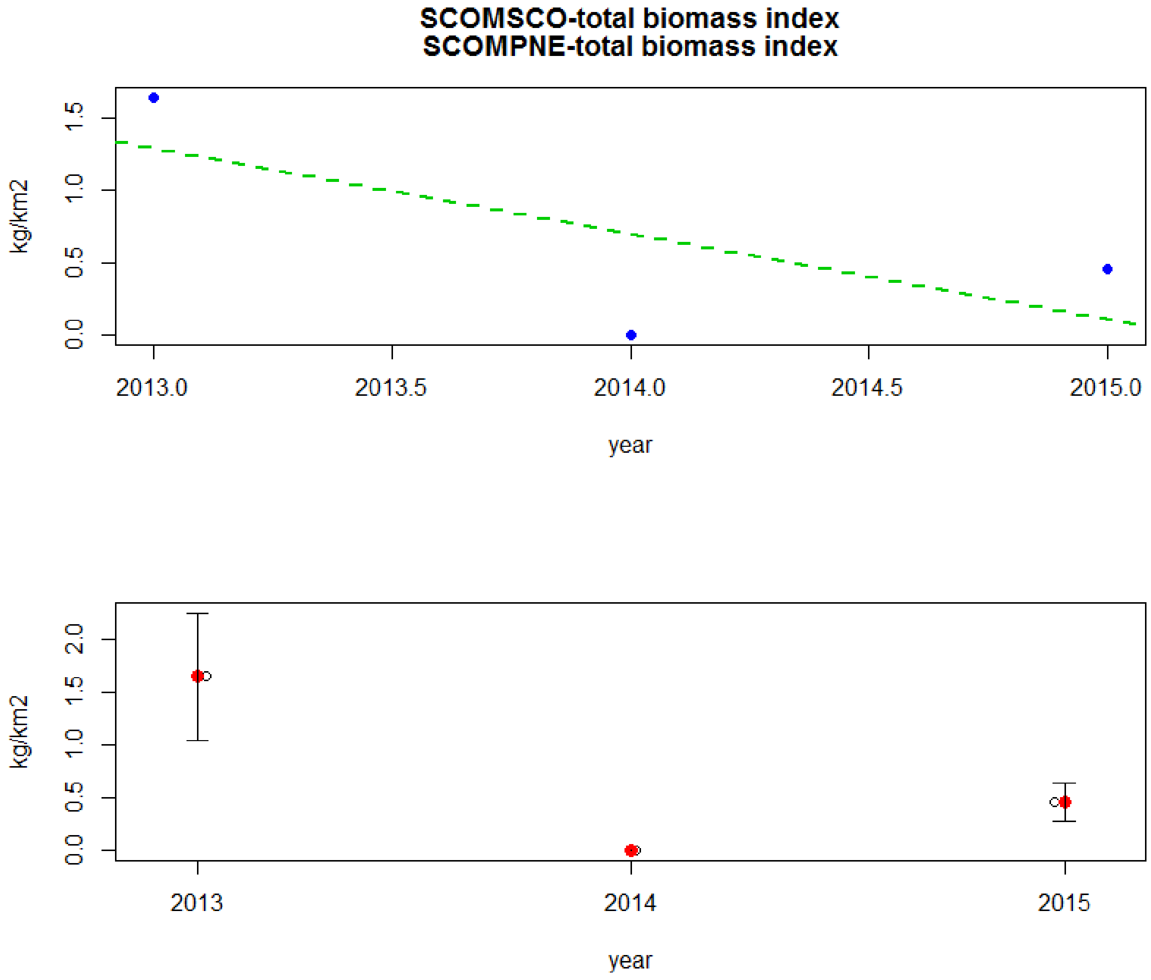


Figure 6.17.4.2. Scomber spp. In GSAS 1,5,6,7. MEDITS-derived biomass index (kg/km2) for *Scomber* spp. in GSA 1 in 2013-2015

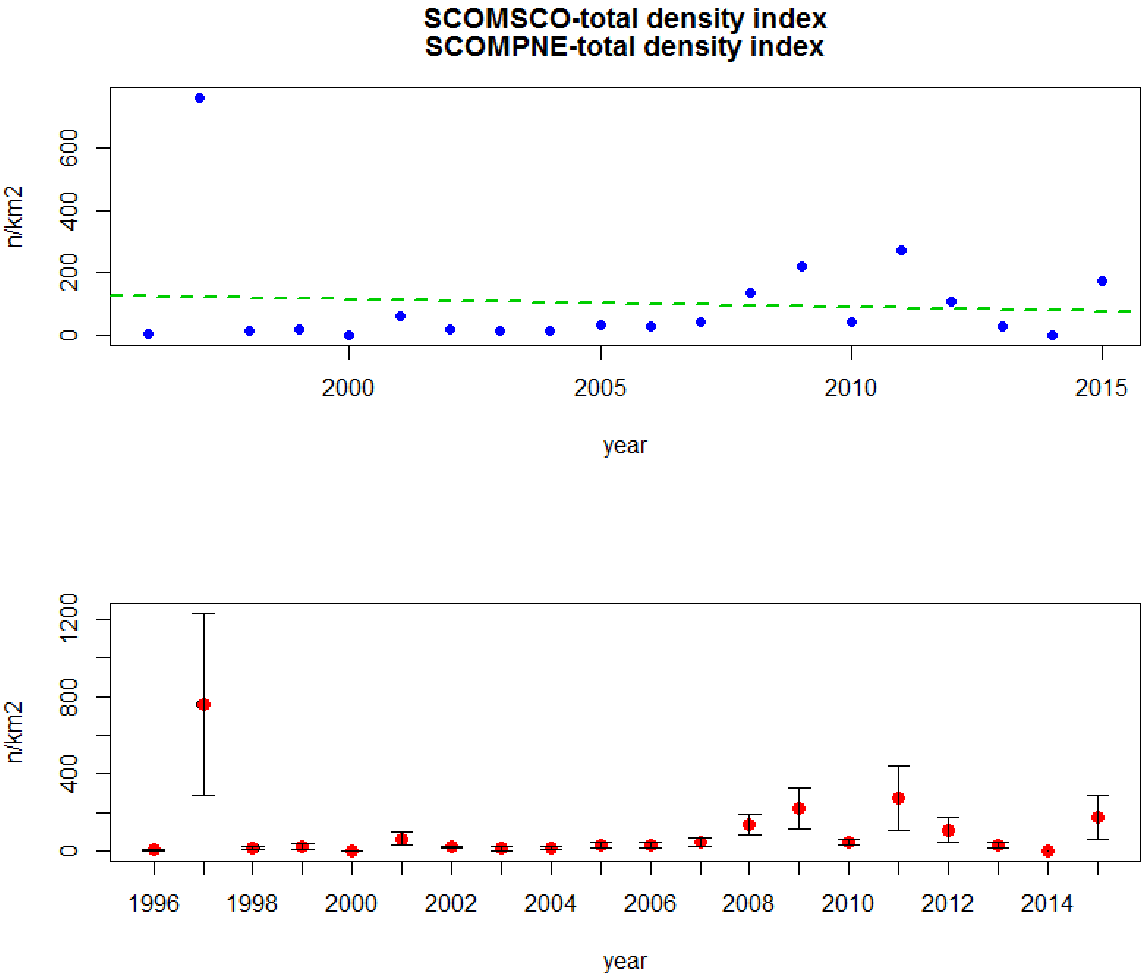


Figure 6.17.4.3. Scomber spp. In GSAS 1,5,6,7**.** MEDITS-derived abundance index (n/km2) for *Scomber* spp. in GSA 6 in 1996-2015

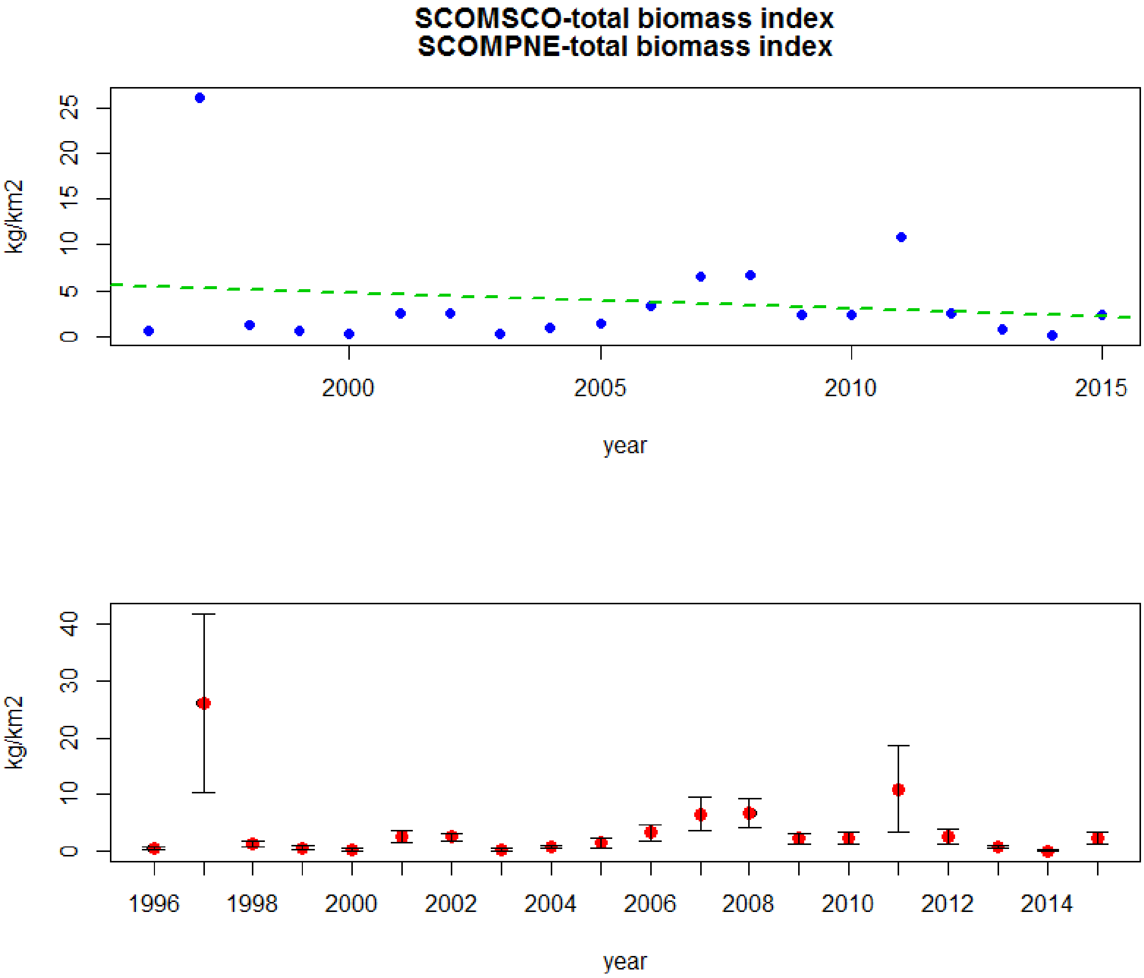


Figure 6.17.4.4. Scomber spp. In GSAS 1,5,6,7. MEDITS-derived biomass index (n/km2) for *Scomber* spp. in GSA 6 in 1996-2015

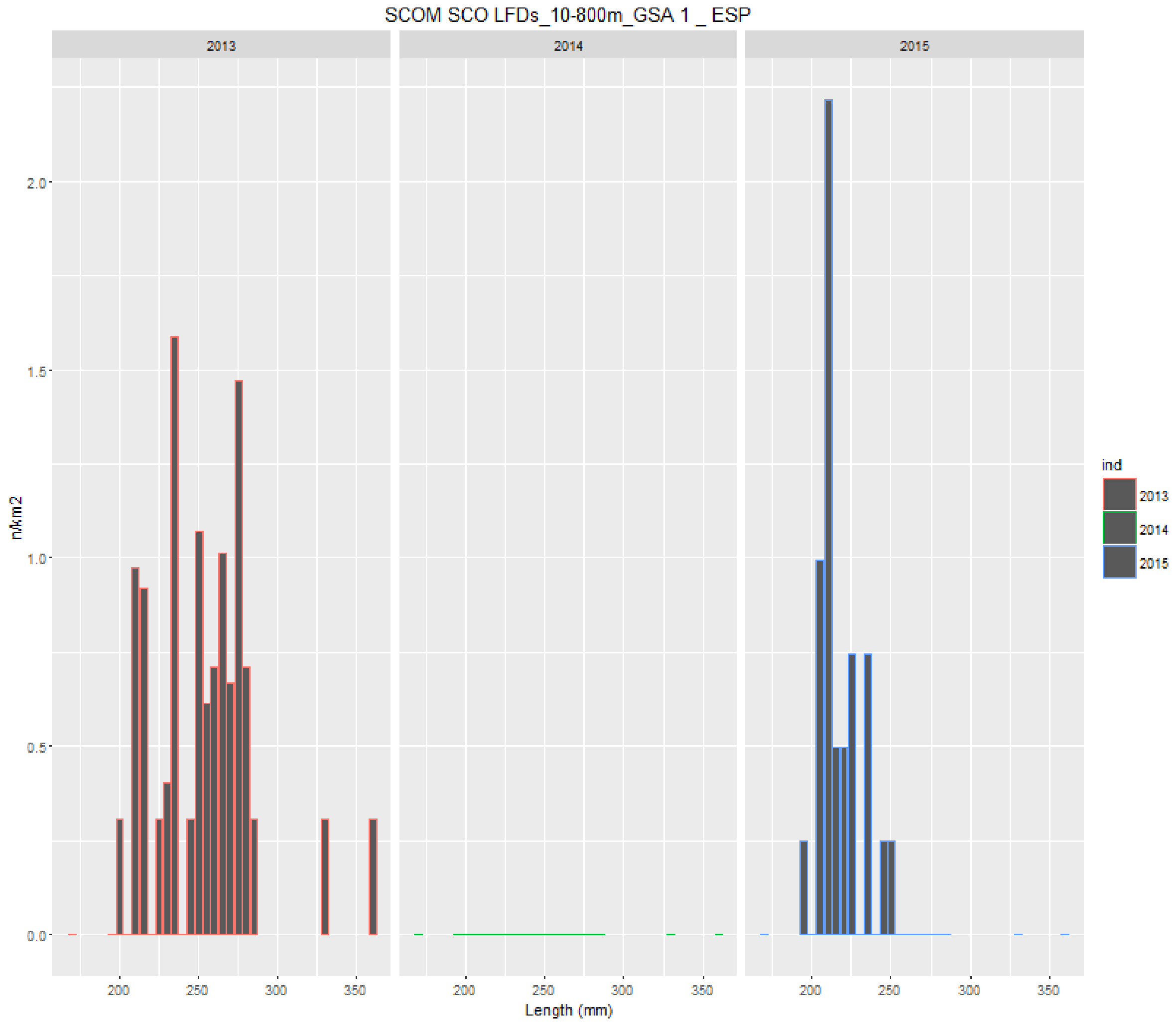


Figure 6.17.4.5. Scomber spp. In GSAS 1,5,6,7. MEDITS-derived length frequency distribution of *Scomber* spp. in GSA 1 in 2013-2015.

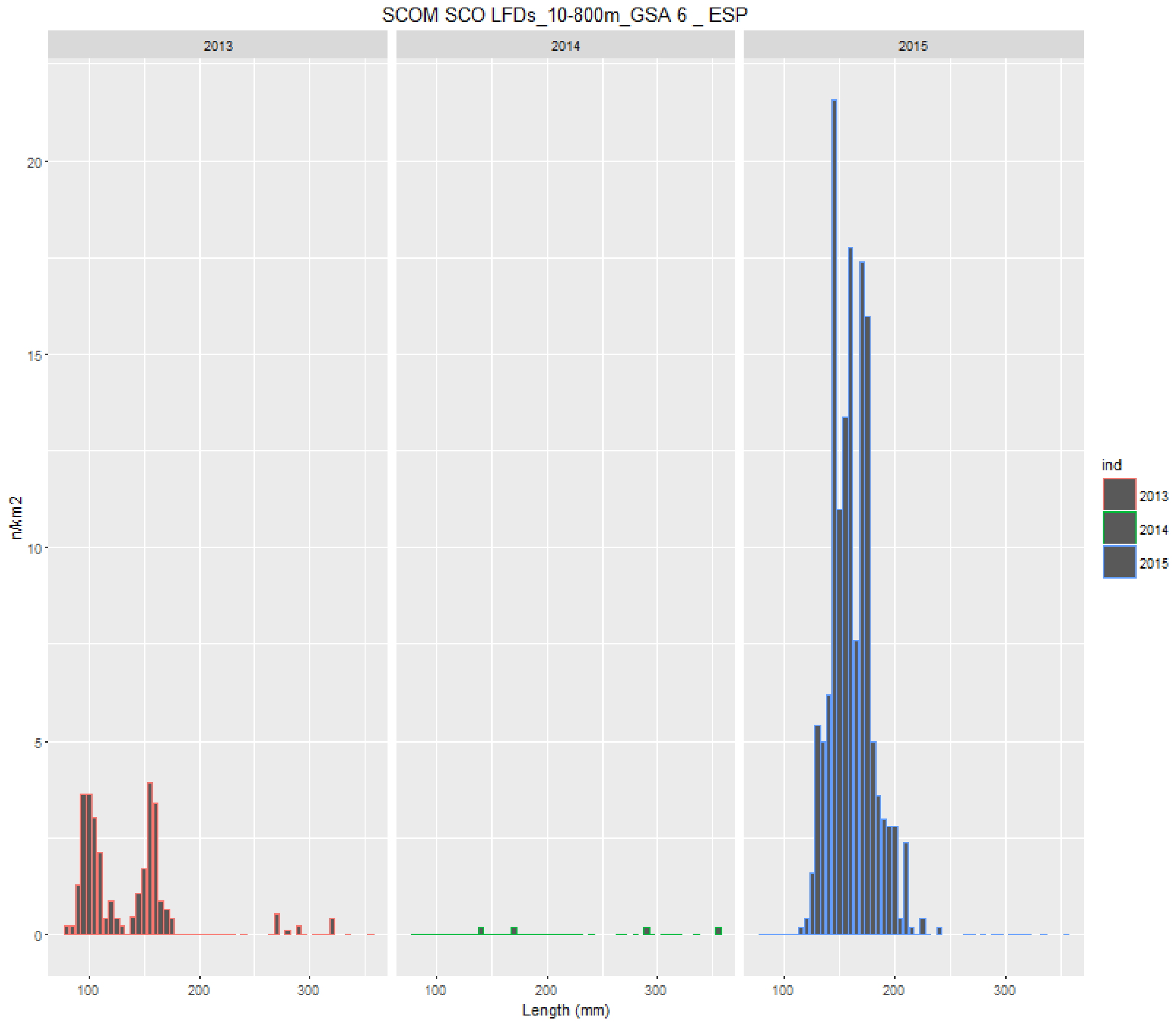


Figure 6.17.4.6. Scomber spp. In GSAS 1,5,6,7. MEDITS-derived length frequency distribution of *Scomber* spp. in GSA 6 in 2013-2015.

6.18. DATA GATHERING OF *SCOMBER SPP.* IN GSAs 9, 10 and 11

6.18.1. Stock Identity and Biology

Scomber scombrus (MAC) was examined together with *Scomber japonicus* (MAS) because the majority of catch data available in the DCF referred to the genus level (*Scomber* spp. - MAZ).

Examination of the population genetic structures of *S. scombrus* and *S. japonicus* by Zardoya et al. (2004) suggested an extensive gene flow between the Mediterranean Sea and Atlantic Ocean populations of *S. japonicus*, which are organized into a larger panmictic unit. By contrast, Mediterranean Sea populations of *S. scombrus* showed some degree of genetic differentiation between the eastern and western Mediterranean, with specimens from GSAs 13, 17, 18, 19 and

22 being clearly separated from specimens from GSA 6, the latter forming a panmictic unit with eastern Atlantic Ocean populations.

Here the *Scomber* spp. stocks in GSAs 9, 10 and 11 were examined (Fig. 6.18.1.1)

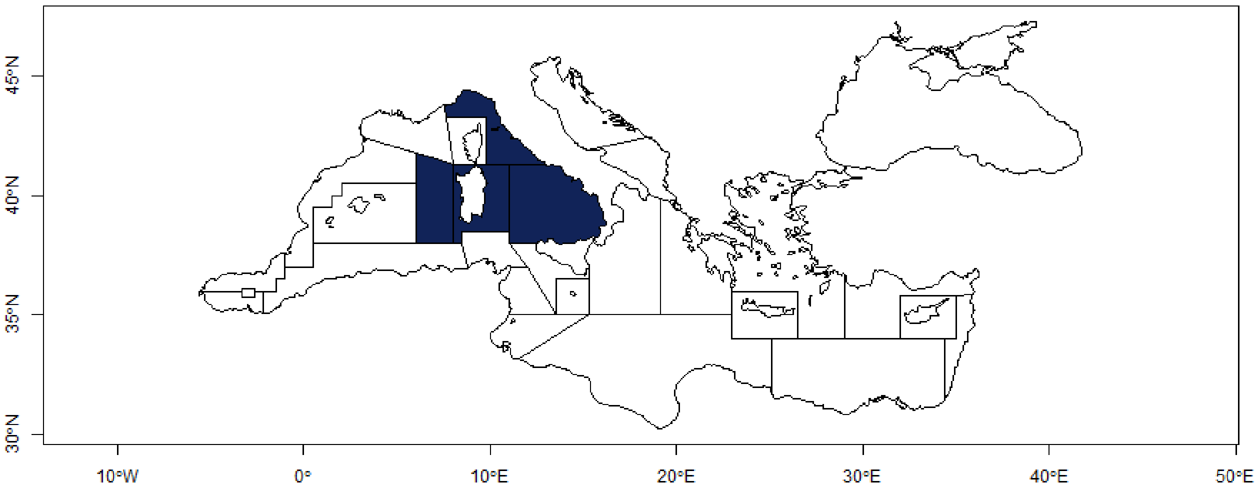


Figure 6.18.1.1. Geographical location of GSAs 9,10,11.

Age and growth

No growth parameters for *Scomber* spp. in GSAs 9-11 were available in the DCF.

Maturity

No maturity information for *Scomber* spp. in GSAs 9-11 was available in the DCF.

6.18.2. Catch data

Landings

Scomber spp. landings data for consecutive years were only available for GSA 10 in 2006-2015. Relevant data from GSA 9 were only available for years 2009, 2010 and 2013. No landings data were available for GSA 11. The available landings data did not exhibit any consistent trend (Fig. 6.18.2.1; Table 6.18.2.1). The majority of landings in most years were caught by PS, followed by OTB (Fig. 6.18.2.2; Table 6.18.2.2).

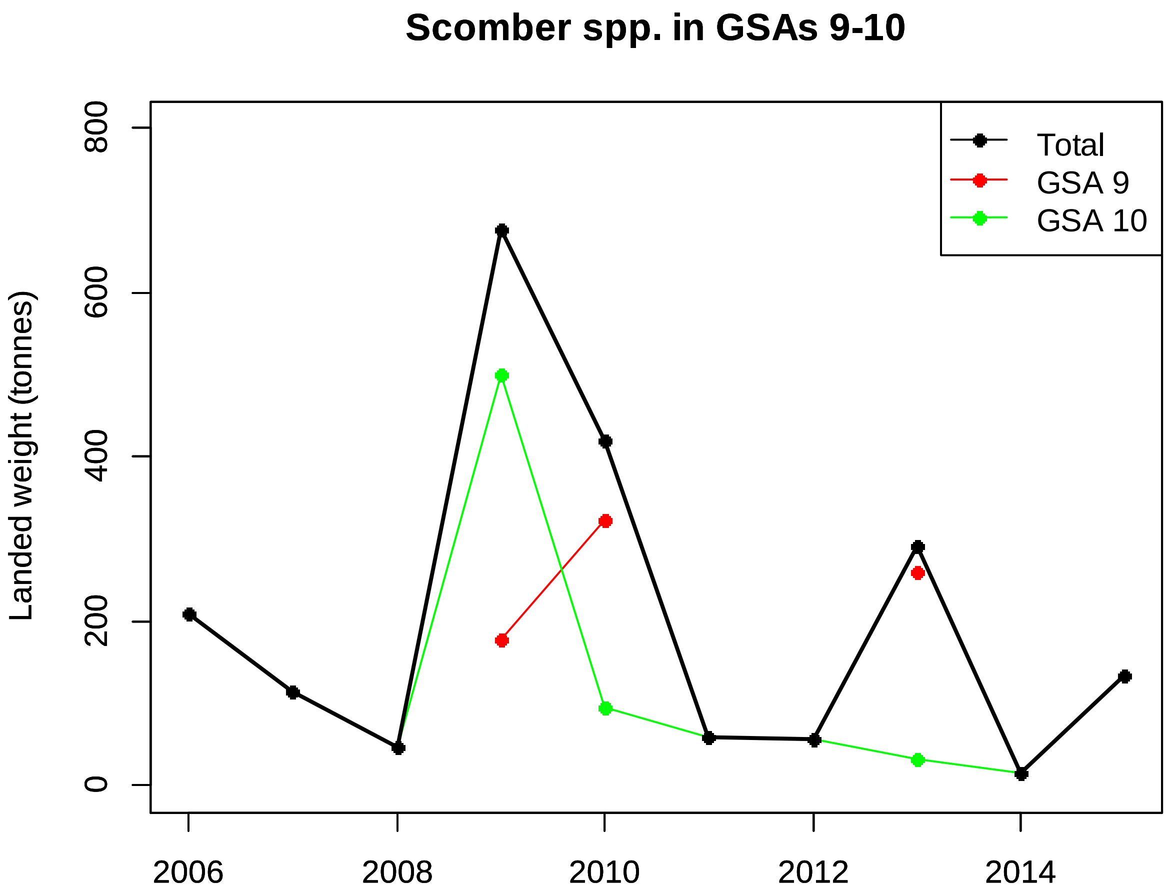


Figure 6.18.2.1. Scomber spp. In GSAS 9,10,11. Landings in 2006-2015

Table 6.18.2.1. Scomber spp. In GSAS 9,10,11**.** Landings in 2006-2015

Year	Area	Landings weight (tonnes)	Total landings weight (tonnes)
2006	GSA 10	208.69	208.69
2007	GSA 10	115.55	115.55
2008	GSA 10	47.52	47.52
2009	GSA 9	177.59	678.26
	GSA 10	500.66	
2010	GSA 9	323.42	419.68
	GSA 10	96.26	
2011	GSA 10	58.62	58.62
2012	GSA 10	56.13	56.13
2013	GSA 9	260.01	292.58

	GSA 10	**32.57**	
2014	**GSA 10**	**16.05**	**16.05**
2015	**GSA 10**	**133.25**	**133.25**

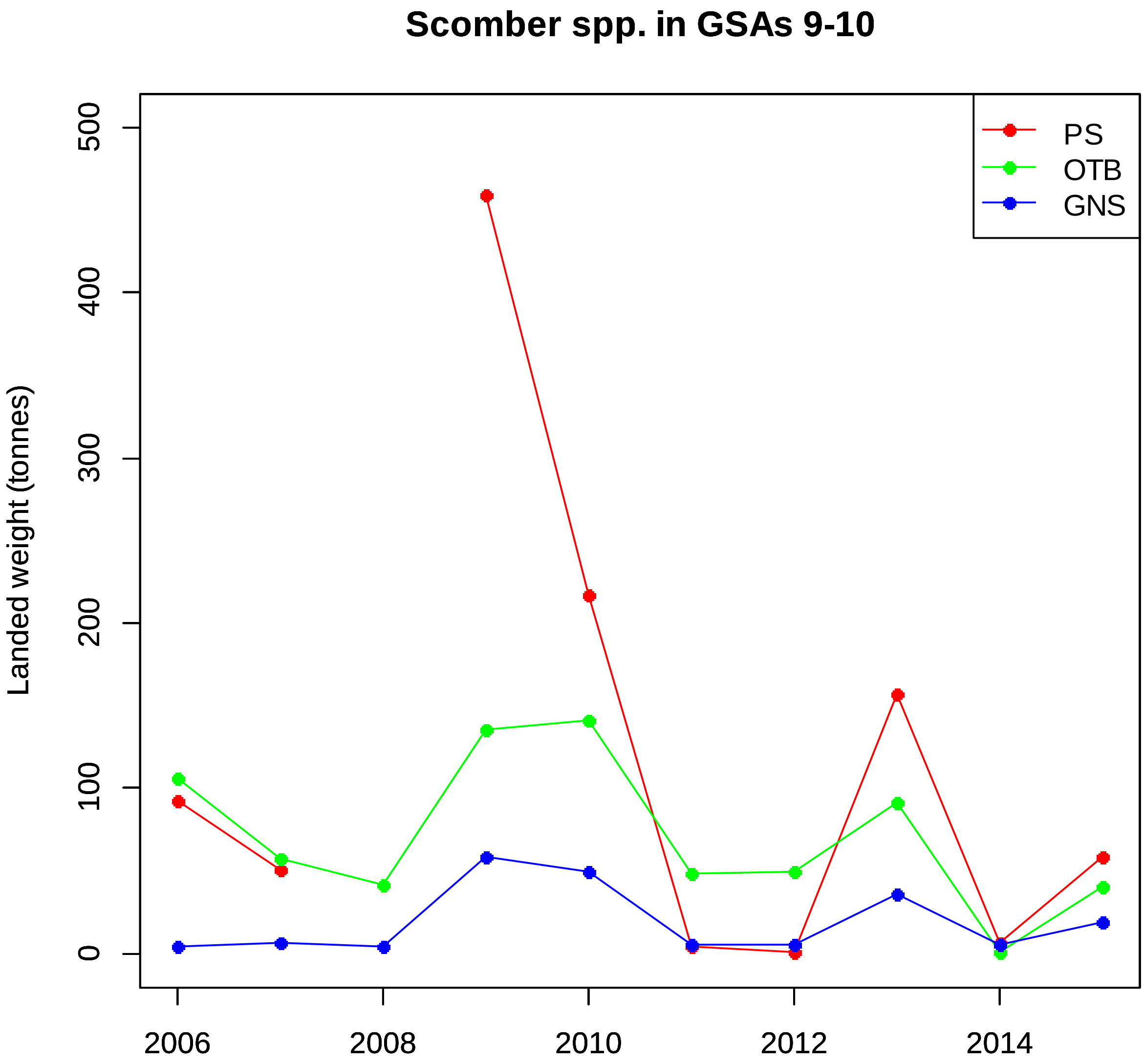


Figure 6.18.2.2. Scomber spp. In GSAS 9,10,11. Landings by fishing gear in GSAs 9 and 10 in 2006-2015. The first three gears in terms of landings volume are shown. GSA 9 data were available only in 2009, 2010, 2013. PS: Purse seine; OTB: Bottom otter trawl; GNS: Set gillnet

Table 6.18.2.2. Scomber spp. In GSAS 9,10,11. Landings by fishing gear in GSAs 9 and 10 in 2006-2015. GSA 9 data were available only in 2009, 2010, 2013.

Year	Gear	Landings weight (tonnes)	Total landings weight (tonnes)
2006	**NK**	**1.80**	**208.69**

	GND	**2.18**	
	GNS	**4.88**	
	OTB	**106.70**	
	PS	**93.14**	
	GNS	**7.21**	
2007	**OTB**	**57.75**	**115.55**
	PS	**50.59**	
	NK	**1.21**	
2008	**GNS**	**4.36**	**47.52**
	LLD	**0.66**	
	OTB	**41.30**	
	NK	**1.42**	
	GND	**7.78**	
2009	**GNS**	**58.73**	**678.26**
	GTR	**15.27**	
	OTB	**135.83**	
	PS	**459.24**	
	NK	**0.34**	
	GNS	**50.00**	
2010	**GTR**	**10.87**	**419.68**
	OTB	**141.01**	
	PS	**217.47**	
	NK	**0.29**	
2011	**GNS**	**5.68**	**58.62**
	OTB	**48.40**	
	PS	**4.24**	
	GNS	**5.03**	
	OTB	**49.99**	
2012	**PS**	**0.62**	**56.13**
	SB	**0.25**	
	SV	**0.25**	
2013	**GNS**	**35.78**	**292.58**

	GTR	8.72	
	OTB	91.32	
	PS	156.76	
	GNS	5.89	
	GTR	2.37	
2014	OTB	0.58	16.05
	PS	7.21	
	GND	1.33	
	GNS	18.94	
	GTR	6.42	
2015	LLD	1.95	133.25
	LLS	5.62	
	OTB	40.32	
	PS	58.67	

Very limited information exists in the DCF regarding the length frequency distribution of *Scomber* spp. landings; this information regards only two years and two gears in GSA 9 (Fig. 6.18.2.3, 6.18.2.4).

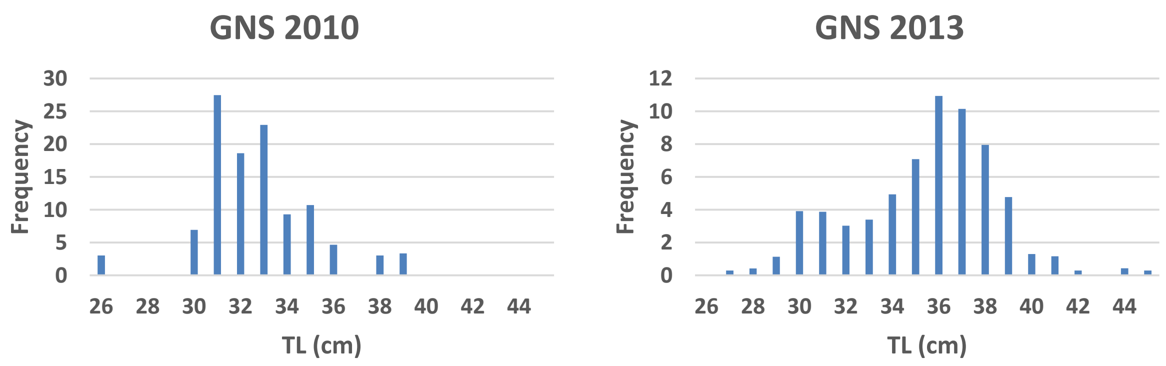


Figure 6.18.2.3. Scomber spp. In GSAS 9,10,11. Length frequency distribution (in thousands) of *Scomber* spp. landings from set gillnets (GNS) in GSA 9 in 2010 and 2013.

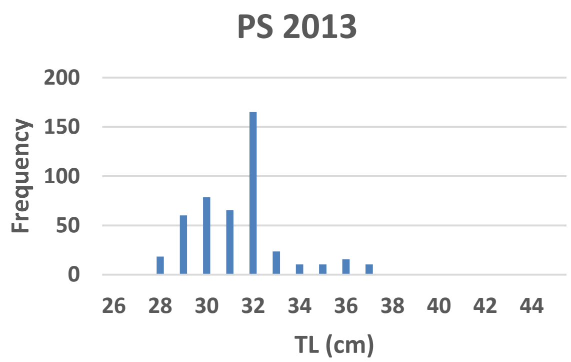


Figure 6.18.2.4. Scomber spp. In GSAS 9,10,11. Length frequency distribution (in thousands) of *Scomber* spp. landings from purse seine (PS) in GSA 9 in 2013.

There is no information in the DCF on the age structure of *Scomber* spp. landings in GSAs 9-11.

Discards

There is no information in the DCF on the discards of *Scomber* spp. landings in GSAs 9-11.

6.18.3. Fishing effort data

Effort of PS, OTB and GNS in GSAs 9 and 10, remained relatively stable in 2006-2015 in terms of GT*days at sea, but days at sea increased (Fig. 6.18.3.1, 6.18.3.2; Table 6.18.3.1). More PS effort has been allocated to GSA 10 compared to GSA 9, with an increasing trend in 2006-2015 (Fig. 6.18.3.3, 6.18.3.4; Table 6.18.3.2)

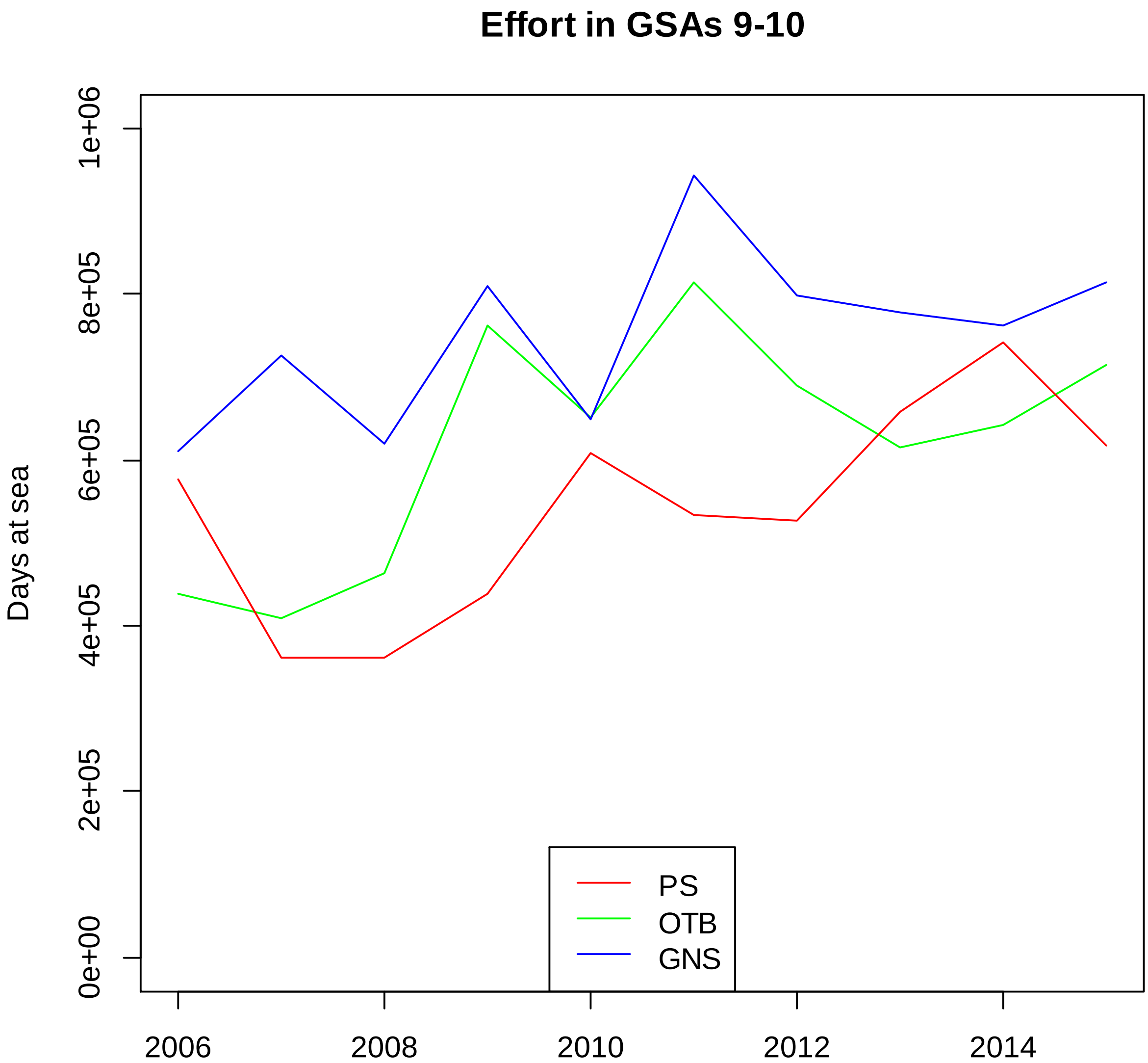


Figure 6.18.3.1. Scomber spp. In GSAS 9,10,11. Effort (in days at sea) of the main gears catching *Scomber* spp. in GSAs 9 and 10 in 2006-2015.

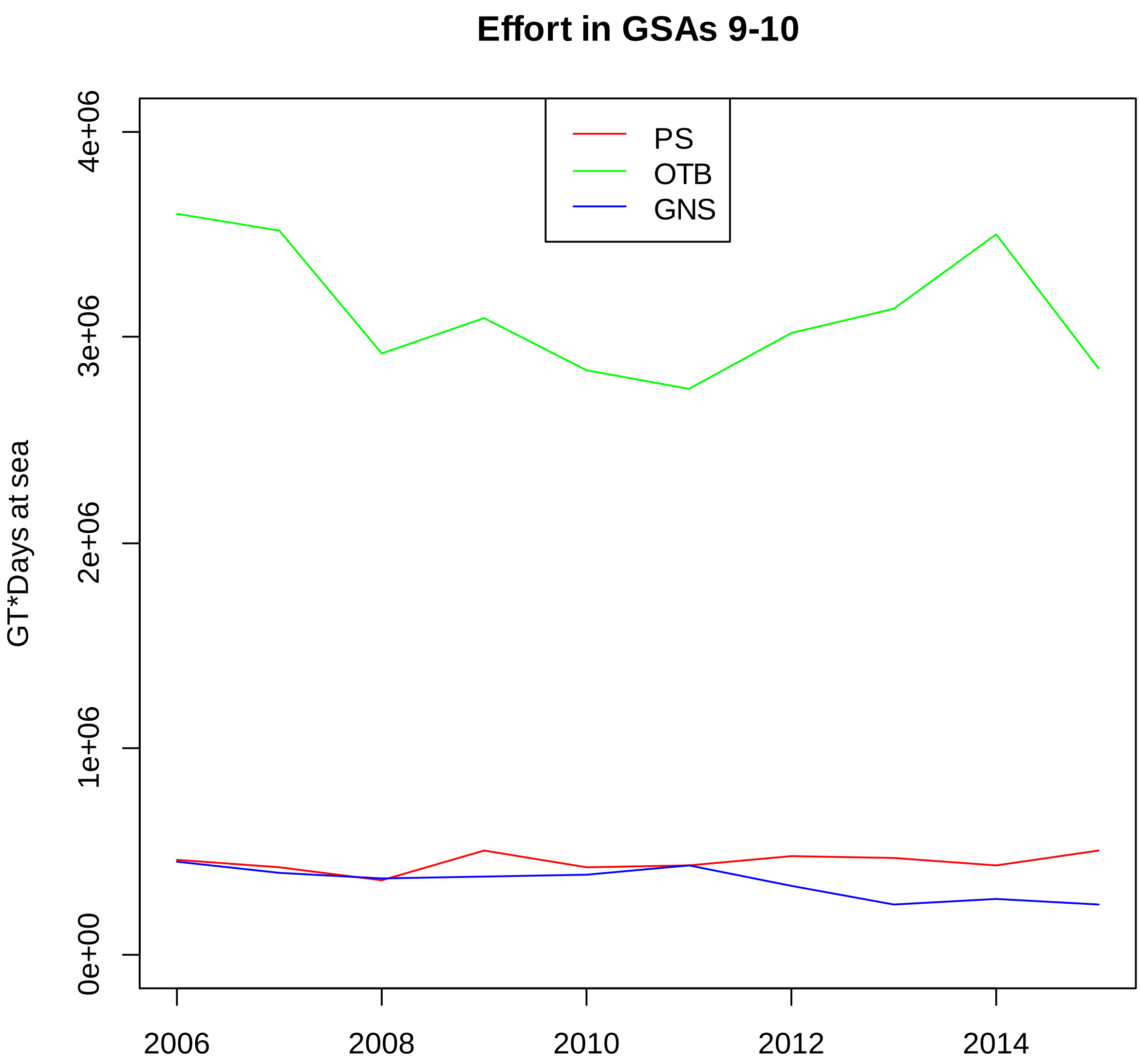


Figure 6.18.3.2. Scomber spp. In GSAS 9,10,11. Effort (in gt*days at sea) of the main gears catching *Scomber* spp. in GSAs 9 and 10 in 2006-2015.

Table 6.18.3.1. Scomber spp. In GSAS 9,10,11. Effort of the main gears catching *Scomber* spp. in GSAs 9 and 10 in 2006-2015.

Year	Gear	GT*Days at sea	Days at sea
	GNS	449979	609639.5
2006	OTB	3597729	438378
	PS	463117	576252.7
	GNS	401291	727040.3
2007	OTB	3521606	410190.6
	PS	427055	361771.8

	GNS	**366429**	**619384.2**
2008	**OTB**	**2920243**	**462746.4**
	PS	**363271**	**361987**
	GNS	**374719**	**809415.7**
2009	**OTB**	**3094797**	**761475.2**
	PS	**503585**	**439246.4**
	GNS	**384692**	**648763.7**
2010	**OTB**	**2844105**	**651561.4**
	PS	**421316**	**608414.3**
	GNS	**433247**	**942163.4**
2011	**OTB**	**2748293**	**814639.4**
	PS	**434200**	**532832.3**
	GNS	**335799**	**797665.1**
2012	**OTB**	**3023262**	**690097.8**
	PS	**478821**	**526599.9**
	GNS	**239464**	**777089.4**
2013	**OTB**	**3142693**	**614499.9**
	PS	**471455**	**658583**
	GNS	**269562**	**762644.4**
2014	**OTB**	**3502383**	**642966.6**
	PS	**434130**	**742388.8**
	GNS	**245134**	**815013.5**
2015	**OTB**	**2846293**	**714996.8**
	PS	**508054**	**616835.9**

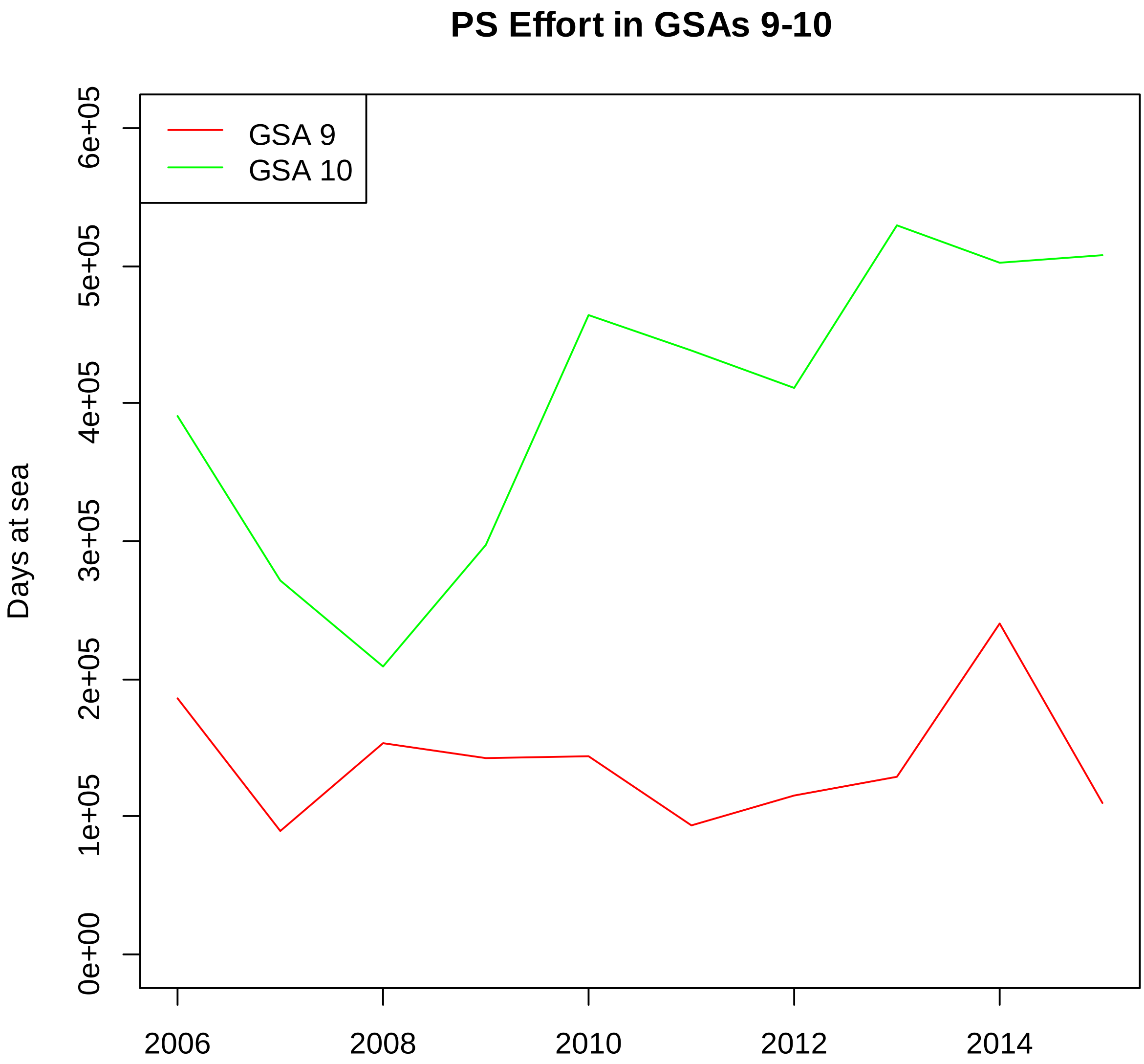


Figure 6.18.3.3. Scomber spp. In GSAS 9,10,11. Purse seine (PS) effort (in days at sea) per GSA in 2006-2015.

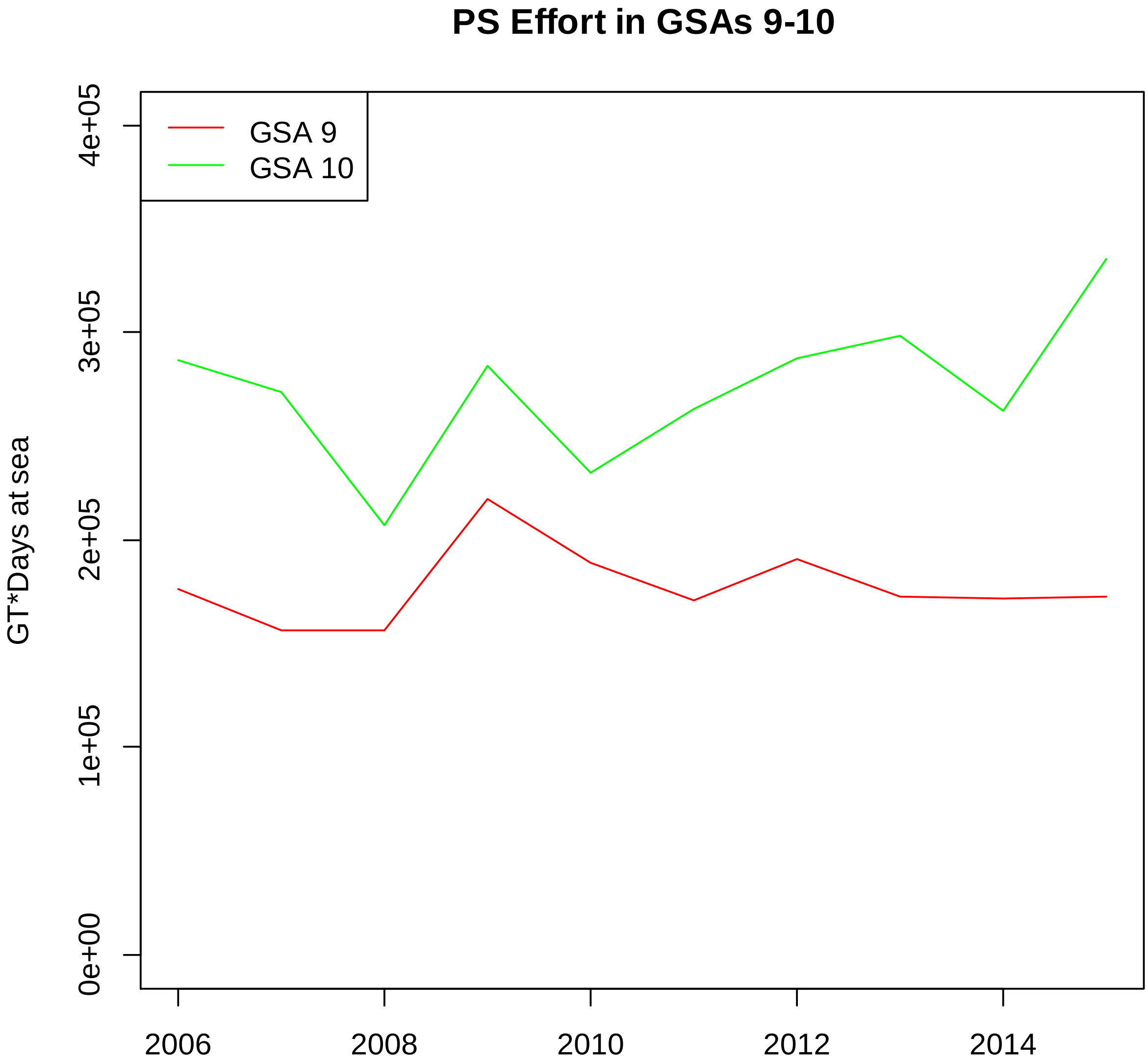


Figure 6.18.3.4. Scomber spp. In GSAS 9,10,11. Purse seine (PS) effort (in gt*days at sea) per GSA in 2006-2015.

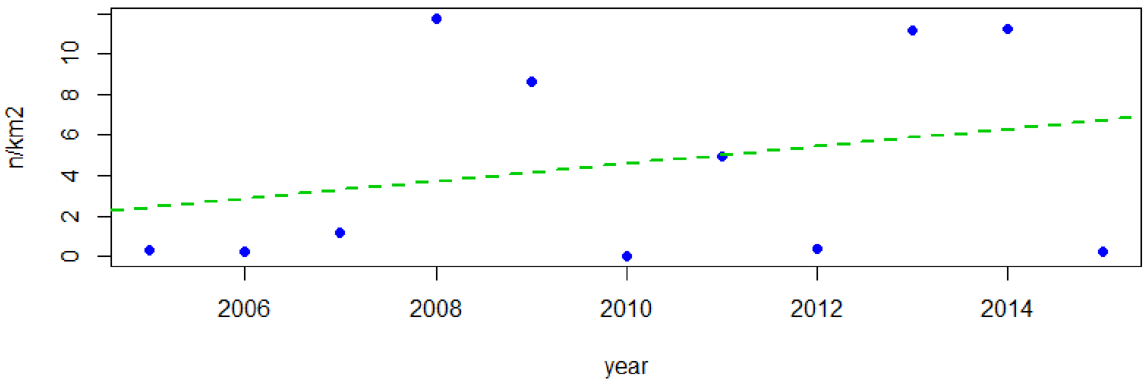
Table 6.18.3.2. Scomber spp. In GSAS 9,10,11. Purse seine (PS) effort per GSA in 2006-2015.

Year	Area	GT*Days at sea	Days at sea
2006	GSA 9	176505	185822.2
	GSA 10	286612	390430.5
2007	GSA 9	156080	89847.38
	GSA 10	270975	271924.5
2008	GSA 9	156092	153593.1
	GSA 10	207179	208393.9

2009	GSA 9	219762	142010.2
	GSA 10	283823	297236.2
2010	GSA 9	188976	144311.9
	GSA 10	232340	464102.5
2011	GSA 9	171094	94197.67
	GSA 10	263106	438634.6
2012	GSA 9	191198	115853.7
	GSA 10	287623	410746.2
2013	GSA 9	172782	128835.4
	GSA 10	298673	529747.7
2014	GSA 9	171483	240144.8
	GSA 10	262647	502244
2015	GSA 9	172442	109223.2
	GSA 10	335612	507612.7

6.18.4. Survey Indices of abundance and biomass by year and size/age

MEDITS data were used to derive abundance and biomass indices for *Scomber* spp. in GSA 10 which was the only area with consistent landings data. MEDITS data for *Scomber* spp. and *S. scombrus* were combined to ensure consistency with the landings data, and were calculated for years 2005-2015 (Fig. 6.18.4.1, 6.18.4.2). No consistent overall trends were observed in the MEDITS-derived indices and there was no particular agreement with the trends of landings. MEDITS-derived length frequency distribution of *Scomber* spp. indicated the existence of many juveniles in 2013 and 2014 (Fig. 6.18.4.3).



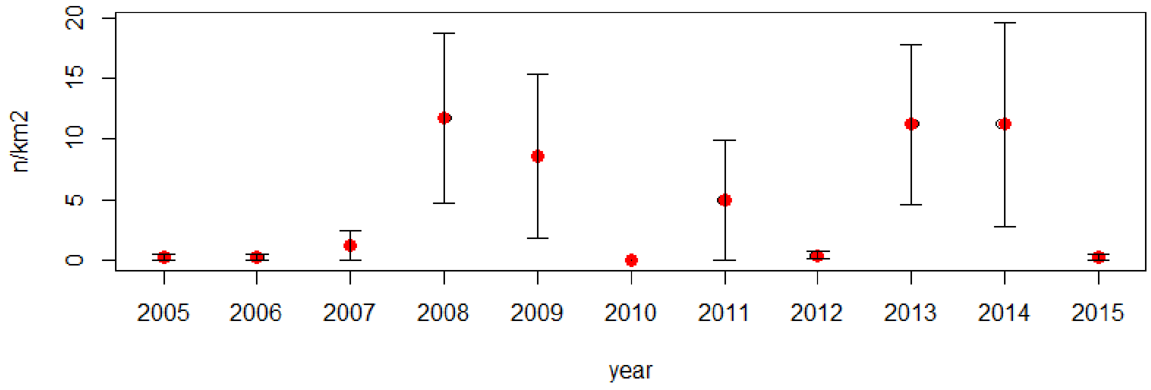


Figure 6.18.4.1. Scomber spp. In GSAS 9,10,11. MEDITS-derived abundance index (n/km2) for *Scomber* spp. in GSA 10 in 2005-2015

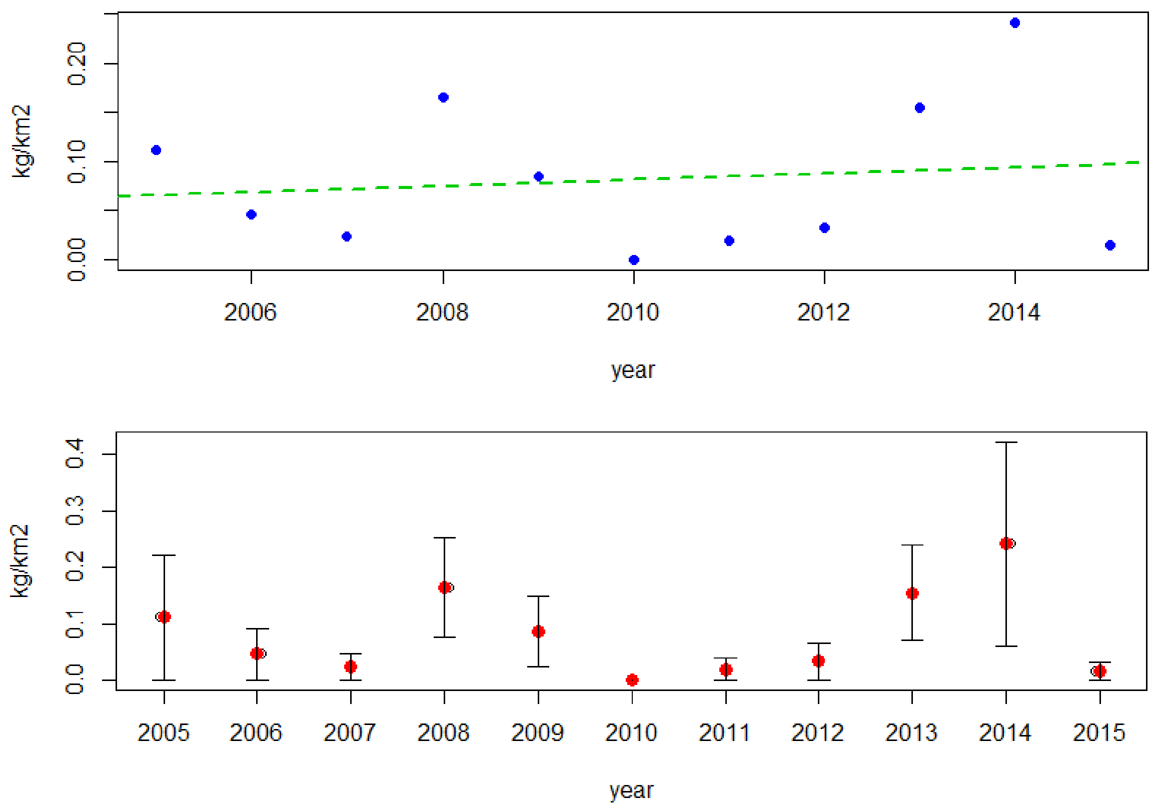


Figure 6.18.4.2. Scomber spp. In GSAS 9,10,11. MEDITS-derived biomass index (kg/km2) for *Scomber* spp. in GSA 10 in 2005-2015

Figure 6.18.4.3. Scomber spp. In GSAS 17,18,19,20. MEDITS-derived length frequency distribution of *Scomber* spp. in GSA 10 in 2013-2015MEDITS-derived length frequency distribution of Scomber spp. in GSA 10 in 2012-2015. No data were available prior to 2012.

6.19. DATA GATHERING OF *SCOMBER SPP.* IN GSAs 17, 18, 19 and 20

6.19.1. Stock Identity and Biology

Scomber scombrus (MAC) was examined together with *Scomber japonicus* (MAS) because the majority of catch data available in the DCF referred to the genus level (*Scomber* spp. - MAZ).

Examination of the population genetic structures of *S. scombrus* and *S. japonicus* by Zardoya et al. (2004) suggested an extensive gene flow between the Mediterranean Sea and Atlantic Ocean populations of *S. japonicus*, which are organized into a larger panmictic unit. By contrast, Mediterranean Sea populations of *S. scombrus* showed some degree of genetic differentiation between the eastern and western Mediterranean, with specimens from GSAs 13, 17, 18, 19 and 22 being clearly separated from specimens from GSA 6, the latter forming a panmictic unit with eastern Atlantic Ocean populations.

Here, the *Scomber* spp. stocks in GSAs 17, 18, 19 and 20 were examined (Fig. 6.19.1.1)

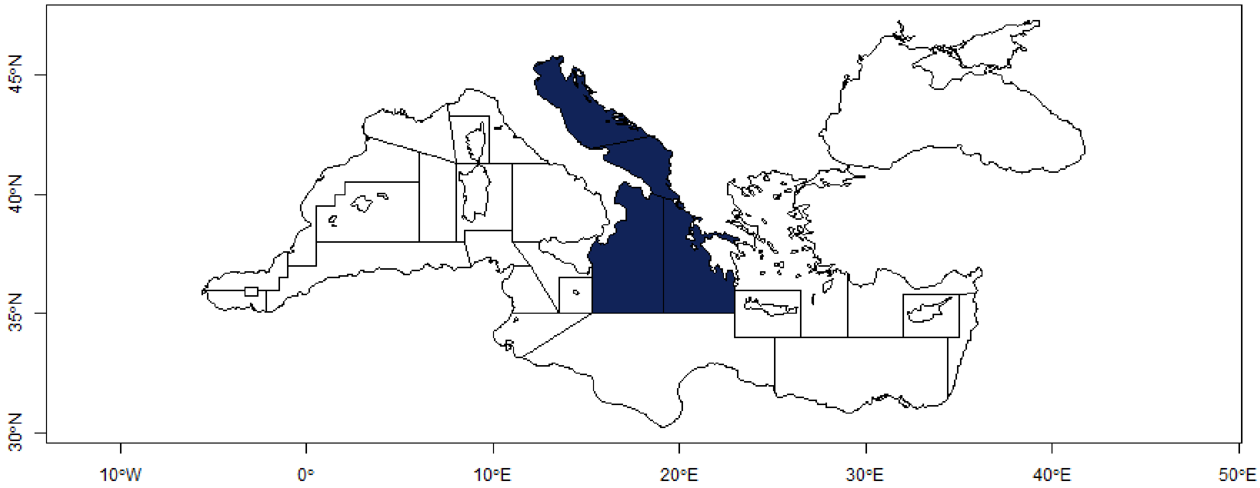


Figure 6.19.1.1 Geographical location of GSAS 17,18,19,20.

Age and growth

No growth parameters for *Scomber* spp. in GSAs 9-11 were available in the DCF.

Maturity

Proportions of mature fish (S. japonicus) per age-class were available for GSA 17 in 2015 as following:

Age (y)	1	2	3	4
Proportion mature	0.091	0.714	0.545	1

Feeding & habitat

S. scombrus and *S. japonicus* are pelagic, migratory and schooling species. They are mainly diurnal, feeding on zooplankton and small fish (Collette et al. 2016). Both Scomber species occupy a key position in the trophic chain of the Mediterranean Sea ecosystems, as they are an important element of the diet of larger pelagic fish (e.g. tuna, swordfish, and sharks) and sea mammals (e.g. dolphins and seals) (Zardoya et al. 2004).

6.19.2. Catch data

Landings

The majority of *Scomber* spp. landings in GSAs 17-20 in 2014-2015 came from GSA 17 and they were landed by the Croatian fleet (Fig. 6.19.2.1, Table 6.19.2.1). However, no Croatian data were available prior to 2014. Consistent time-series of landings existed from the Slovenian fleet in GSA 17 and from the Italian fleet in GSAs 18-19 and indicated stable or decreasing trends. The majority of the landings came from bottom otter trawls (OTB), with the exception of years 2014-2015 when landings from purse seines (PS) were higher due to the inclusion of the Croatian data (Fig. 6.19.2.2; Table 6.19.2.2)

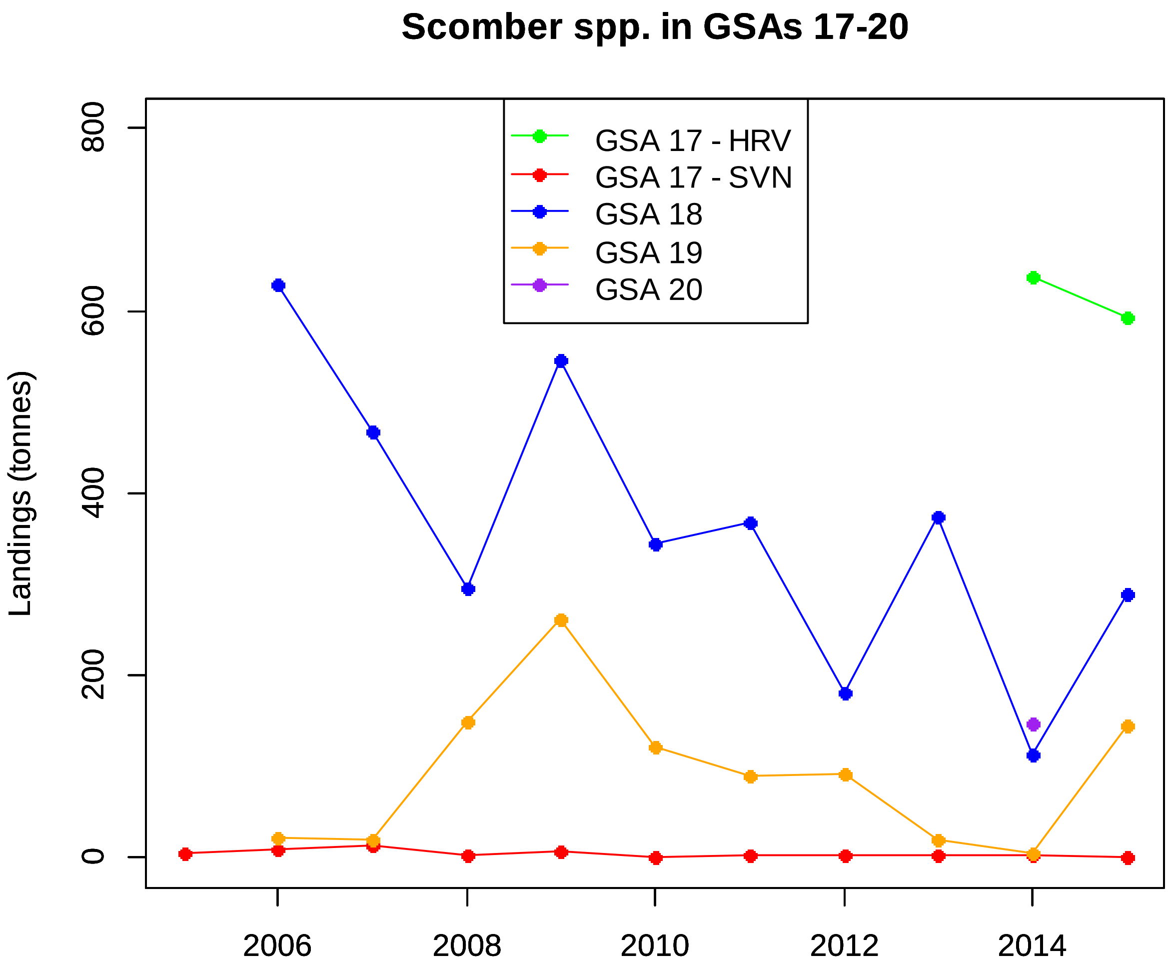


Figure 6.19.2.1. Scomber spp. In GSAS 17,18,19,20. Landings of *Scomber* spp. in GSAs 17-20 in 2005-2015. For GSA 17, Croatian (HRV) data were only available in 2014-2015. For GSA 20, Greek data were only available for 2014.

Table 6.19.2.1. Scomber spp. In GSAS 17,18,19,20. Landings in GSAs 17-20 in 2005-2015. For GSA 17, Croatian (HRV) data were only available in 2014-2015. For GSA 20, Greek data were only available for 2014.

Year	Area	Landings weight (tonnes)
2005	GSA 17 SVN	6.04
	GSA 17 SVN	9.57
2006	GSA 18	629.76
	GSA 19	22.64
	GSA 17 SVN	13.42
2007	GSA 18	468.07
	GSA 19	19.21
	GSA 17 SVN	3.00
2008	GSA 18	295.05
	GSA 19	149.33
	GSA 17 SVN	8.10
2009	GSA 18	545.29
	GSA 19	261.75
	GSA 17 SVN	2.07
2010	GSA 18	344.66
	GSA 19	121.35
	GSA 17 SVN	4.18
2011	GSA 18	367.86
	GSA 19	90.38
	GSA 17 SVN	3.39
2012	GSA 18	181.78
	GSA 19	91.57
	GSA 17 SVN	2.42
2013	GSA 18	374.75
	GSA 19	19.83
	GSA 17 SVN	2.39
2014	GSA 17 HRV	636.78
	GSA 18	114.33

	GSA 19	5.99
	GSA 20	147.54
2015	GSA 17 SVN	1.77
	GSA 17 HRV	592.24
	GSA 18	288.55
	GSA 19	145.00

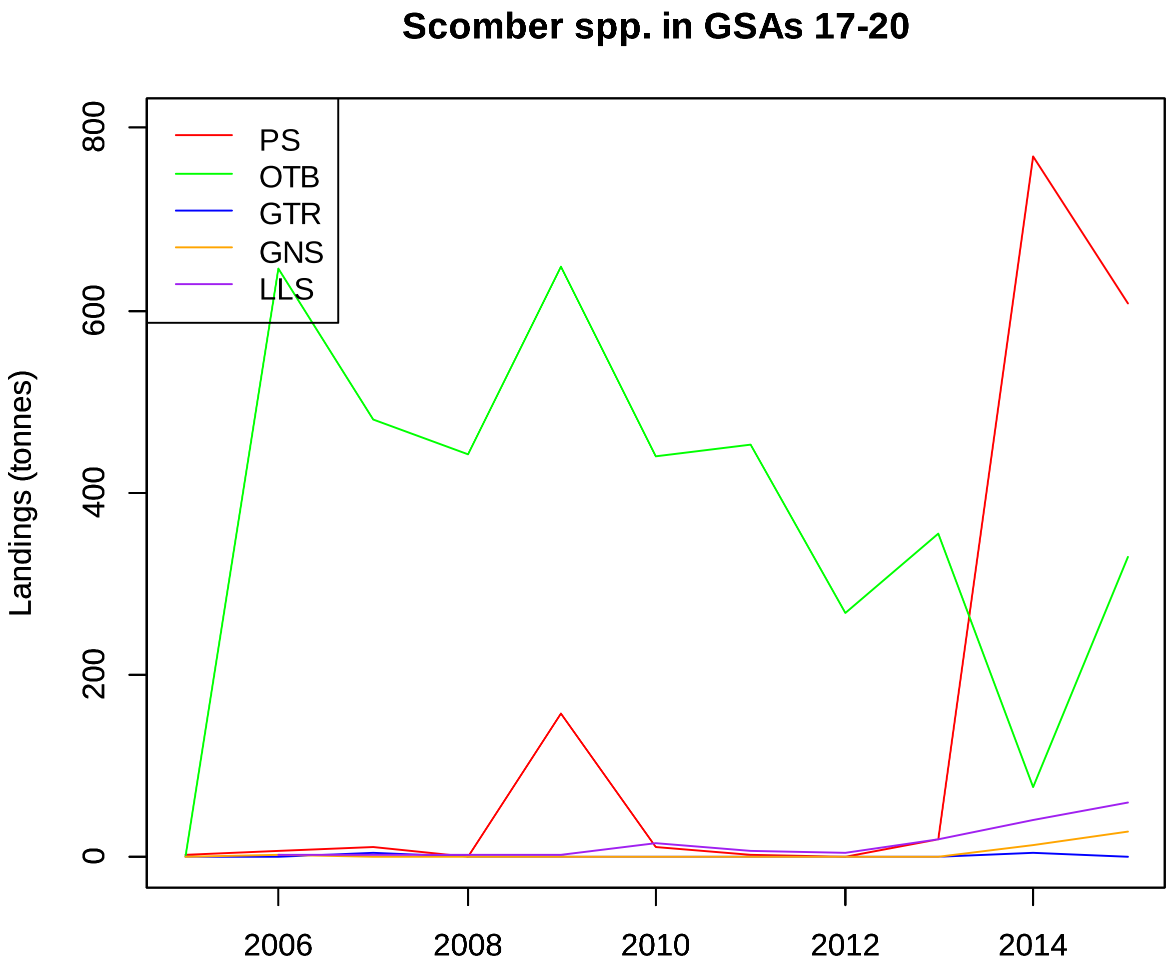


Figure 6.19.2.2. Scomber spp. In GSAS 17,18,19,20. Landings of *Scomber* spp. by gear in GSAs 17-20 in 2005-2015. The five gears with the highest contribution are shown. The peak in OTB landings in 2005 was due to the inclusion of Italian data in that year. The peak in PS landings in 2014 was due to the inclusion of Croatian data in that year. PS: Purse seine; OTB: Bottom otter trawl; GNS: Set gillnet; GTR: trammel net; LLS: Set longlines

Table 6.19.2.2. Scomber spp. In GSAS 17,18,19,20 Landings by gear in GSAs 17-20 in 2005-2015.

Year	Gear	Landings weight (tonnes)
2005	GND	<0.01
	GNS	0.47
	GTR	0.03
	OTB	0.03
	PS	2.29
	PTM	3.22
2006	NK	0.39
	GND	0.01
	GNS	2.94
	GTR	2.05
	LLS	2.25
	OTB	645.07
	PS	6.59
	PTM	2.69
2007	GNS	1.37
	GTR	6.26
	OTB	480.82
	PS	11.44
	PTM	0.80
2008	GNS	0.69
	GTR	0.40
	LLS	2.68
	OTB	441.35
	PS	2.05
	PTM	0.20
2009	GND	<0.01
	GNS	1.46
	GTR	0.33
	LLS	4.02
	OTB	649.00
	PS	158.50

	PTM	**1.82**
	GNS	**0.40**
	GTR	**0.11**
	LHP	**0.01**
2010	**LLS**	**15.69**
	OTB	**439.60**
	PS	**12.22**
	PTM	**0.07**
	GNS	**1.19**
	GTR	**0.08**
	LHP	**0.02**
2011	**LLS**	**6.41**
	OTB	**452.06**
	PS	**2.65**
	PTM	**0.01**
	GND	**0.01**
	GNS	**1.76**
	GTR	**0.07**
2012	**LLS**	**5.19**
	OTB	**268.64**
	PS	**1.08**
	GNS	**0.80**
	GTR	**0.04**
	LHP	**0.09**
2013	**LLS**	**20.83**
	OTB	**355.54**
	PS	**19.68**
	GNS	**13.88**
	GTR	**5.80**
2014	**LHP**	**0.08**
	LLS	**41.75**
	OTB	**76.93**

	PS	**768.58**
2015	**GNS**	**27.65**
	GTR	**1.42**
	LHP	**0.07**
	LLS	**60.64**
	OTB	**330.18**
	PS	**607.60**

The availability of length frequency distributions of the *Scomber* spp. landings from GSAs 17-20 was sporadic. The available *Scomber* spp. length frequency distributions from OTB in 2006-2015 indicated that GSA 19 generally produced the smallest fish, while GSA 18 generally produced the largest fish (Fig. 6.19.2.3). The availability of length frequency distributions from PS was lower than that from OTB, and suggested that generally smaller fish were caught by PS compared to OTB in GSA 17 (Fig. 6.19.2.4), but the opposite was true for GSA 19 (Fig. 6.19.2.5). PS landings from GSA 20 (Fig. 6.19.2.6) consisted of smaller fish than PS landings from GSA 19.

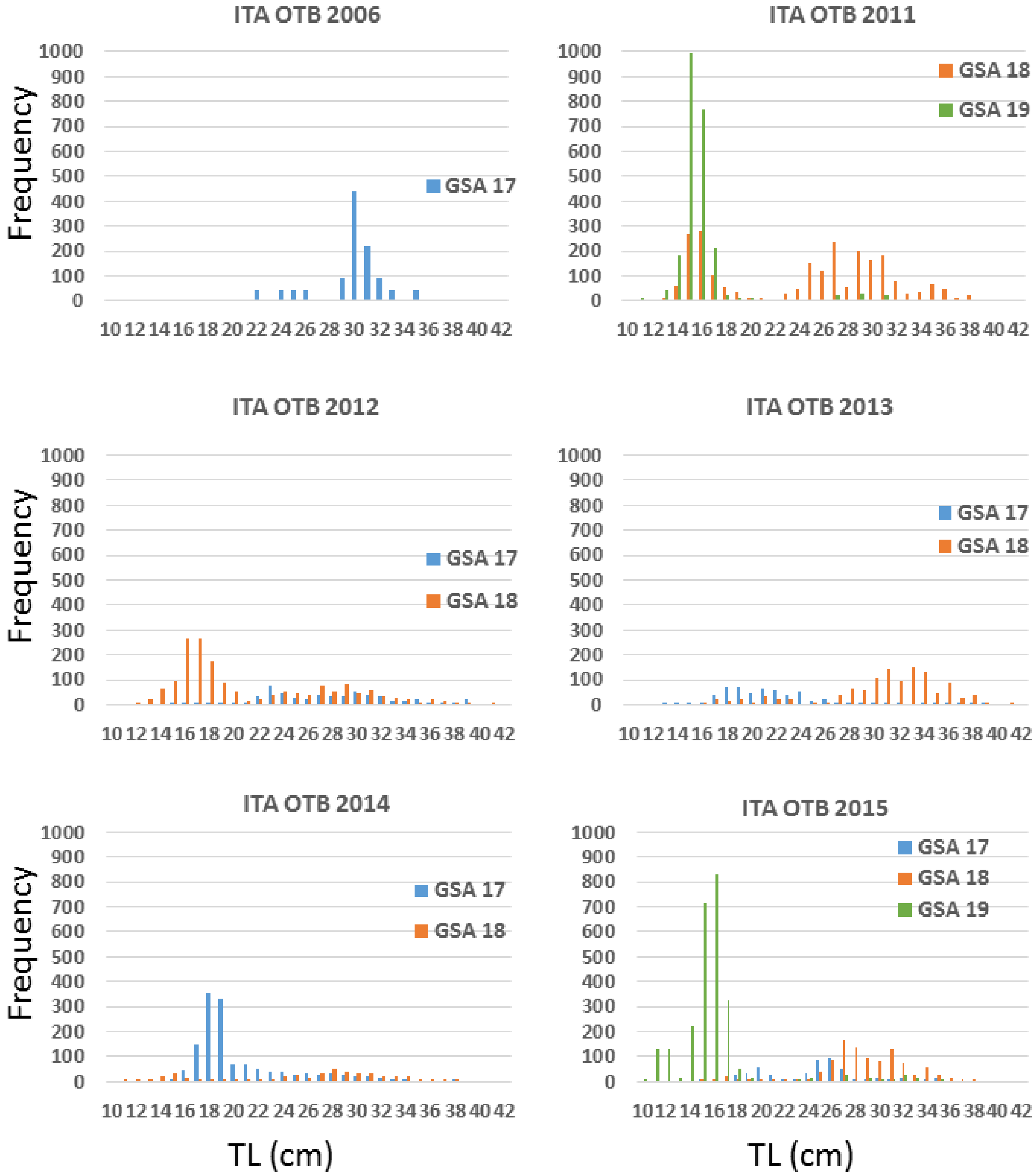


Figure 6.19.2.3. Scomber spp. In GSAS 17,18,19,20. Length frequency distribution (in thousands) of *Scomber* spp. landings from bottom otter trawl (OTB) in GSAs 17-19 in 2006 and 2011-2015.

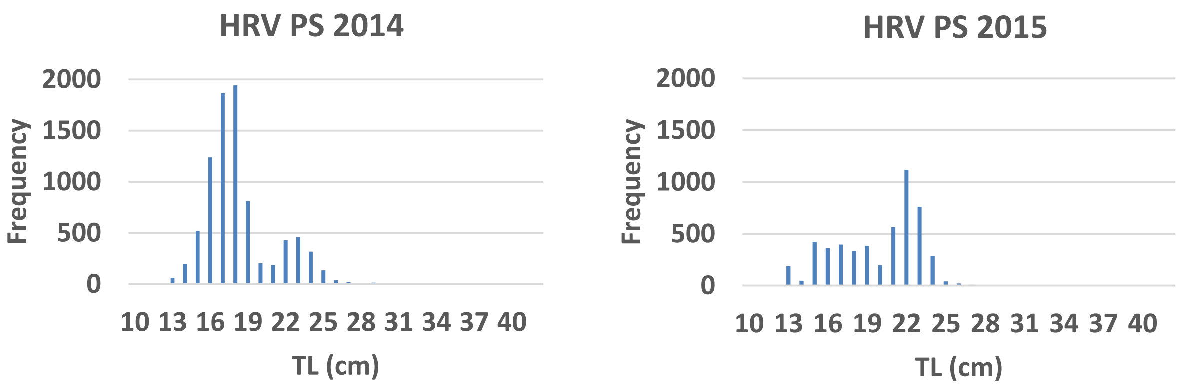


Figure 6.19.2.4. Scomber spp. In GSAS 17,18,19,20. Length frequency distribution (in thousands) of *Scomber* spp. landings from Croatian purse seines (PS) in GSA 17 in 2014-2015.

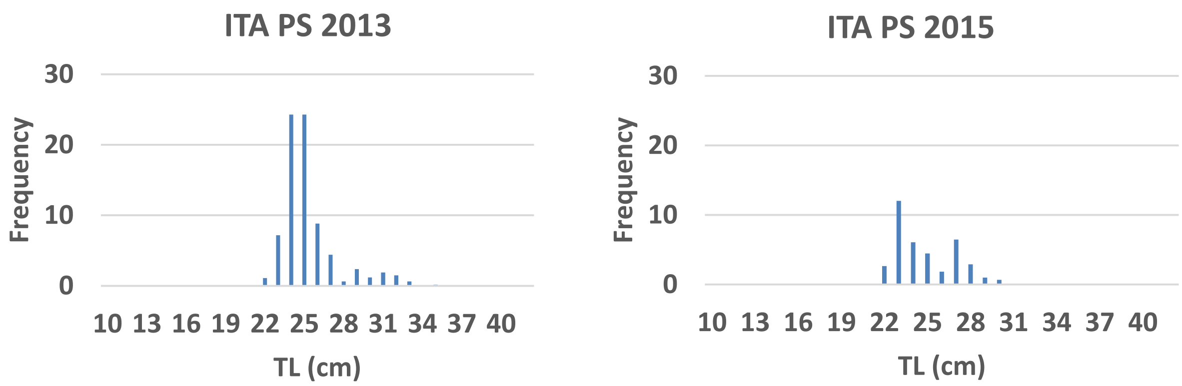


Figure 6.19.2.5. Scomber spp. In GSAS 17,18,19,20. Length frequency distribution (in thousands) of *Scomber* spp. landings from Italian purse seines (PS) in GSA 19 in 2013 and 2015.

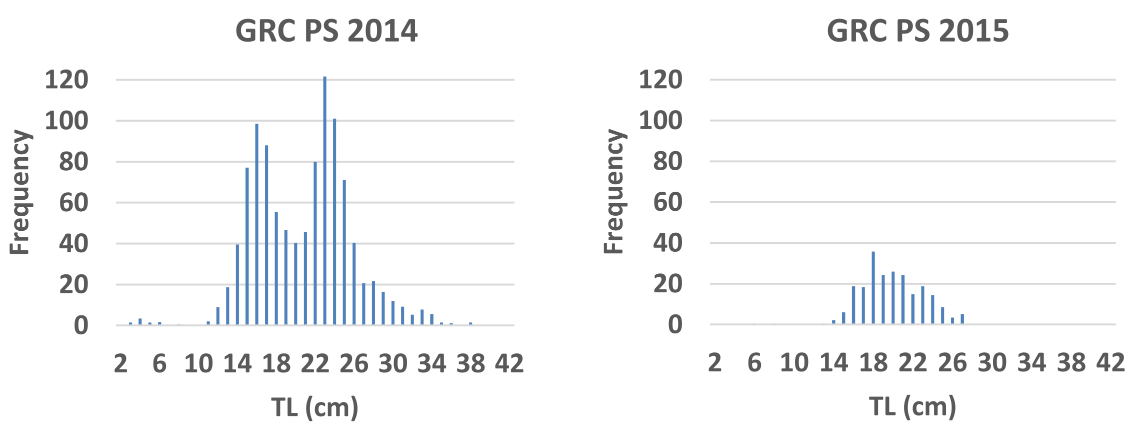


Figure 6.19.2.6. Scomber spp. In GSAS 17,18,19,20. Length frequency distribution (in thousands) of *Scomber* spp. landings from Greek purse seines (PS) in GSA 20 in 2014-2015.

Scomber spp. landings-at-age were only available for Croatian PS in GSA 17 in 2014-2015 (Fig. 6.19.2.7) and for Greek PS in GSA 20 in 2014 (Fig. 6.19.2.8). Catch composition was dominated by fish aged 1-2 in GSA 20, while age-class 0 was the most abundant in GSA 20 landings.

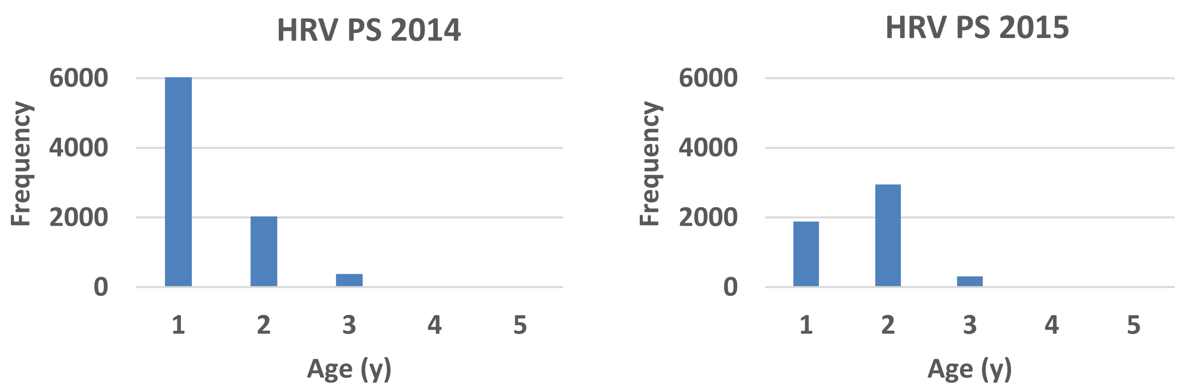


Figure 6.19.2.7. Scomber spp. In GSAS 17,18,19,20. Landings at age (in thousands) from Croatian purse seines (PS) in GSA 17 in 2014-2015.

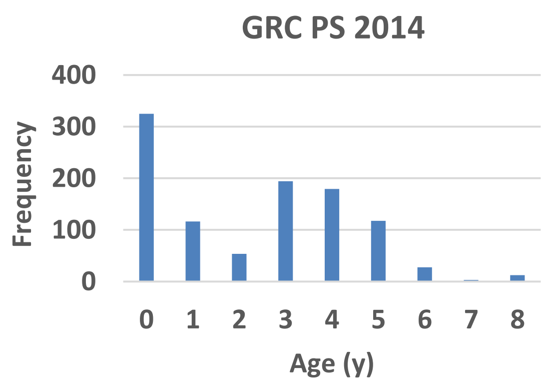


Figure 6.19.2.8. Scomber spp. In GSAS 17,18,19,20 Landings at age (in thousands)from Greek purse seines (PS) in GSA 20 in 2014.

Discards

There was limited availability of discards data in the DCF regarding *Scomber* spp. in GSAs 17-20. Available data indicated more discards in GSA 18 compared to GSA 19 (Fig. 6.19.2.9; Table 6.19.2.3) and more discards from OTB compared to other gears (Fig. 6.19.2.10; Table 6.19.2.4)

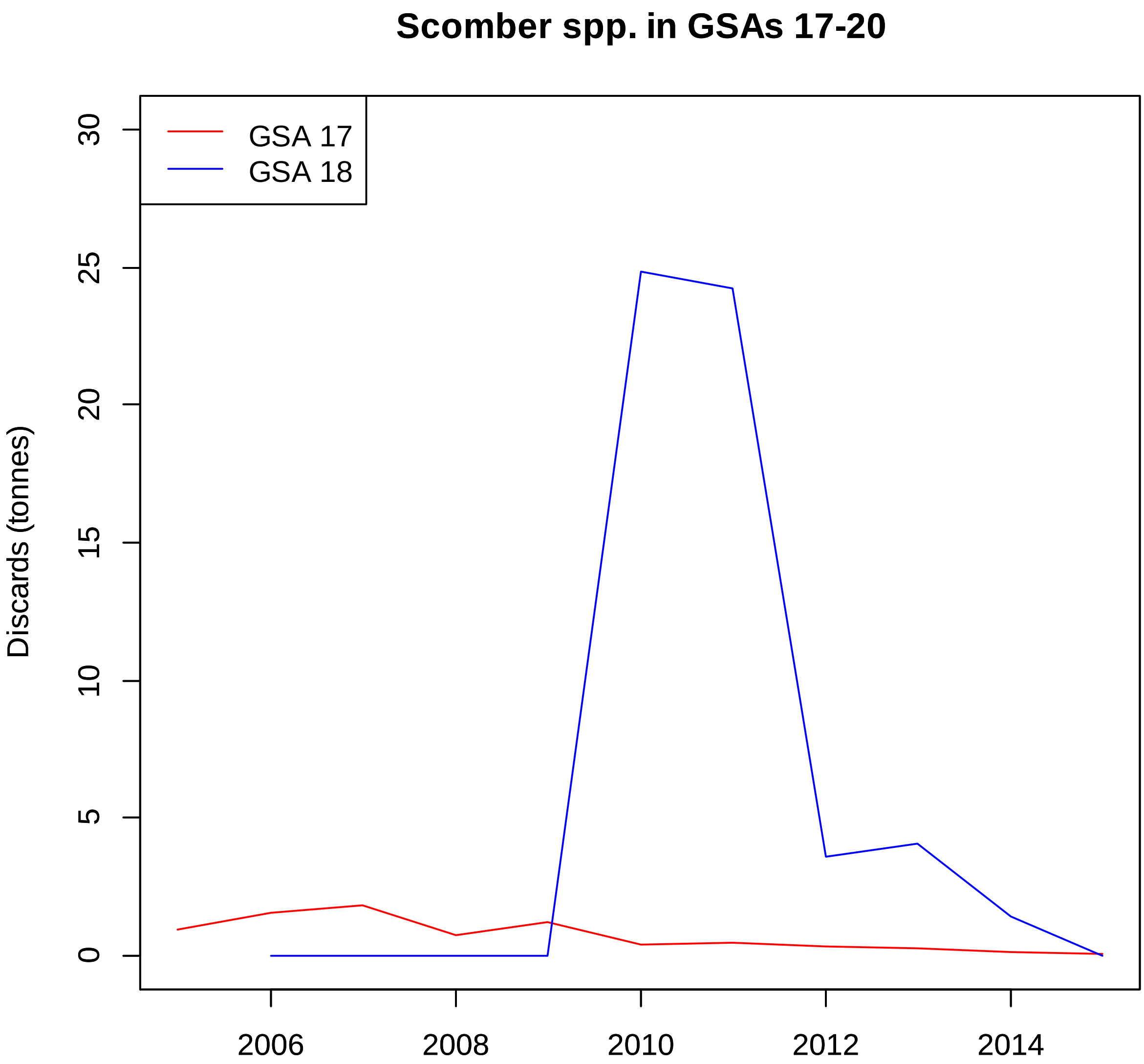


Figure 6.19.2.9. Scomber spp. In GSAS 17,18,19,20. Discards of *Scomber* spp. in GSAs 17-18 in 2005-2015

Table 6.19.2.3. Scomber spp. In GSAS 17,18,19,20. Discards of *Scomber* spp. in GSAs 17-18 in 2005-2015

Year	Area	Landings weight (tonnes)
2005	GSA 17	0.93
2006	GSA 17	1.52
	GSA 18	0

2007	**GSA 17**	**1.82**
	GSA 18	**0.00**
2008	**GSA 17**	**0.71**
	GSA 18	**0**
2009	**GSA 17**	**1.19**
	GSA 18	**0**
2010	**GSA 17**	**0.38**
	GSA 18	**24.81**
2011	**GSA 17**	**0.45**
	GSA 18	**24.25**
2012	**GSA 17**	**0.31**
	GSA 18	**3.59**
2013	**GSA 17**	**0.23**
	GSA 18	**4.08**
2014	**GSA 17**	**0.12**
	GSA 18	**1.44**
2015	**GSA 17**	**0.08**
	GSA 18	**0**

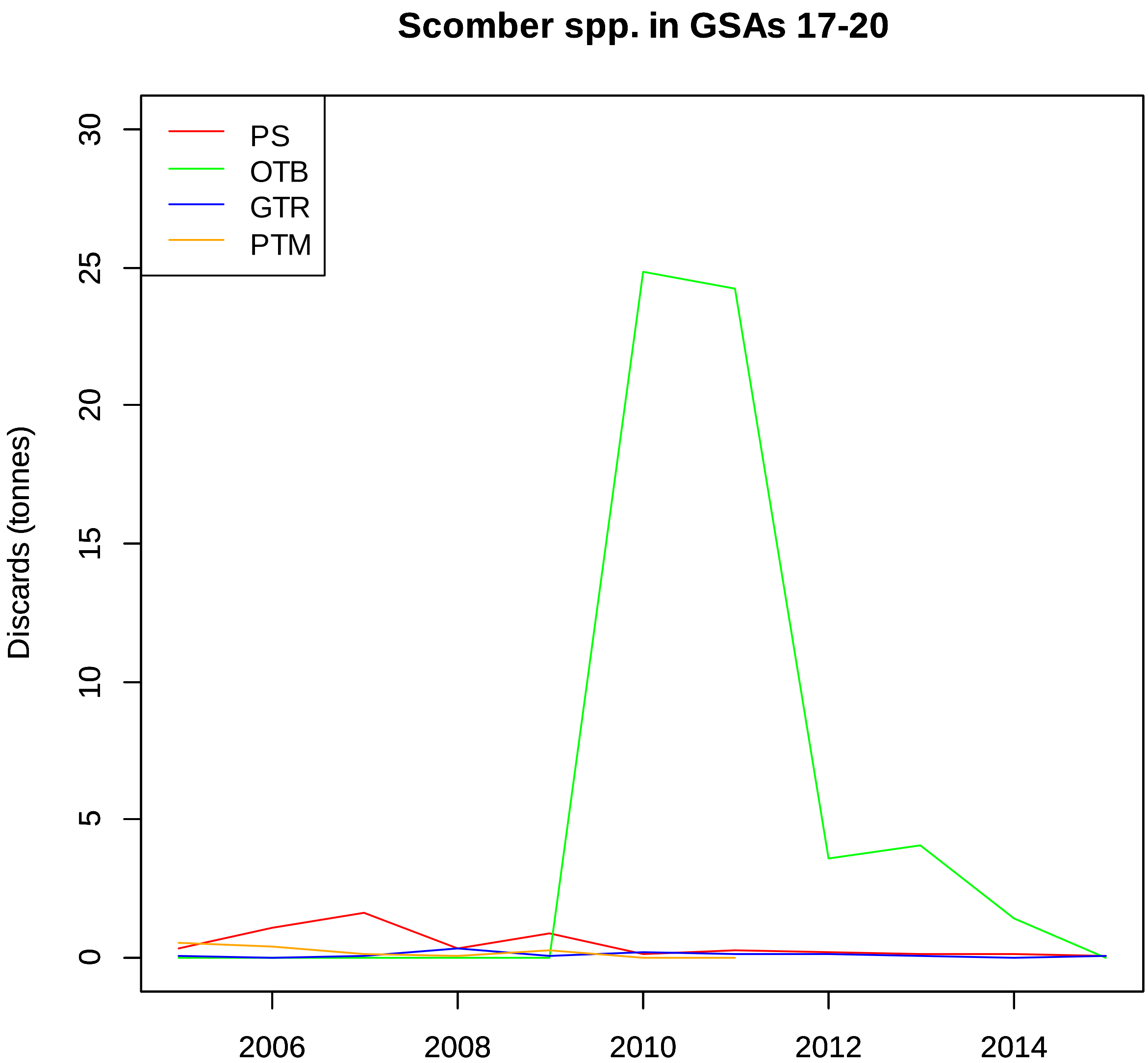


Figure 6.19.2.10. Scomber spp. In GSAS 17,18,19,20. Discards by fishing gear in GSAs 17-18 in 2005-2015. The first four gears in terms of discards volume are shown. PS: Purse seine; OTB: Bottom otter trawl; GTR: trammel net; PTM: Pelagic pair trawl

Table 6.19.2.7. Scomber spp. In GSAS 17,18,19,20. Discards by fishing gear in GSAs 17-18 in 2005-2015.

Year	Gear	Landings weight (tonnes)
2005	PTM	0.54
	PS	0.33
	OTB	0.00
	GTR	0.06
2006	PTM	0.43

	PS	**1.07**
	OTB	**0.00**
	GTR	**0.02**
	PTM	**0.12**
2007	**PS**	**1.63**
	OTB	**0.00**
	GTR	**0.06**
	PTM	**0.03**
2008	**PS**	**0.34**
	OTB	**0.00**
	GTR	**0.34**
	PTM	**0.28**
2009	**PS**	**0.85**
	OTB	**0.00**
	GTR	**0.05**
	PTM	**0.01**
2010	**PS**	**0.14**
	OTB	**24.81**
	GTR	**0.23**
	PTM	**0.00**
2011	**PS**	**0.29**
	OTB	**24.25**
	GTR	**0.16**
	PS	**0.16**
2012	**OTB**	**3.59**
	GTR	**0.15**
	PS	**0.14**
2013	**OTB**	**4.08**
	GTR	**0.09**
	PS	**0.10**
2014	**OTB**	**1.44**
	GTR	**0.02**

	PS	**0.05**
2015	**OTB**	**0.00**
	GTR	**0.03**

Length frequency distribution of discards indicates that generally larger fish are discarded in GSA 17 (Fig. 6.9.2.11, 6.9.2.12) than in GSA 18 (Fig. 6.9.2.13).

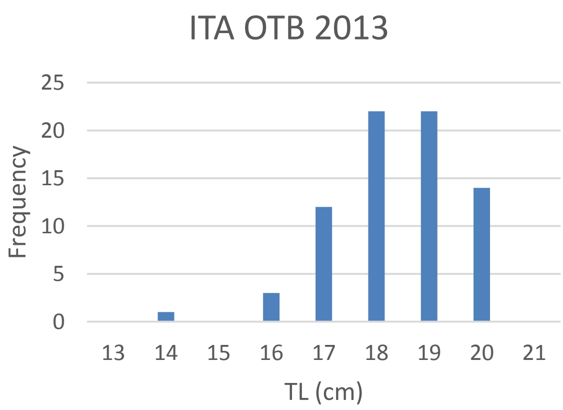


Figure 6.19.2.11. Scomber spp. In GSAS 17,18,19,20. Length frequency distribution (in thousands) of *Scomber* spp. discards from Italian bottom otter trawls (OTB) in GSA 17 in 2013.

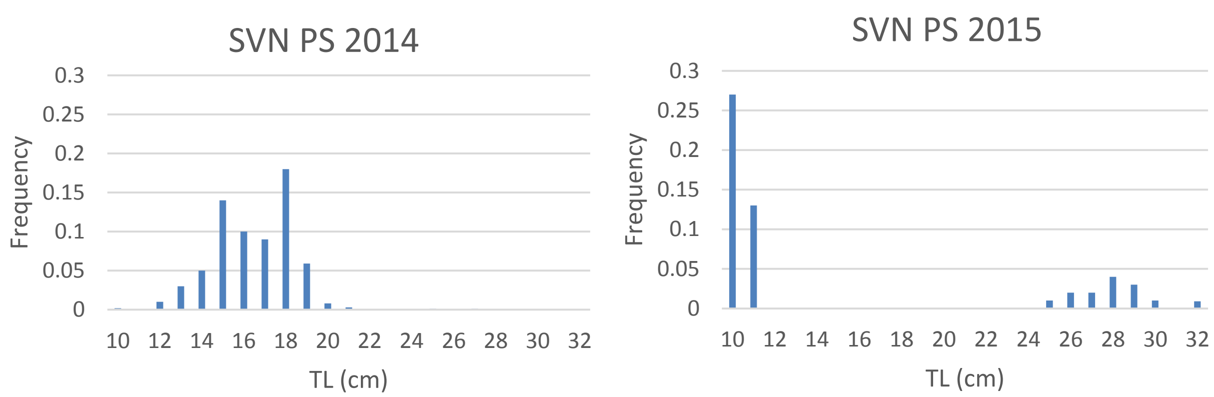


Figure 6.19.2.12. Scomber spp. In GSAS 17,18,19,20. Length frequency distribution (in thousands) of *Scomber* spp. discards from Slovenian purse seines (PS) in GSA 17 in 2014-2015.

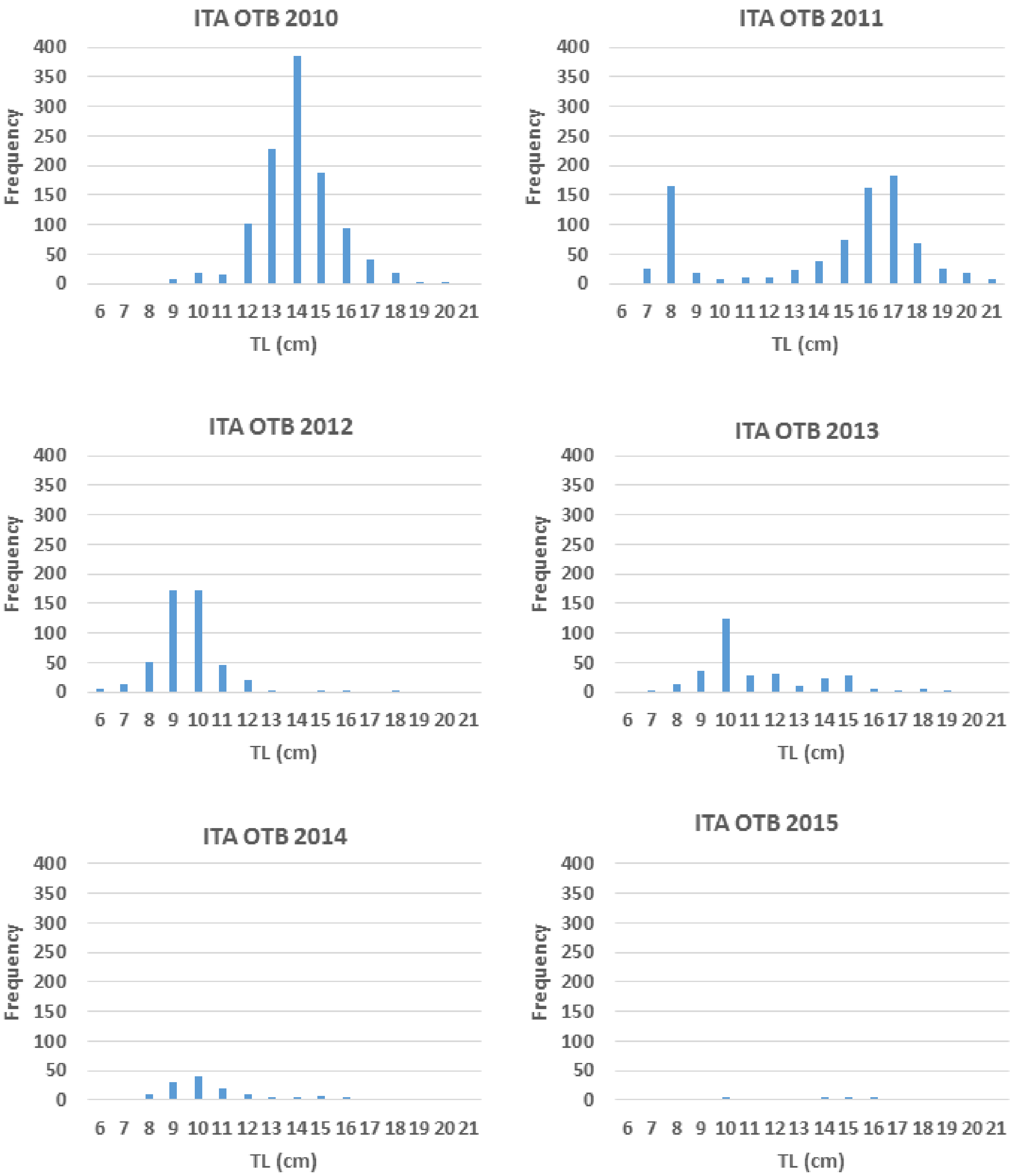


Figure 6.19.2.13. Scomber spp. In GSAS 17,18,19,20. Length frequency distribution (in thousands) of *Scomber* spp. discards from Italian bottom otter trawl (OTB) in GSA 18 in 2010-2015.

6.19.3. Fishing effort data.

The majority of PS effort was allocated to GSAs 17 and 18 (Fig. 6.19.3.1, 6.19.3.2; Table 6.19.3.1). Italian and Slovenian PS effort has been generally decreasing in 2006-2015, with a distinct increase occurring in 2015 in GSAs 17 and 18. Croatian (GSA 17) and Greek (GSA 20) effort data were sporadic and were not included in the graphs. OTB effort was generally higher in GSA 17 compared to GSAs 18-19 in 2006-2015 (Fig. 6.19.3.3, 6.19.3.4; Table 6.19.3.2).

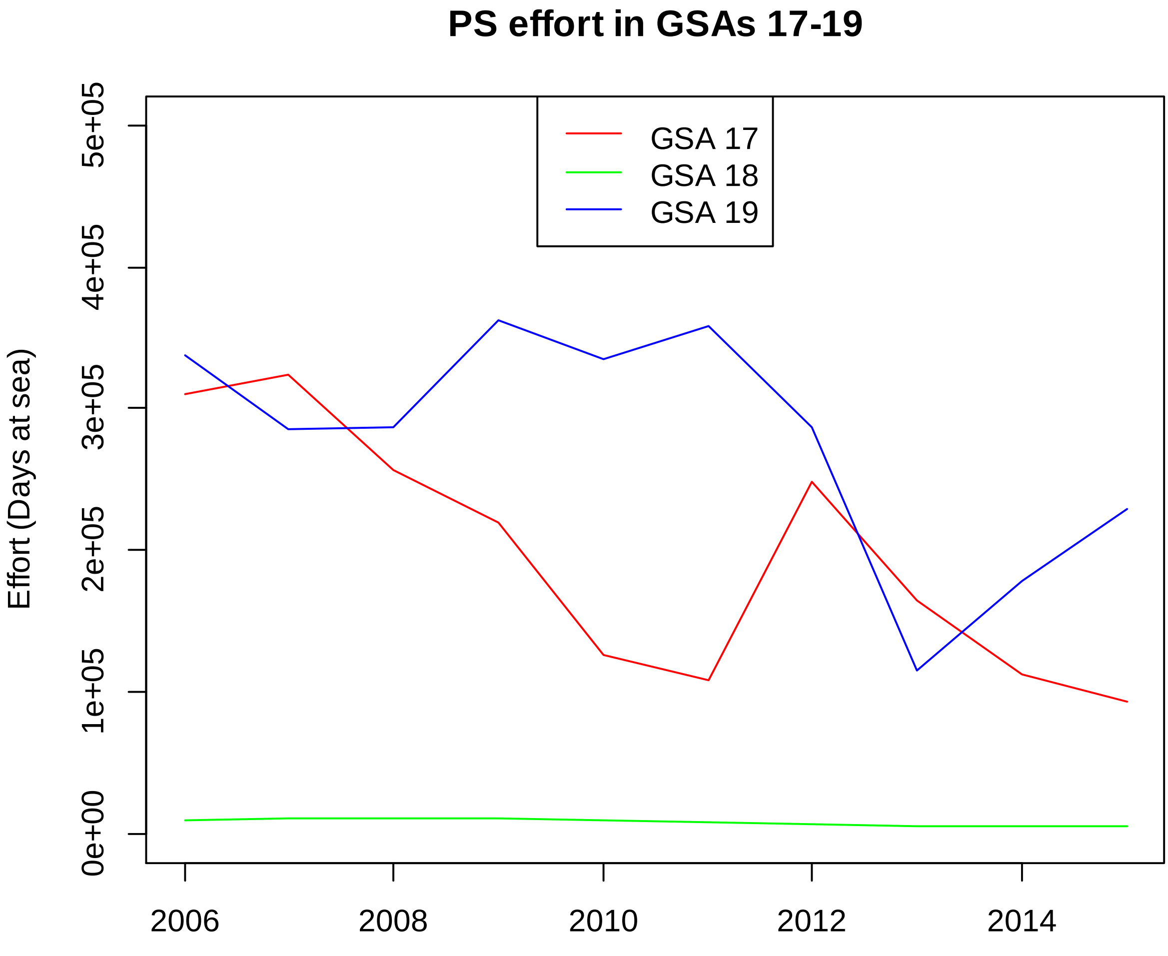


Figure 6.19.3.1. Scomber spp. In GSAS 17,18,19,20. Purse seine (PS) effort (in days at sea) in GSAs 17-19 in 2006-2015. Only Italian and Slovenian data are shown.

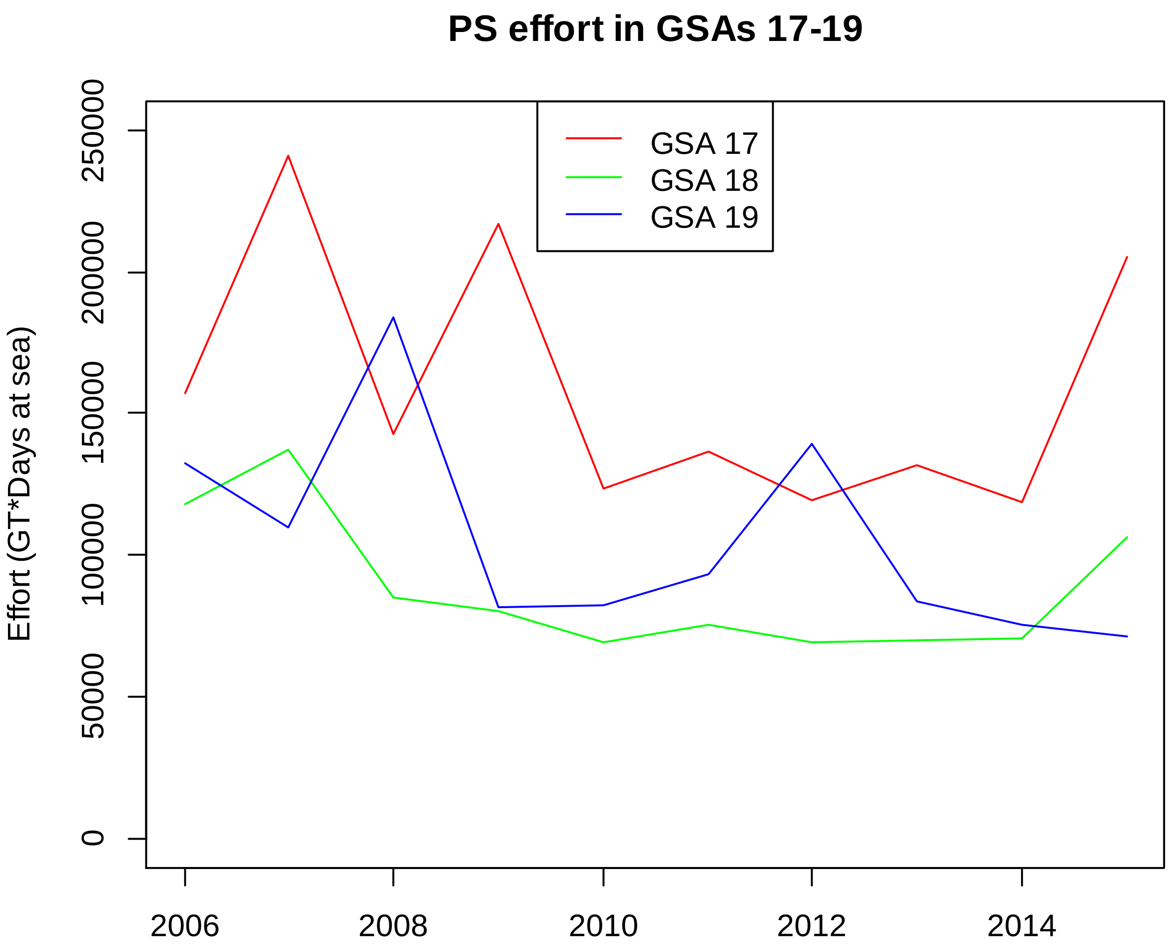


Figure 6.19.3.2. Scomber spp. In GSAS 17,18,19,20. Purse seine (PS) effort (in GT*days at sea) in GSAs 17-19 in 2006-2015. Only Italian and Slovenian data are shown.

Table 6.19.3.1. Scomber spp. In GSAS 17,18,19,20. Purse seine (PS) effort (in days at sea) in GSAs 17-19 in 2006-2015. Only Italian and Slovenian data are shown.

Year	Area	GT*Days at sea	Days at sea
	GSA 17	157176.9	309772.3
2006	GSA 18	118184	9815.4
	GSA 19	132197	337451.7
	GSA 17	241143.6	323899.4
2007	GSA 18	137249	10373.08
	GSA 19	109924	285808.1
	GSA 17	142608.2	256128.3
2008	GSA 18	85003	10486.46
	GSA 19	184237	286475.9

	GSA 17	**216851.7**	**220258.7**
2009	**GSA 18**	**80357**	**10702.6**
	GSA 19	**81658**	**362578.7**
	GSA 17	**123891.6**	**125974.8**
2010	**GSA 18**	**69161**	**9844.86**
	GSA 19	**82491**	**335268.3**
	GSA 17	**136351.8**	**108675.7**
2011	**GSA 18**	**75416**	**8911.67**
	GSA 19	**93319**	**357699.3**
	GSA 17	**119114.3**	**249039.6**
2012	**GSA 18**	**68998**	**6290.15**
	GSA 19	**139663**	**286902.9**
	GSA 17	**131630**	**165324.4**
2013	**GSA 18**	**69846**	**5868.75**
	GSA 19	**83819**	**115696**
	GSA 17	**118433.6**	**113106.5**
2014	**GSA 18**	**70755**	**5642.25**
	GSA 19	**75839**	**178189.3**
	GSA 17	**205342.7**	**93566.55**
2015	**GSA 18**	**106734**	**5641.24**
	GSA 19	**71124**	**229562.3**

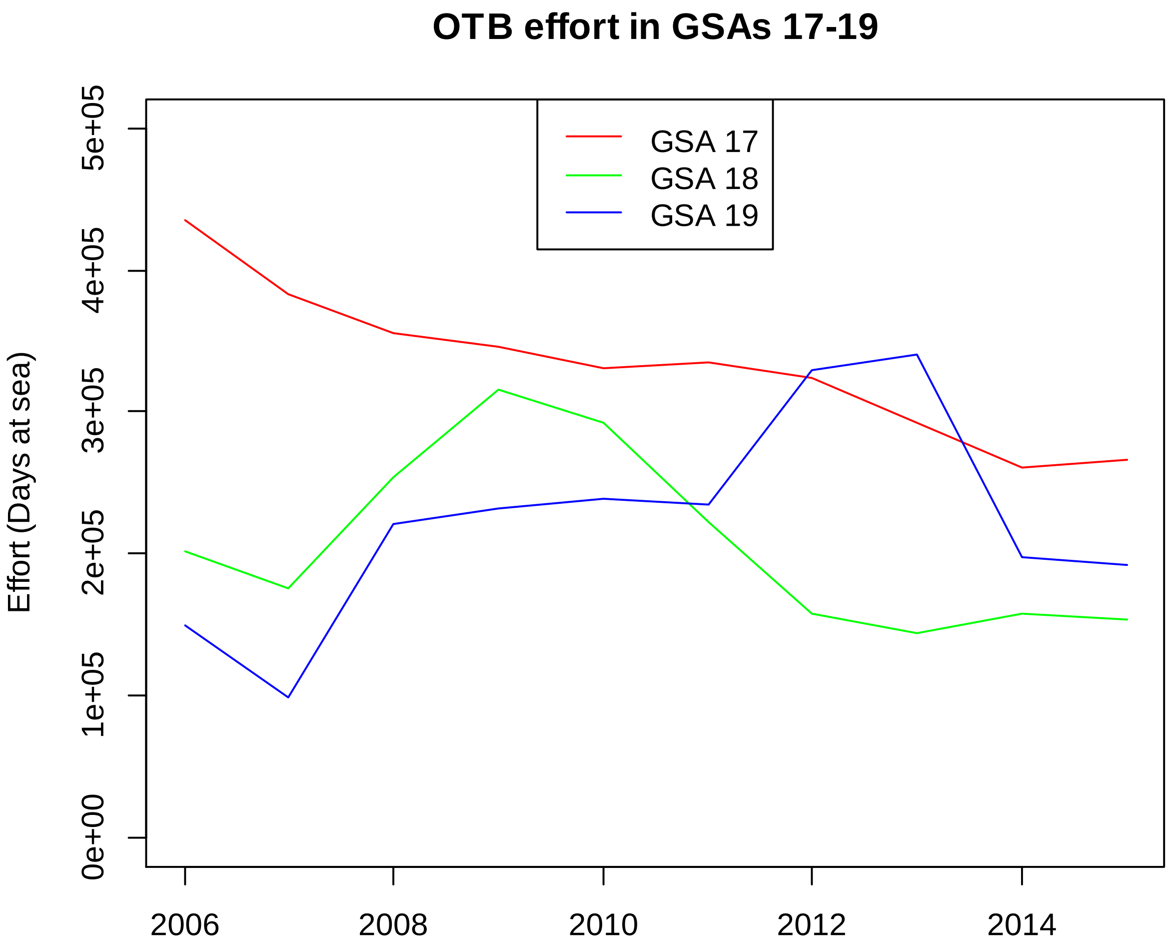


Figure 6.19.3.3. Scomber spp. In GSAS 17,18,19,20. Bottom otter trawl (OTB) effort (in days at sea) in GSAs 17-19 in 2006-2015. Only Italian and Slovenian data are shown.

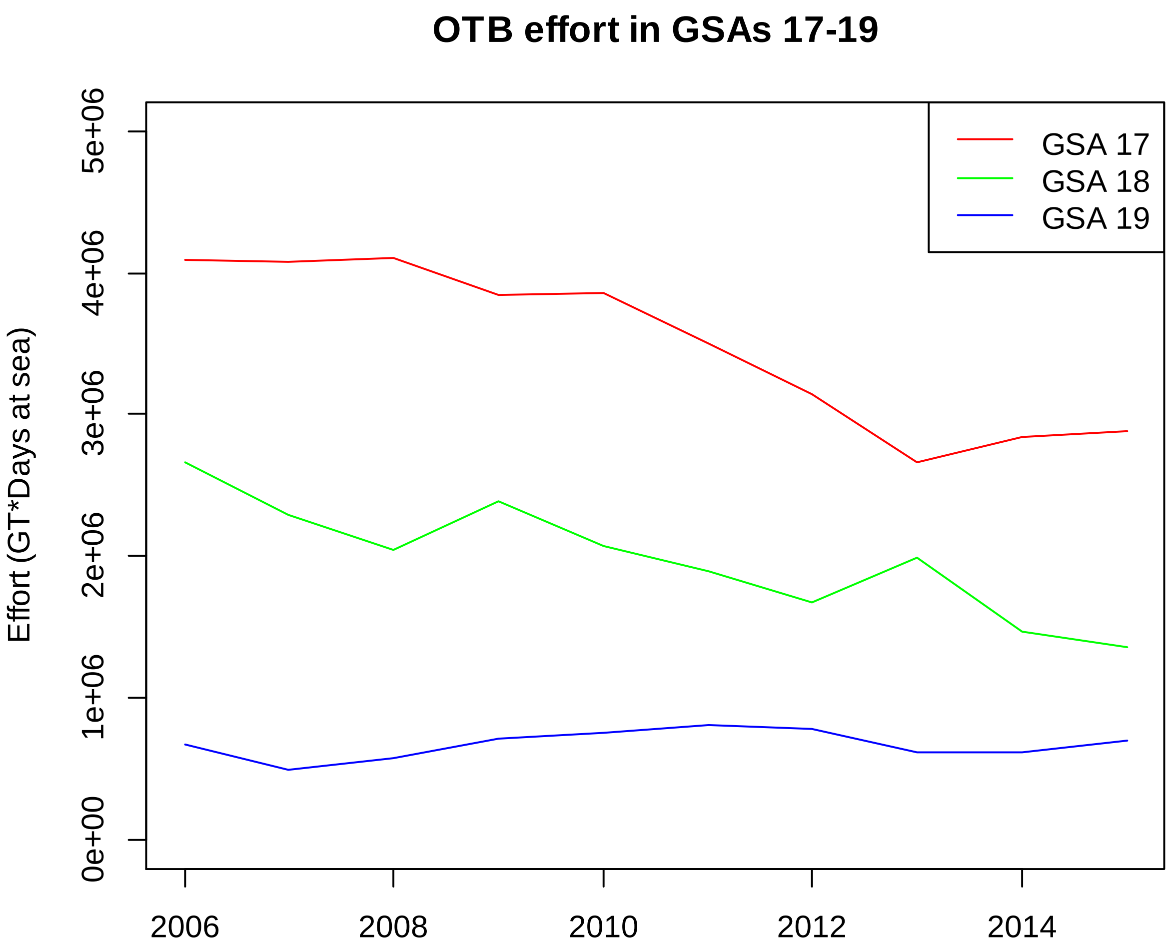


Figure 6.19.3.4. Scomber spp. In GSAS 17,18,19,20. Bottom otter trawl (OTB) effort (in GT*days at sea) in GSAs 17-19 in 2006-2015. Only Italian and Slovenian data are shown.

Table 6.19.3.2. Scomber spp. In GSAS 17,18,19,20. Bottom otter trawl (OTB) effort (in GT*days at sea) in GSAs 17-19 in 2006-2015. Only Italian and Slovenian data are shown.

Year	Area	GT*Days at sea	Days at sea
2006	GSA 17	4091960	435617.9
	GSA 18	2662179	201679.1
	GSA 19	672536	148969.2
2007	GSA 17	4074189	383694.9
	GSA 18	2294240	176344.8
	GSA 19	491942	99351.49
2008	GSA 17	4101323	355763.6
	GSA 18	2039422	253576.7

	GSA 19	**574366**	**220628.5**
	GSA 17	**3848666**	**346300**
2009	**GSA 18**	**2386555**	**316410.5**
	GSA 19	**711619**	**231642.2**
	GSA 17	**3855681**	**331027**
2010	**GSA 18**	**2068044**	**292886.9**
	GSA 19	**759137**	**238933.1**
	GSA 17	**3500396**	**334481**
2011	**GSA 18**	**1900240**	**222708**
	GSA 19	**805415**	**235343.9**
	GSA 17	**3145706**	**323702.2**
2012	**GSA 18**	**1668749**	**157791.9**
	GSA 19	**785235**	**329279.5**
	GSA 17	**2657375**	**292895.8**
2013	**GSA 18**	**1994855**	**143901.5**
	GSA 19	**621952**	**339802.6**
	GSA 17	**2845553**	**260181.9**
2014	**GSA 18**	**1463644**	**157301**
	GSA 19	**615493**	**197050.1**
	GSA 17	**2882518**	**266540.9**
2015	**GSA 18**	**1355193**	**154211.3**
	GSA 19	**696946**	**192136.1**

6.19.4. Survey Indices of abundance and biomass by year and size/age

MEDITS data were used to derive abundance and biomass indices for *Scomber* spp. in GSAs 17-19. MEDITS data for *Scomber* spp. and *S. scombrus* were combined to ensure consistency with the landings data. In GSA 17 the indices were calculated for years 2002-2015 (Fig. 6.19.4.1, 6.19.4.2), while in GSAs 18 and 19 the indices were calculated for years 1994-2015 (Fig. 6.19.4.3, 6.19.4.4, 6.19.4.5, 6.19.4.6). No strong overall trends were observed in the MEDITS-derived indices. Length frequency distribution of *Scomber* spp. in MEDITS suggested a similar size structure in GSAs 17 and 18 (6.19.4.7, 6.19.4.8).

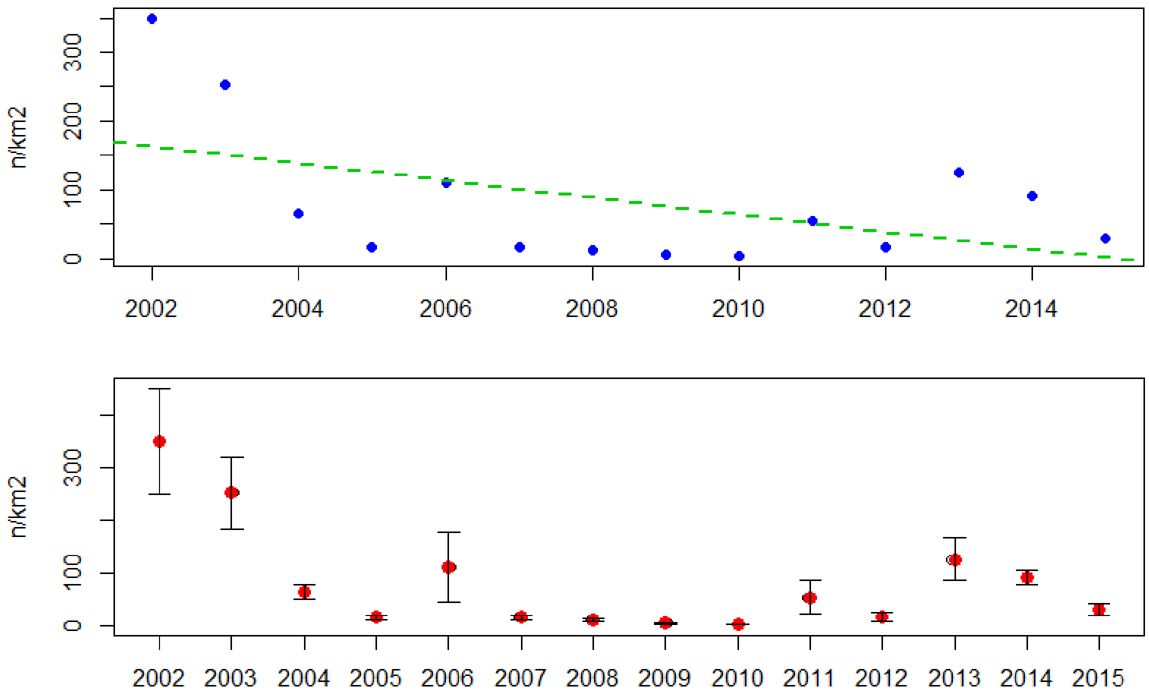


Figure 6.19.4.1. Scomber spp. In GSAS 17,18,19,20. MEDITS-derived abundance index (n/km2) for *Scomber* spp. in GSA 17 in 2002-2015

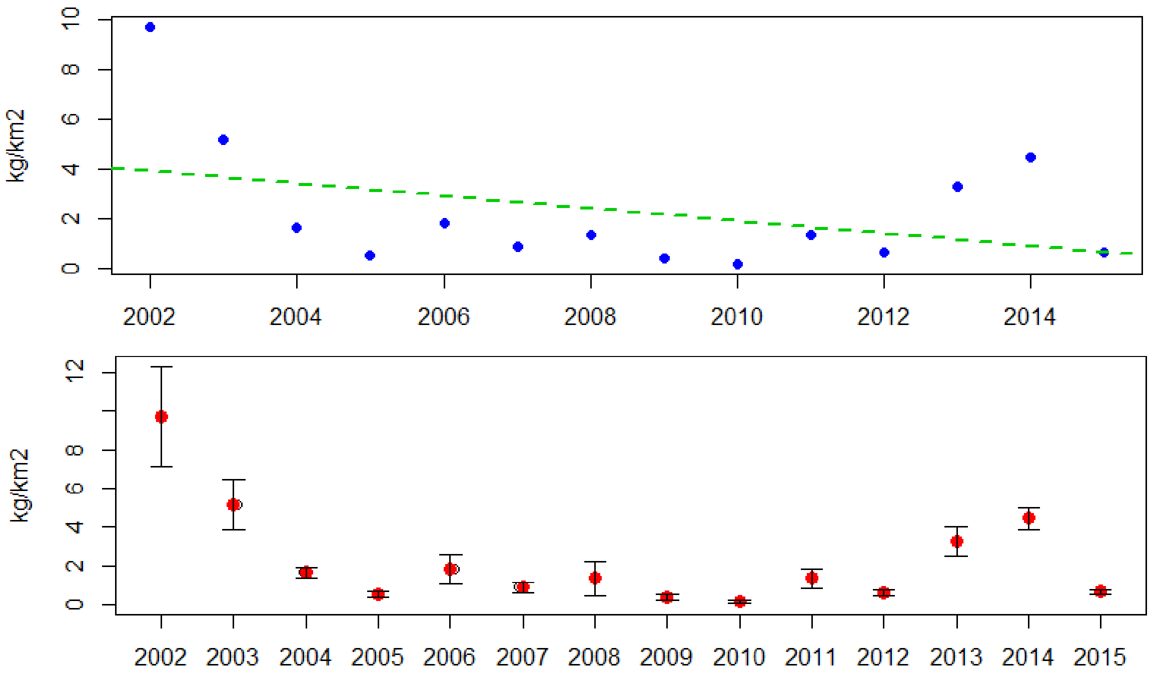


Figure 6.19.4.2. Scomber spp. In GSAS 17,18,19,20. MEDITS-derived biomass index (kg/km2) for *Scomber* spp. in GSA 17 in 2002-2015

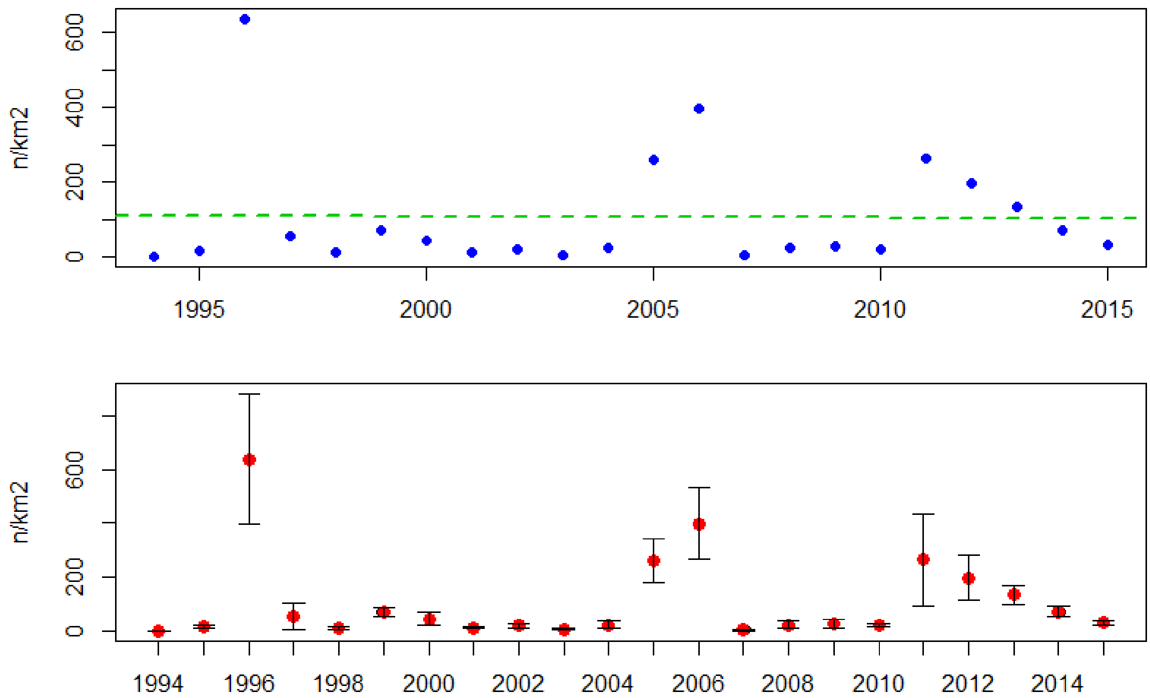


Figure 6.19.4.3. Scomber spp. In GSAS 17,18,19,20. MEDITS-derived abundance index (n/km2) for *Scomber* spp. in GSA 18 in 1994-2015

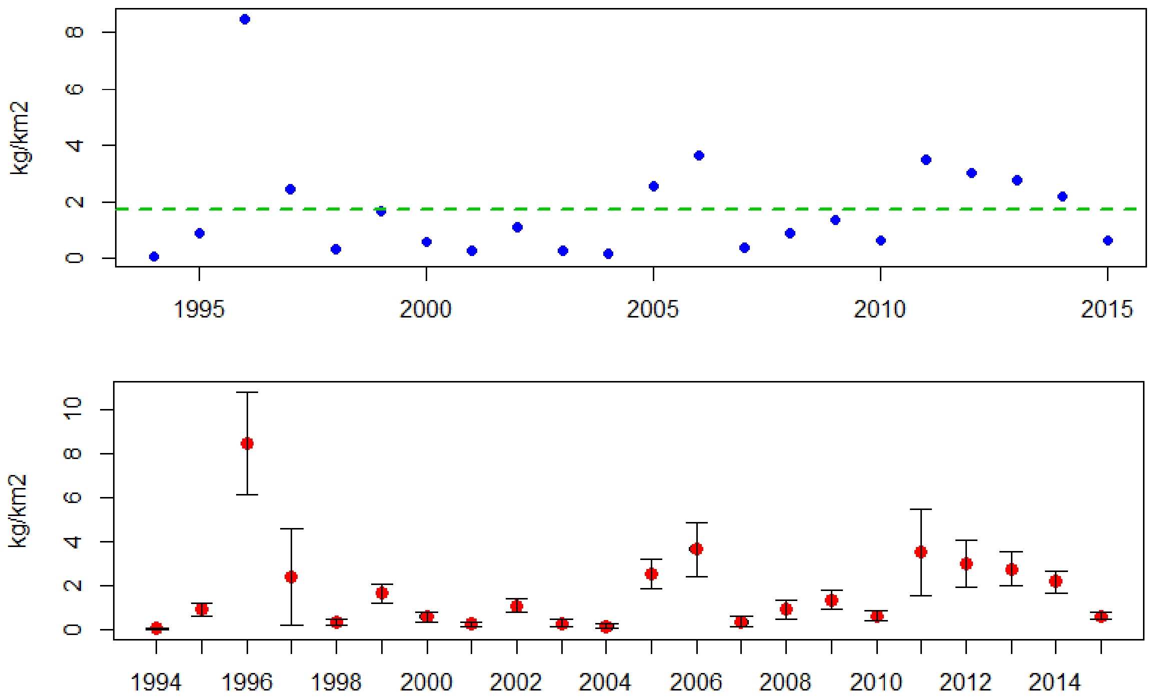


Figure 6.19.4.4. Scomber spp. In GSAS 17,18,19,20. MEDITS-derived biomass index (kg/km2) for *Scomber* spp. in GSA 18 in 1994-2015

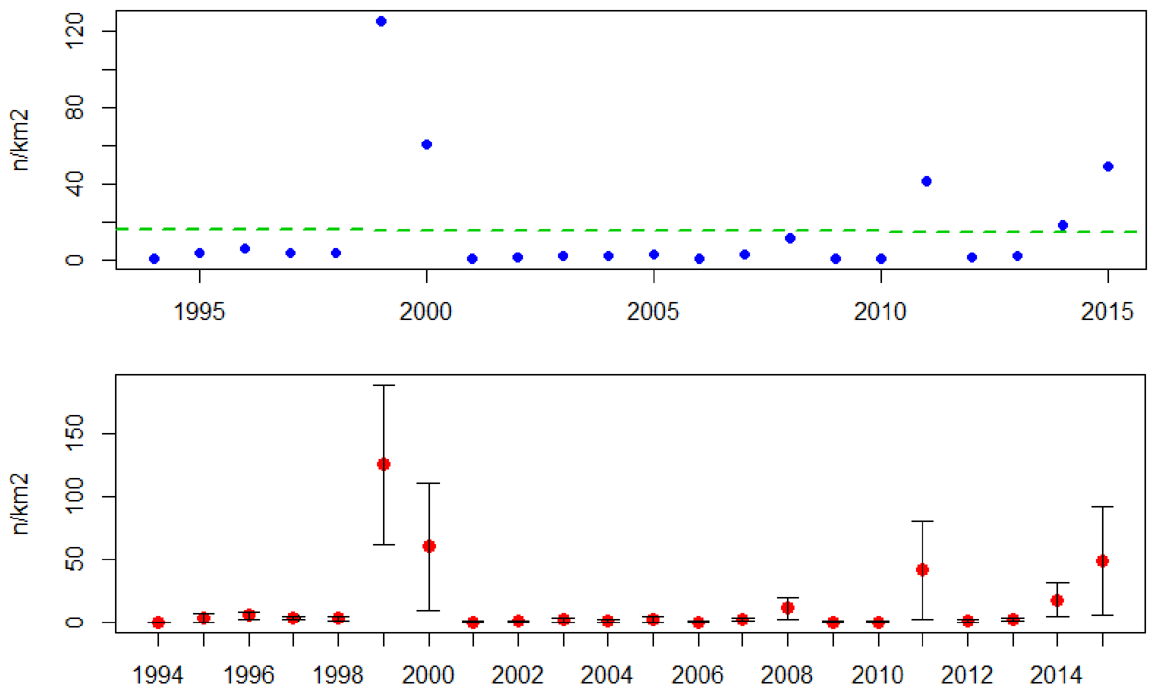


Figure 6.19.4.5. Scomber spp. In GSAS 17,18,19,20. MEDITS-derived abundance index (n/km2) for *Scomber* spp. in GSA 19 in 1994-2015

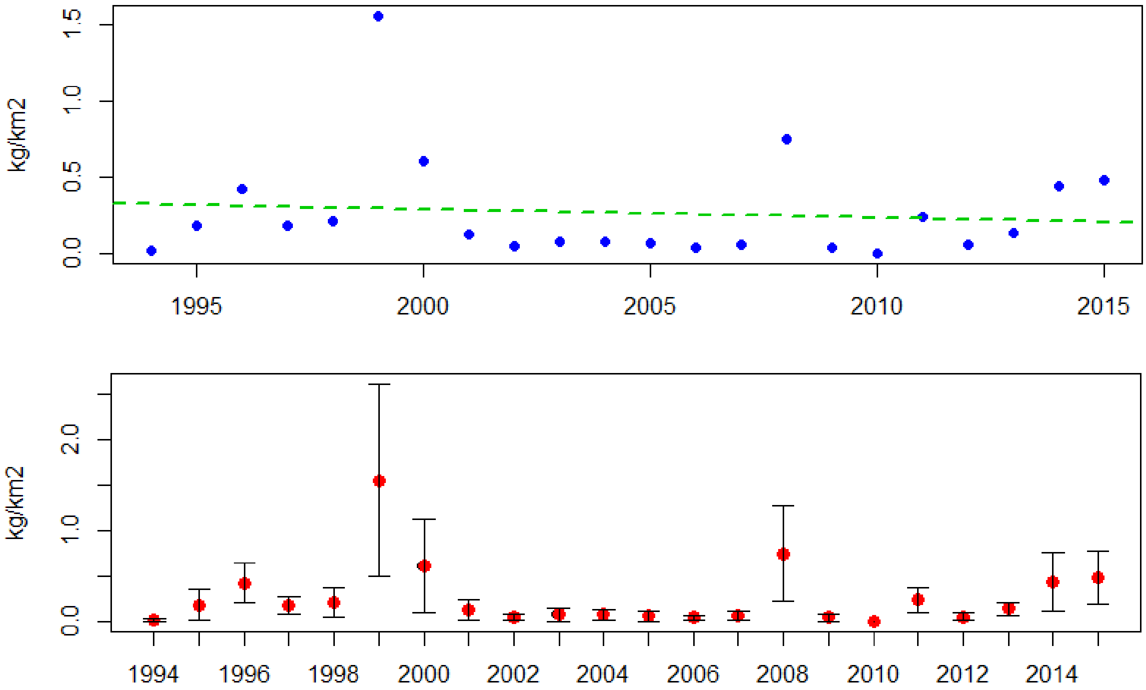


Figure 6.19.4.6. Scomber spp. In GSAS 17,18,19,20. MEDITS-derived biomass index (kg/km2) for *Scomber* spp. in GSA 19 in 1994-2015

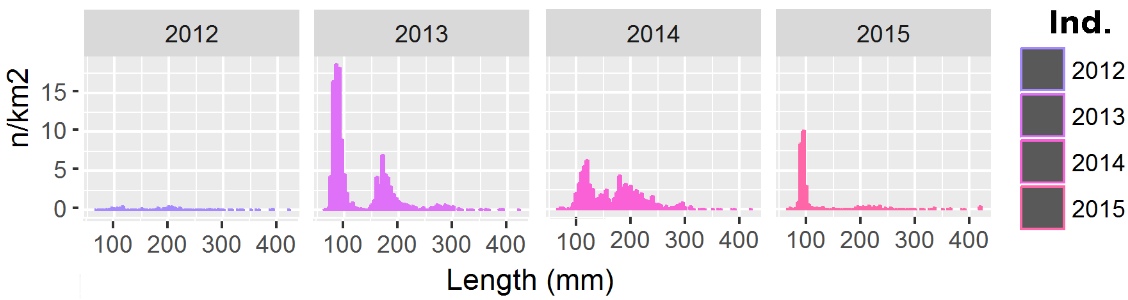


Figure 6.19.4.7. Scomber spp. In GSAS 17,18,19,20. MEDITS-derived length frequency distribution of *Scomber* spp. in GSA 17 in 2012-2015

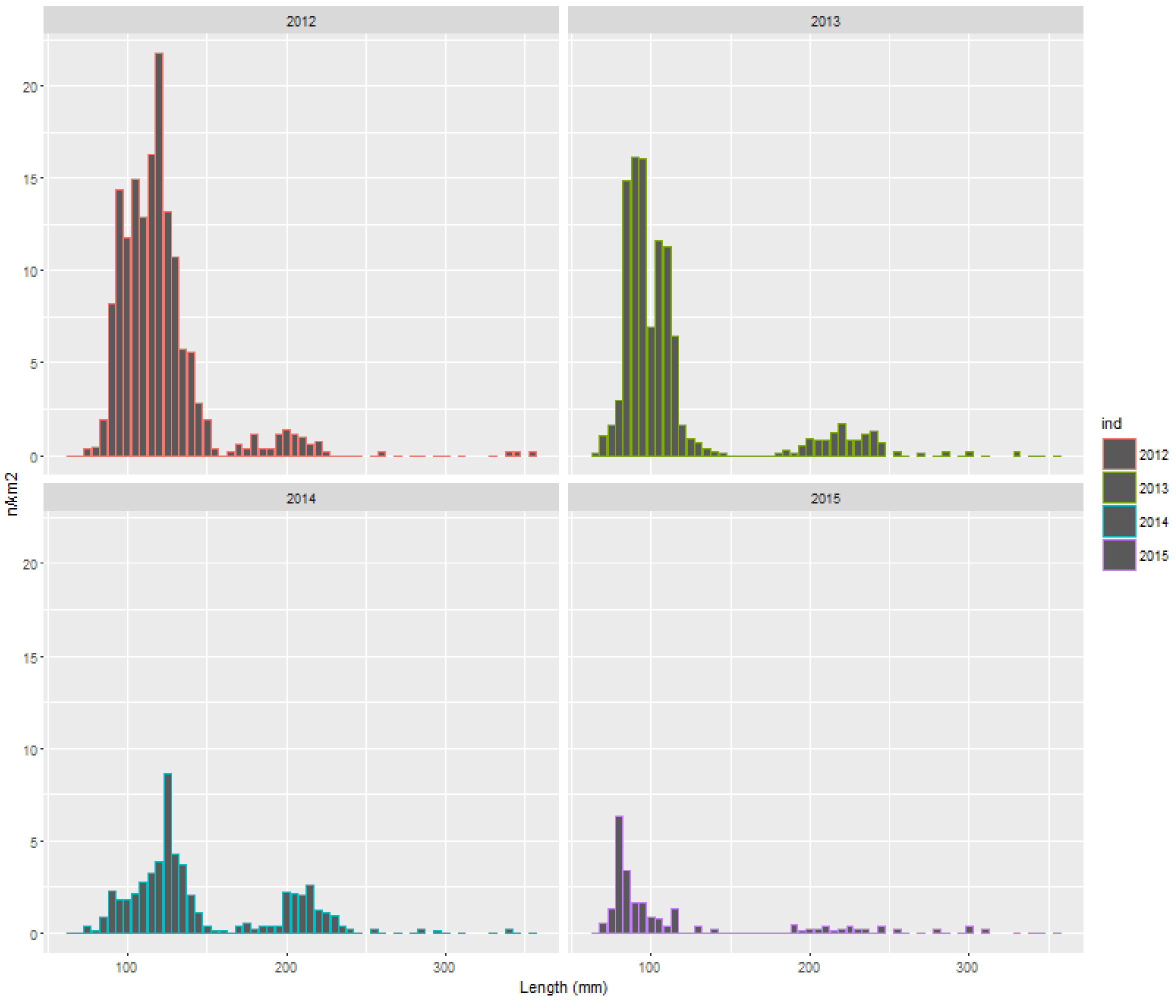


Figure 6.19.4.8. Scomber spp. In GSAS 17,18,19,20. MEDITS-derived length frequency distribution of *Scomber* spp. in GSA 18 in 2012-2015

7. Stock assessments (Level 1)

ToR 2 For the stocks given in Annex I-A, or combinations thereof, the STECF-EWG 16-13 is requested to:

ToR 2.1. Assess trends in fishing mortality, stock biomass, spawning stock biomass, and recruitment. Different assessment models should be applied as appropriate. Models should be compared using model diagnostics including retrospective analyses when the models can produce one. The selection of the most reliable assessment should be justified. Assumptions and uncertainties should be reported.

ToR 2.2. Propose and evaluate candidate MSY value, range of values and safeguard points in terms of fishing mortality and stock biomass. The proposed values shall be related to long-term high yields and low risk of stock/fishery collapse and ensure that the exploitation levels restore and maintain marine biological resources at least at levels which can produce the maximum sustainable yield.

ToR 2.3. Provide short and medium1 term forecasts of spawning stock biomass, stock biomass and catches. The forecasts shall include different management scenarios, *inter alia*: zero catch, the status quo fishing mortality, and target to FMSY or other appropriate proxy by 2018 and 2020 (by means of a proportional reduction of fishing mortality as from 2017). In particular, predict the level of fishing effort exerted by the different fleets which is commensurate with the short- and medium-term forecasts of the proposed scenarios. (1 Medium term forecast only when an acceptable stock-recruitment relationship is identifiable.)

ToR 2.4. Make any appropriate comments and recommendations to improve the quality of the assessments. Furthermore, advise on the ideal assessment frequency.

7.1. STOCK ASSESSMENT ON EUROPEAN ANCHOVY IN GSA 6

7.1.1. Assessment

Method 1- XSA

DCF data provided to EWG 16-13 included biological parameters, landings, catches and catch at age during 2002-2015. Fishery independent abundance indexes (ECOMED and MEDIAS acoustic surveys) were available for the period 2003- 2015. These data series were long enough to perform an Extended Survivor Analysis (XSA). The analyses were made using R software and the FLR libraries with scripts provided by JRC.

The values of M vector calculated with the available growth parameters and the method proposed by Gislason *et al.* (2010) were much lower than those estimated for sardine in other Mediterranean areas, for example in the Adriatic Sea, are were considered unrealistic. Nevertheless, the estimated M was similar to M= 0.6 proposed for GSA 6 (Giráldez *et al*., 2015).

Inconsistencies were found between the numbers at age in the landings and in the surveys. In the last years the presence of age class 2 was observed in the surveys, conducted in summer, that is, in the spawning peak. Nevertheless, class 2 was absent in the landings. As a result, when performing an XSA, F values for the older ages were unrealistically high. Due to the poor fit, which was considered to be driven by the differences in age structure (see figure 6.1.2.2 and Figure 6.1.4.4. in surveys and catch, the age based approach was rejected

Results are not shown.

Method 2- ASPIC

A surplus production model (ASPIC V.5.34.9, Prager 1999) was attempted on anchovy in GSA 6 thanks to the long time series of landings made available to the EWG in combination with the acoustic biomass index covering the period 2003-2015.

Different models were configured, as follows:

1. Landings and an effort index (PS nominal effort), plus 2 biomass indexes split in a end of the year series (to account for a November survey) and an average of the year series (to account for the MEDIAS summer survey)

2. Landings and an CPUE index (landings/PS nominal effort), plus 2 biomass indexes split in a end of the year series (to account for a November survey) and an average of the year series (to account for the MEDIAS summer survey)

3. Landings and as CPUE index the biomass.

Model fitting was attempted in different modes "FIT", "BOT". In FIT program mode, ASPIC fits the model and computes estimates of parameters and other quantities of management interest, including time trajectories of fishing intensity and stock biomass. In BOT program mode, ASPIC fits the model and computes bootstrapped confidence intervals on estimated quantities. Conditioning was always on Yield, which is usually preferable on statistical grounds to compute residuals in the more imprecise quantity.as recommended by ASPIC user manual.

Different model shapes and optimization control were attempted for deriving the best performing model.

LOGISTIC Fit the logistic (Schaefer) model.
GENGRID Fit the generalized model at grid of values or at one specified value.
FOX Fit the Fox model (a special case of GENFIT, below).
GENFIT Fit the generalized model and estimate its exponent directly.

All the models attempted with a logistic (Schaefer fit) or a Fox model did either not fit or hit the bounds on MSY and are not reported here. Models fitted with the generalized fit (Pella-Tomlinson) were the only formulations able to converge.
Under the generalized fit to improve the fitting, two runs were defined with different time series, one from 1945-2015 and one truncated to 1960-2015. The latter run was attempted to explore if the model was giving better estimates with higher proportion overlapping time series. Since on the shorter time series run the estimate of q were at the program-set bound, the results of this run needed be taken with caution, so were discarded.

The final run was on the full time series of landings with the acoustic biomass survey treated as a CPUE. Summary of the control parameters and initial parameter guests:

CONTROL PARAMETERS (FROM INPUT FILE) Input file: c:\...6\final_runs\ane6_6_combined_index_final_1945_2015.inp

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Operation of ASPIC: Fit generalized (Pella-Tomlinson) model at grid of model shapes.

Number of years analyzed: 71 Number of bootstrap trials: 0

Number of data series: 1 Bounds on MSY (min, max): 5.000E+04 1.000E+05

Objective function: Least squares Bounds on K (min, max): 6.000E+04 2.000E+08

Relative conv. criterion (simplex): 1.000E-08 Monte Carlo search mode, trials: 0 100

Relative conv. criterion (restart): 3.000E-08 Random number seed: 65166348

Relative conv. criterion (effort): 1.000E-04 Identical convergences required in fitting: 8

Maximum F allowed in fitting: 8.000 Number of steps for numerical integration: 12

Bounds factor for generalized fit: 8.000 Bounds on phi (%): 35 70

Reported goodness of fit from best model run:

GOODNESS-OF-FIT AND WEIGHTING (NON-BOOTSTRAPPED ANALYSIS)

Weighted Weighted Current Inv. var. R-squared

Loss component number and title SSE N MSE weight weight in CPUE

Loss(-1) SSE in yield 0.000E+00

Loss(0) Penalty for B1 > K 0.000E+00 1 N/A 0.000E+00 N/A

Loss(1) Series 1 3.244E+00 13 2.949E-01 1.000E+00 1.000E+00 0.593

..

TOTAL OBJECTIVE FUNCTION, MSE, RMSE: 3.24381496E+00 3.604E-01 6.004E-01

Estimated contrast index (ideal = 1.0): 0.8261 C* = (Bmax-Bmin)/K

Estimated nearness index (ideal = 1.0): 1.0000 N* = 1 - |min(B-Bmsy)|/K

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

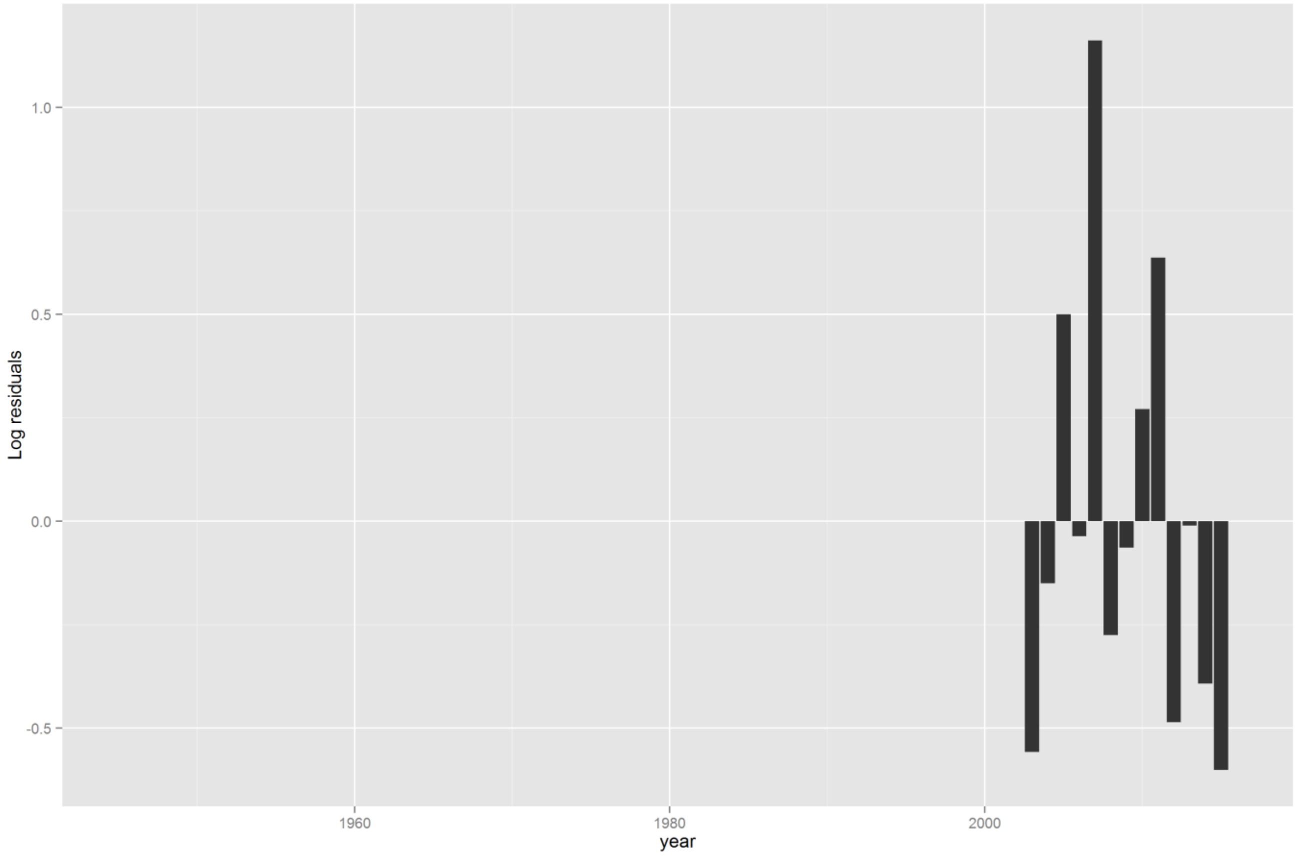
--

Parameter		Estimate	User/pgm guess	2nd guess	Estimated	User guess
B1/K	Starting relative biomass (in 1945)	4.493E-01	6.000E-01	3.930E-01	1	1
MSY	Maximum sustainable yield	1.787E+04	7.100E+04	6.000E+04	1	1
K	Maximum population size	6.991E+04	1.000E+05	4.005E+07	1	1
phi	Shape of production curve (Bmsy/K)	0.6500	0.000E+00	0.000E+00	1	1

--------- Catchability Coefficients by Data Series ---------------

q(1)	Series 1	9.446E-01	4.915E-01	1.140E+00	1	1

The model log residuals are acceptable and don't present trends or extreme departures


Log residuals
1.0
0.5
0.0
-0.5
1960
1980
2000
year

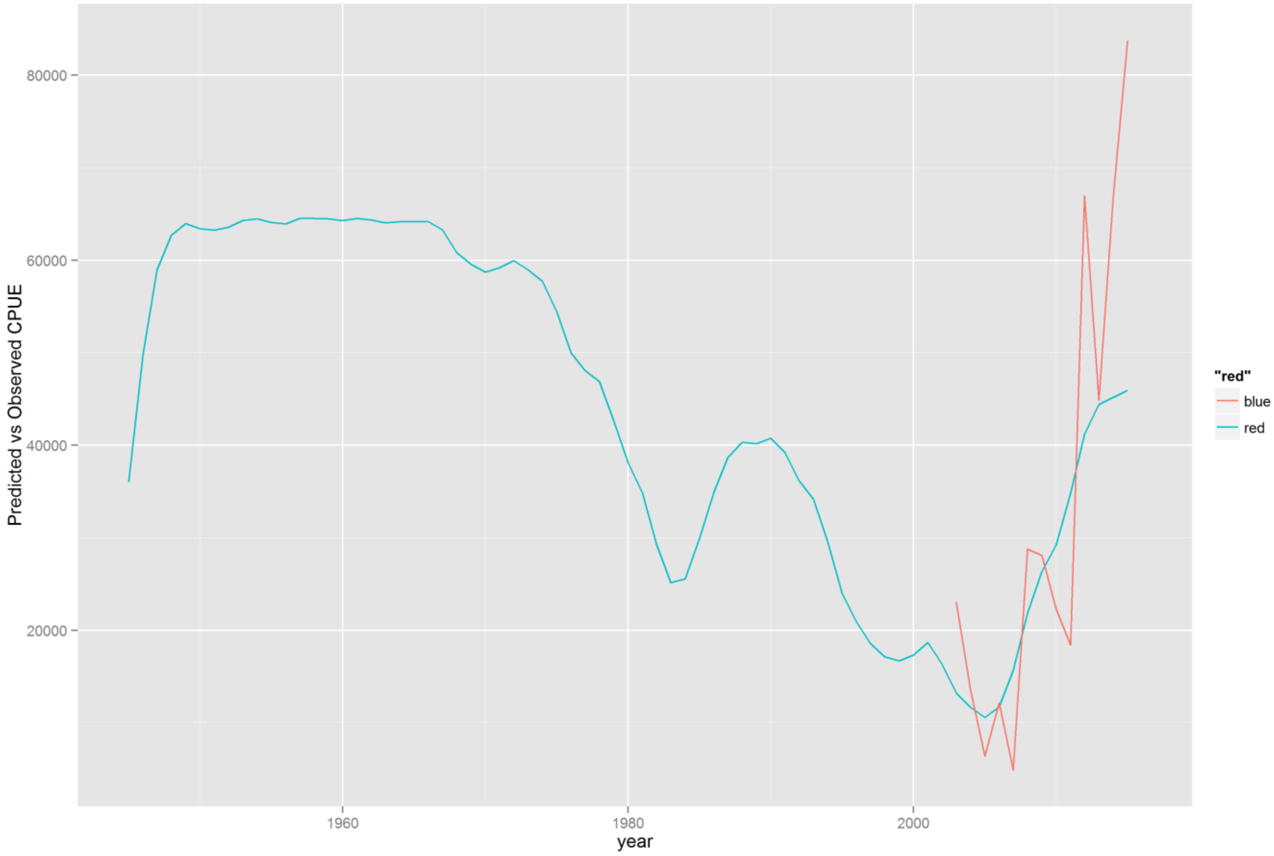


Figure 7.1.1.1. European Anchovy in GSA 6. Model log residuals (up) and Predicted versus observed CPUE (down)

A retrospective was ran by running the same model with time series respectively up to 2013 (retro 3), 2014 (retro2) and 2015 (retro 1). The retro is presented for total F, biomass (b), F/Fmsy and B/Bmsy. The retrospective is good as there are no large departures in the retro years and retro 1 lies between retro 2 and 3. The initial part of the series is more variable in terms of biomass for retro 2.

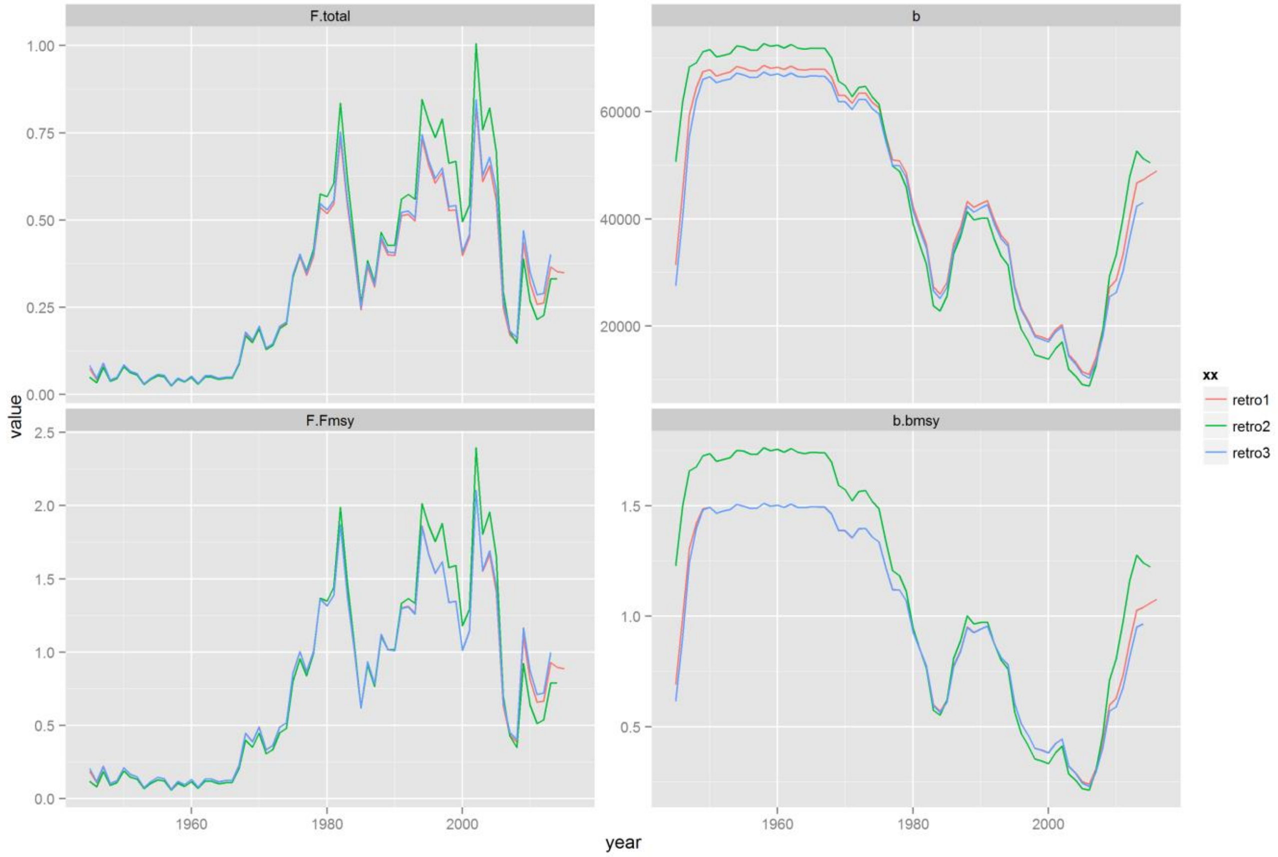


Figure 7.1.1.2. European Anchovy in GSA 6.1Retrospective analysis of best model run for total F, total biomass (b), F/Fmsy and B/Bmsy

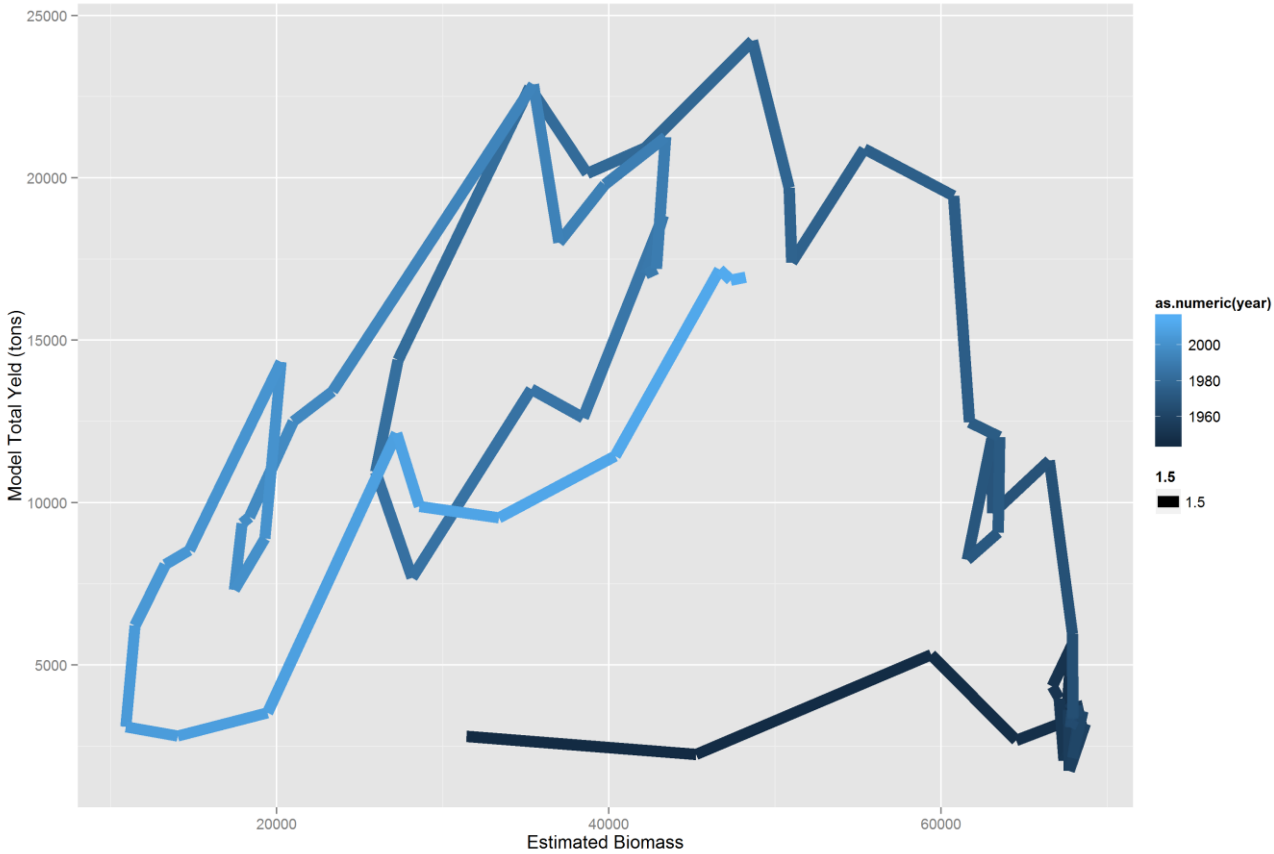


Figure 7.1.1.3. European Anchovy in GSA 6. Total Yield vs Estimated Biomass phase plot.

Final model run

Based on fit and absence of warning (parameter boundary issues) the best model is that running on the full time series 1945-2015 with the biomass index modelled as a CPUE fitted with a Pella Thomlinson. The pattern of residuals is acceptable, without trend, and the retrospective analysis shows stability of the assessment. The fact that it was possible to fit meaningful results only with this one combination of data and model, leaves some concerns about the stability of the assessment, even though the retrospective was acceptable.

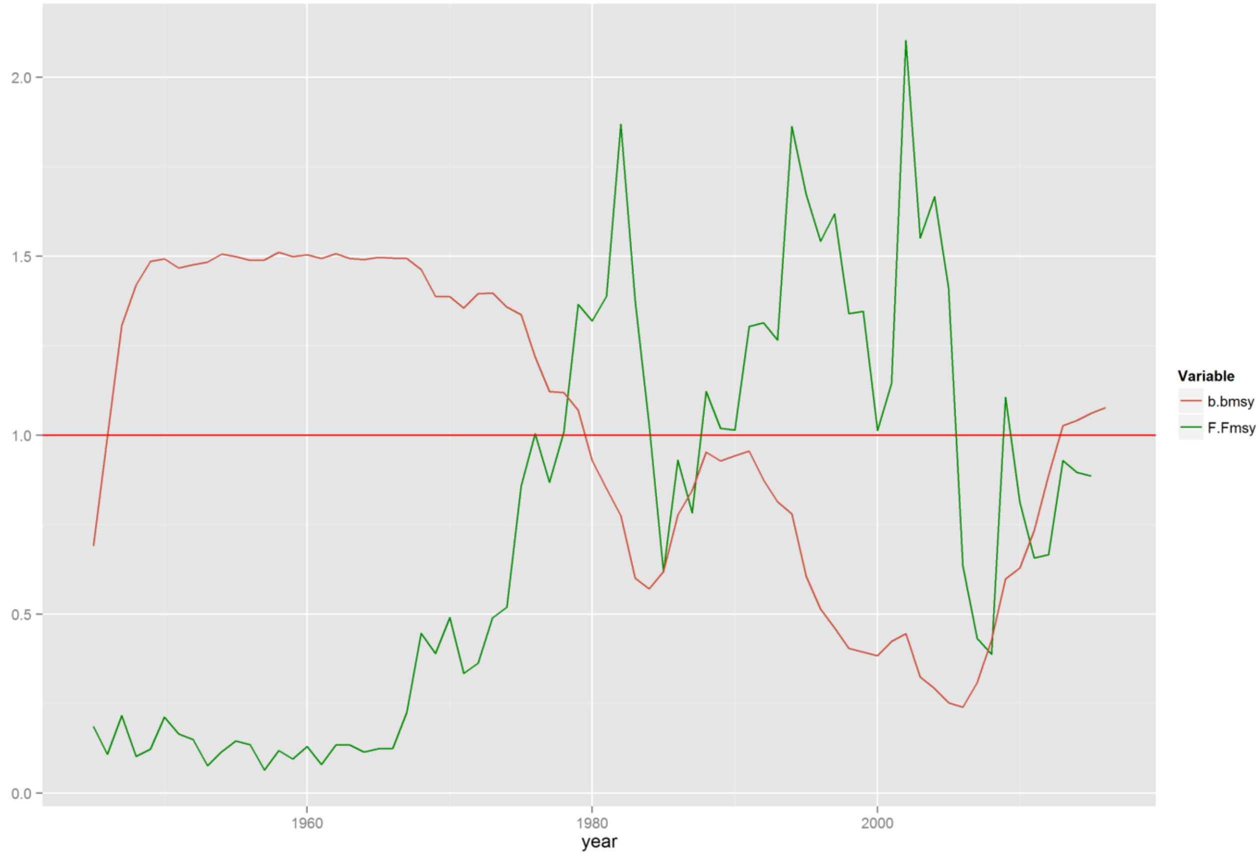


Figure 7.1.1.3. European Anchovy in GSA 6. Trends in F/Fmsy and B/Bmsy according to the best ASPIC model run.

MANAGEMENT and DERIVED PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Logistic formula	General formula
MSY	**Maximum sustainable yield**	**1.787E+04**	**----**	**----**
Bmsy	**Stock biomass giving MSY**	**4.544E+04**	**K/2**	**K*n**(1/(1-n))**
Fmsy	**Fishing mortality rate at MSY**	**3.933E-01**	**MSY/Bmsy**	**MSY/Bmsy**

n Exponent in production function 4.4825 ---- ----

g Fletcher's gamma 1.980E+00 ---- [n(n/(n-1))]/[n-1]**

B./Bmsy Ratio: B(2016)/Bmsy 1.077E+00 ---- ----

F./Fmsy Ratio: F(2015)/Fmsy 8.861E-01 ---- ----

Fmsy/F. Ratio: Fmsy/F(2015) 1.129E+00 ---- ----

Y.(Fmsy) Approx. yield available at Fmsy in 2016 1.860E+04 MSY*B./Bmsy MSY*B./Bmsy

...as proportion of MSY 1.041E+00 ---- ----

Ye. Equilibrium yield available in 2016 1.762E+04 4*MSY*(B/K-(B/K)2) g*MSY*(B/K-(B/K)**n)**

...as proportion of MSY 9.857E-01 ---- ----

--------- Fishing effort rate at MSY in units of each CE or CC series ---------

fmsy(1) Series 1 4.164E-01 Fmsy/q(1) Fmsy/q(1)

The state of the adult biomass can’t be determined separately in a production model. On the basis of ASPCI, the estimated biomass was high till the 1970’s, had a first deep decline to 1982-83, then slightly recovered and reduced to about 15% of Bo in 2005 and has been recovering since then. The acoustic biomass index derived from ECOMED and MEDIAS shows a downward trend in the early 2000’s, in line with the catches and a steep increase since then.

F trends show a historically low fishing mortality in the early part of the series with a progressive increase into the early 1980’s, corresponding to the first dip in biomass. Subsequently Fs dropped allowing an increase in biomass in the early 1990’s which preceded the maximum observed F (0.827) in 2002 which lead to the lowest biomass of 1.119E+04 tons in 2005. After 2005 F stayed at a lower level and allowed the biomass to recover.

7.1.2. Reference points

The EWG 16-13 proposes Fmsy = 0.39 as limit management reference point consistent with high long term yield and low risk of fisheries collapses. The stock is considered sustainably exploited (Bcurr/Bmsy of about 1.077), with estimates of the current fishing mortality F_{2015} of 0.34 , F/Fmsy = 0.8861 (derived from ASPIC) that is lower to the estimated values that were considered limit reference point obtained with the same approach.

The EWG 16-13 proposes Bmsy= 4.544E+04 as limit management reference point consistent with high long term yield an low risk of fisheries collapses on the basis of the ASPCI model runs.

7.1.3. Short term forecasts

The production model fitted with a Pella Thomlinson does not allow running a bootstrap in ASPIC, which is a necessary step for running a short term forecast. Since it was not possible to derive meaningful results with a Fox or Shaefer, it was not possible to run a forecast in ASPIC.

7.1.4. Quality and proposals for future assessments

Since the fishery is based on recruits, it would be advisable to assess the anchovy stock on a yearly basis.

The stock boundaries for Anchovy were assumed here to be in line with the GSA geographical boundaries, but there is no strong biological evidence supporting this definition. Future assessments should explore joining also GSA 5 and 7.

The tuning series derived from the acoustic biomass starts in 2003, ideally some prior CPUE's, effort complete series should be recovered to improve the earlier part of the series fitting.

7.2 STOCK ASSESSMENT ON SARDINE IN GSA 6

7.2.1. Assessment

An assessment using XSA was performed using DCF data as input: PS catch at age data from 2003-2015, mean maturity ogive, ECOMED and MEDIAS surveys data. The values of M vector were the used in the last approved assessment for sardine in GSA 6 and compiled in STECF Med Ass part 2 (STECF-15-06, 2015).

0 values in catch at age matrix (ages 4 and 5), need to be replaced with non-zero values to allow a VPA type analysis to be implemented and have been changed to a numeric value corresponding to the half of the smallest value of the age series, this provides a low value close to the observed range of catch values, so that any residuals in the fit are kept within a reasonable range.

The analysis was carried out for the ages 0 to 5+ class.

Concerning the Fbar, the range used was 0-2.

Input parameters: XSA input parameters to the XSA model.

M natural mortality

ages	0	1	2	3	4	5+
	2.8	1.14	0.78	0.6	0.53	0.48

Maturity ogive

ages	0	1	2	3	4	5+
	0.7	1	1	1	1	1

Catch at age (thousands) (age 5+ replaced in years 2013-15

	0	1	2	3	4	5+
2003	215131	384115	59922	12987	3775	671
2004	306081	470162	77497	21871	13625	2208
2005	338376	287683	127139	21525	3084	1160
2006	129262	355651	241042	73699	14065	1042
2007	109821	198232	165099	100084	38697	6269
2008	133899	255378	106594	35972	2951	42
2009	183806	160658	17614	5423	816	64
2010	100226	229452	9752	1676	982	201
2011	404484	191607	25599	1436	137	157
2012	170241	286247	10387	1364	266	13
2013	97253	297512	108476	5844	794	6
2014	94412	335423	89136	8360	103	6
2015	144199	199296	33157	586	51	6

Weight at age (kg)

	0	1	2	3	4	5+
2003	0.014	0.022	0.031	0.039	0.052	0.052

2004	0.012	0.021	0.031	0.041	0.056	0.053
2005	0.015	0.021	0.032	0.042	0.051	0.06
2006	0.015	0.025	0.032	0.041	0.051	0.068
2007	0.015	0.024	0.033	0.045	0.05	0.056
2008	0.015	0.023	0.04	0.05	0.057	0.079
2009	0.014	0.019	0.035	0.05	0.06	0.079
2010	0.013	0.019	0.032	0.053	0.065	0.074
2011	0.013	0.023	0.033	0.051	0.06	0.059
2012	0.011	0.019	0.032	0.046	0.055	0.076
2013	0.011	0.016	0.022	0.029	0.031	0.066
2014	0.009	0.015	0.022	0.031	0.051	0.066
2015	0.011	0.016	0.022	0.039	0.053	0.066

Tuning parameters

MEDIAS 2009-2015

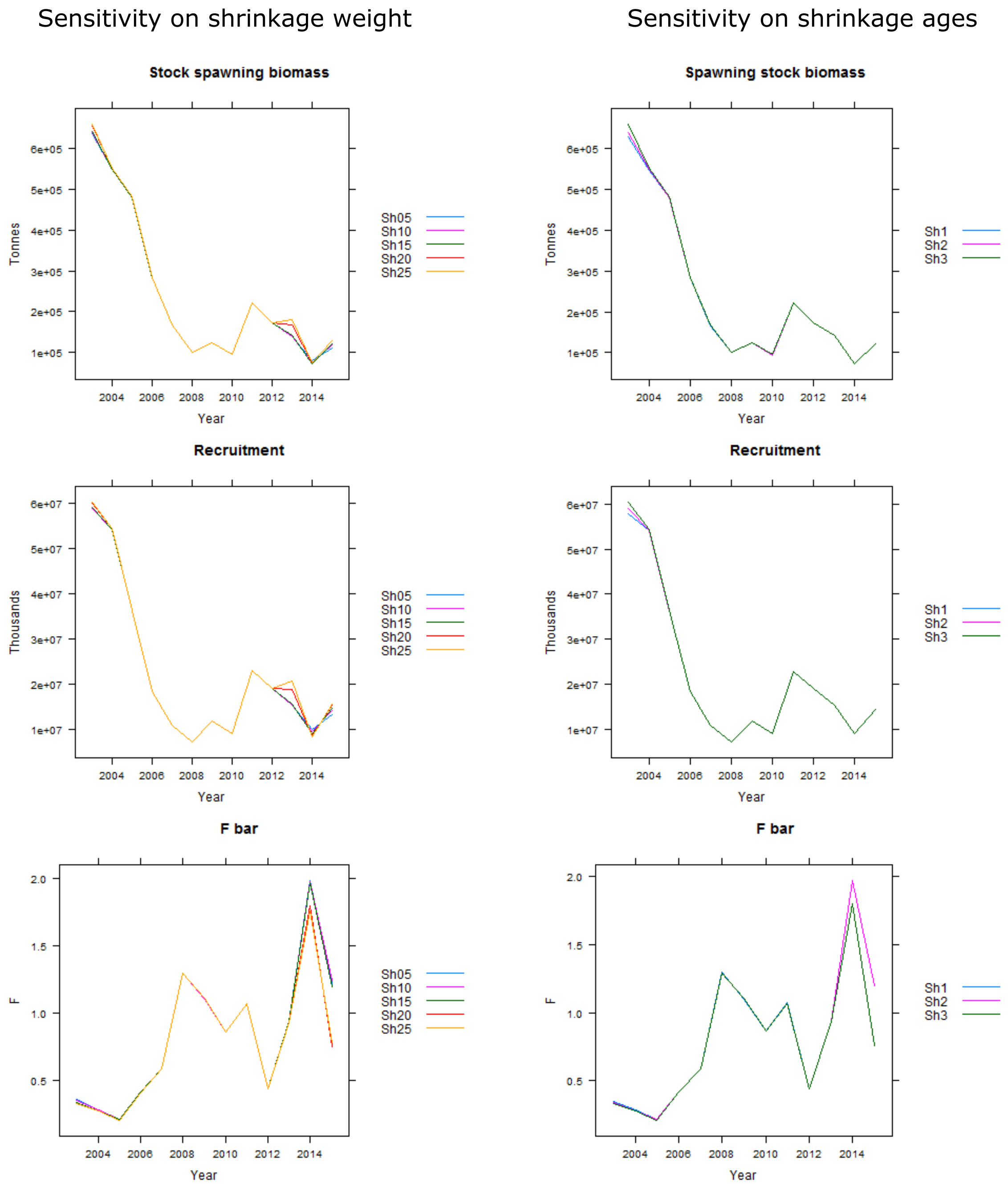
	0	1	2
2009	3622843	67341	5614
2010	1925819	238062	14919
2011	3817869	452391	49658
2012	5136729	729875	72323
2013	6237760	313753	79291
2014	510166	260377	17873
2015	3089951	275404	266153

ECOMED 2003-2008

	0	1	2	3	4	5
2003	2489245	1259398	206650	79375	64396	13003
2004	1452950	665679	41285	7767	7812	1677
2005	1276577	533431	152533	34723	7415	3912
2006	1162345	674689	106773	34419	9700	7446
2007	508217	155257	62100	15067	6626	3193

2008	411195	37240	7071	2422	734	518

Different sensitivity analyses were performed before selecting the final XSA run, considering different weight and ages for shrinkage.



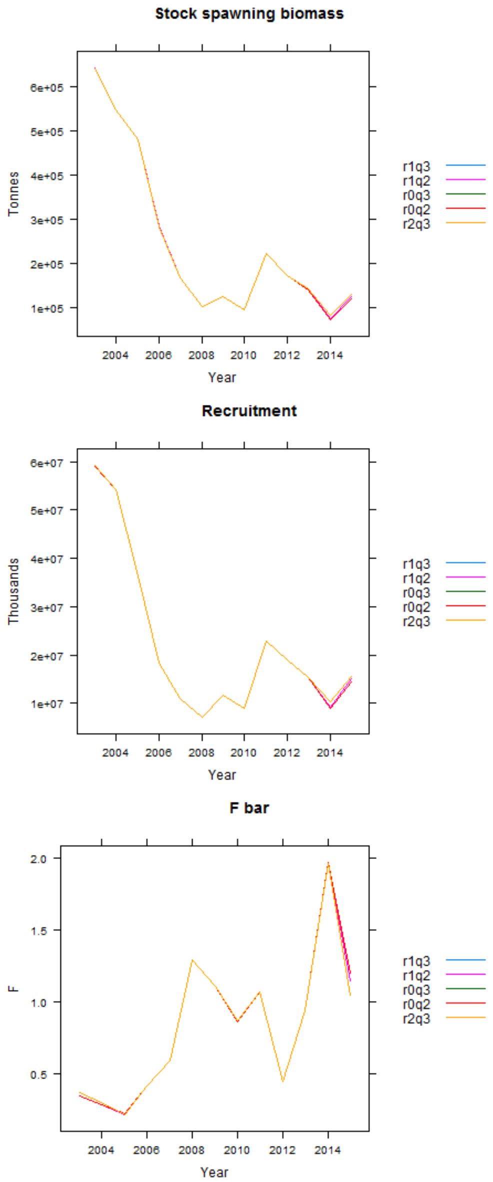


Figure 7.2.1.1. Sardine in GSA 6. Sensitivity analysis considering different weight and ages for shrinkage and different rage and qage.

For the final run, the following settings were selected:

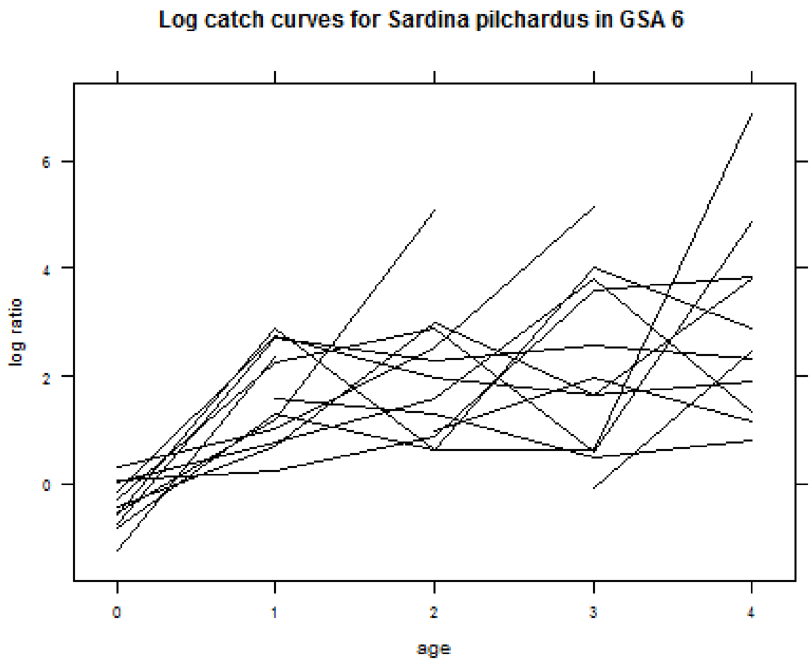
fse=1.5, rage=-1, qage=2, shk.n=TRUE, shk.f=TRUE, shk.yrs=3, shk.ages=2

XSA results for Assessment are presented in Fig. 7.2.1.2 to Fig. 7.2.1.5 and Table 7.2.1.1 to Table 7.2.1.3.

Based on the declining catches in the input data the results show a decreasing SSB and recruitment until 2014. F increases to above 1.0 and variable in recent years in the most recent period 2013-2015 (Fig. 7.2.1.3).

The residuals between assessment and the survey data (Fig 7.2.1.4 and 7.2.1.5) do not show any concern regarding the pattern, as no trends are observed, however the values are large suggesting uncertainty in the results

A retrospective analysis (Fig. 7.2.1.) shows considerable variability in most parameters and indicates a rather uncertain assessment, although all show low SSB and high F in recent years.



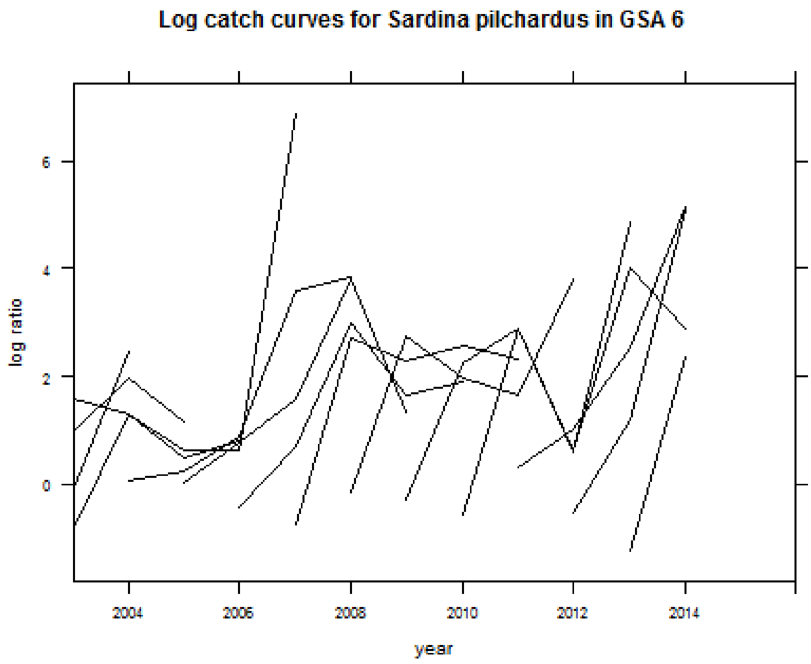


Figure 7.2.1.2. Sardine in GSA 6. Log catch curves.

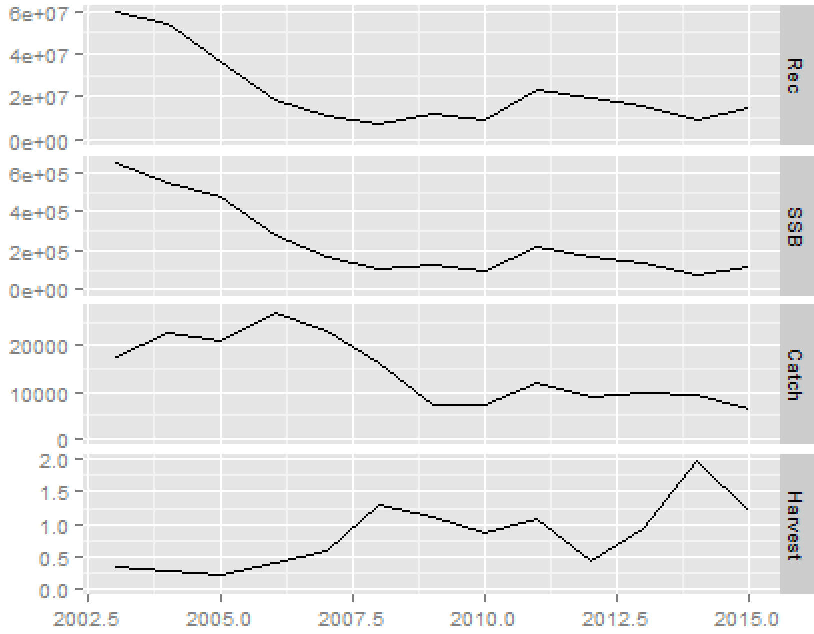


Figure 7.2.1.3. Sardine in GSA 6. XSA summary results. SSB and catch are in tons, recruitment in 1000s individuals.

Table 7.2.1.1. Sardine in GSA 6. XSA summary results.

	Stock number (thousands)	Stock biomass (tons)	Recruitment (thousands)	SSB (tons)	Fbar(0-2)
2003	62446627	904686	59794837	653547	0.50
2004	58469001	745878	54365754	550161	0.40
2005	40453838	644002	36297269	480665	0.29
2006	21551703	366576	18331550	284084	0.60
2007	12700353	216216	10935547	167006	0.86
2008	8113209	134202	7210876	101753	1.90
2009	12143027	173277	11692426	124169	1.62
2010	9559882	128981	8868706	94393	1.26
2011	23412596	310687	22845945	221588	1.56
2012	20325252	234791	19005963	172071	0.64
2013	16729103	192110	15397552	141298	1.39
2014	9947070	97348	8865797	73410	2.92
2015	14964404	167906	14387416	120428	1.77

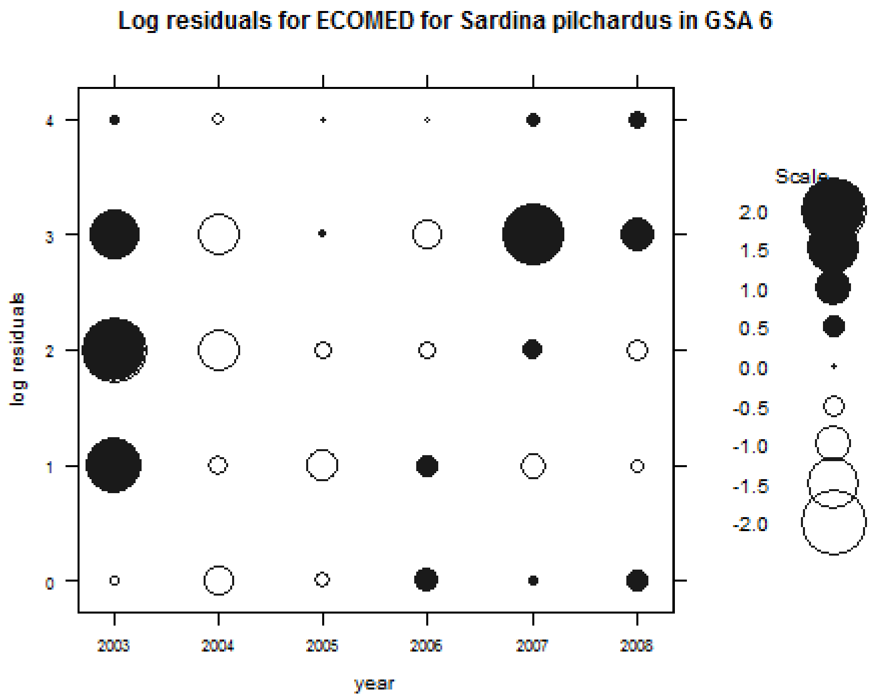


Figure 7.2.1.4. Sardine in GSA 6. Log catchability residuals of the tuning data used from ECOMED surveys.

Table 7.2.1.3. Sardine in GSA 6. Log catchability residuals of the tuning data used from ECOMED surveys.

age	2003	2004	2005	2006	2007	2008
0	-0.065	-0.497	-0.204	0.372	0.076	0.318
1	1.021	-0.289	-0.526	0.346	-0.398	-0.153
2	1.249	-0.769	-0.231	-0.235	0.303	-0.317
3	0.923	-0.768	0.051	-0.485	1.150	0.597
4	0.097	-0.118	0.005	-0.009	0.155	0.242

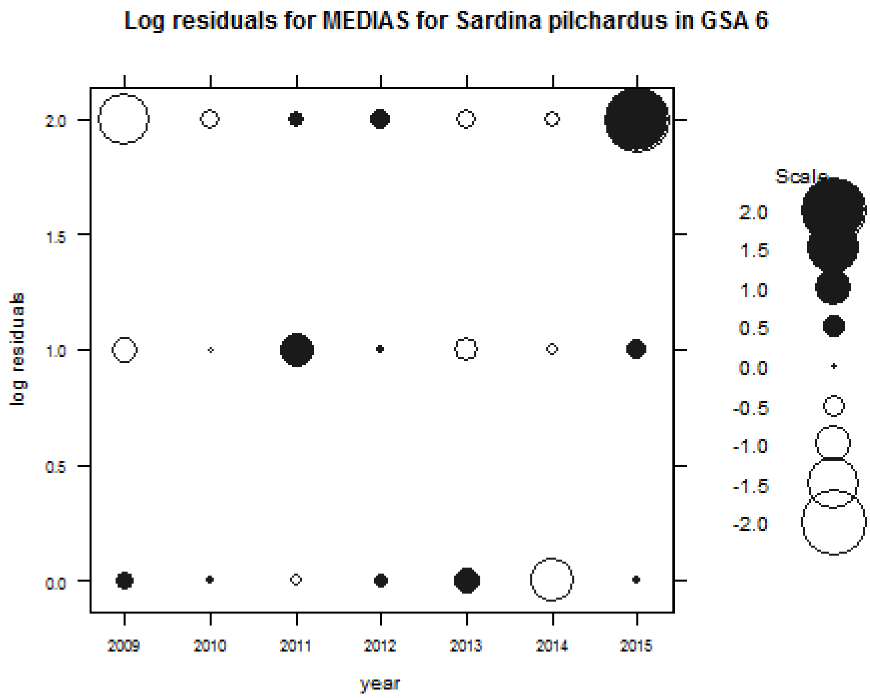
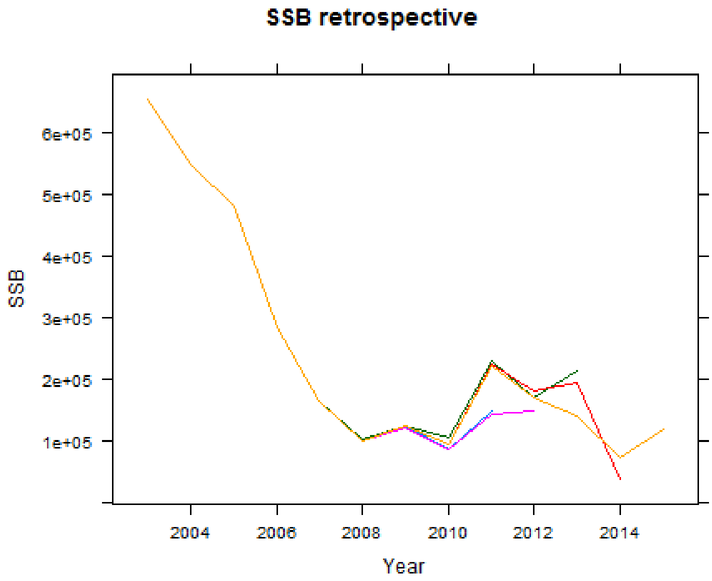


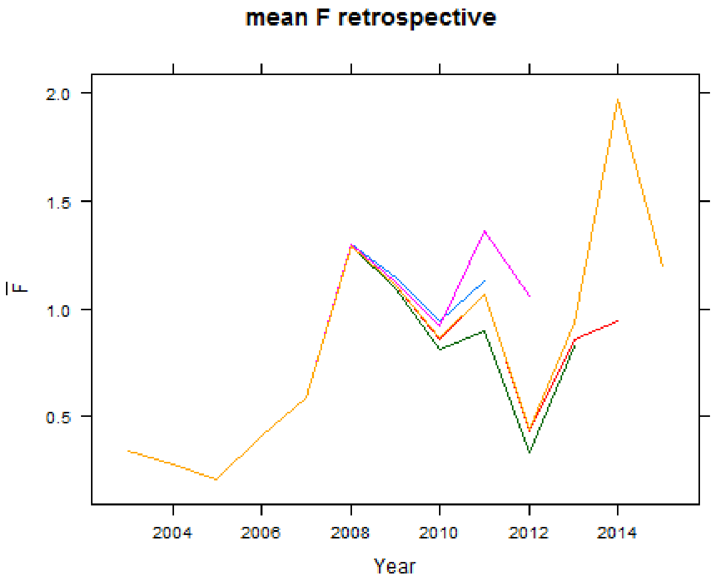
Figure 7.2.1.5. Sardine in GSA 6. Log catchability residuals of the tuning data used from MEDIAS surveys.

Table 7.2.1.4. Sardine in GSA 6. Log catchability residuals of the tuning data used from MEDIAS surveys.

age	2009	2010	2011	2012	2013	2014	2015
0	0.423	0.058	-0.188	0.270	0.667	-1.272	0.042
1	-0.656	-0.017	0.914	0.039	-0.575	-0.179	0.473
2	-1.507	-0.447	0.323	0.437	-0.445	-0.343	1.982

Retrospective analysis has consistent results for SSB, but not for Mean F, that is unstable in recent years (Fig. 7.2.1.6). Due to this F instability it is not consistent to do short term analysis.


SSB retrospective
SSB
6e+05
5e+05
4e+05
3e+05
2e+05
1e+05
2004
2006
2008
2010
2012
2014
Year


mean F retrospective
F
2.0
1.5
1.0
0.5
2004
2006
2008
2010
2012
2014
Year

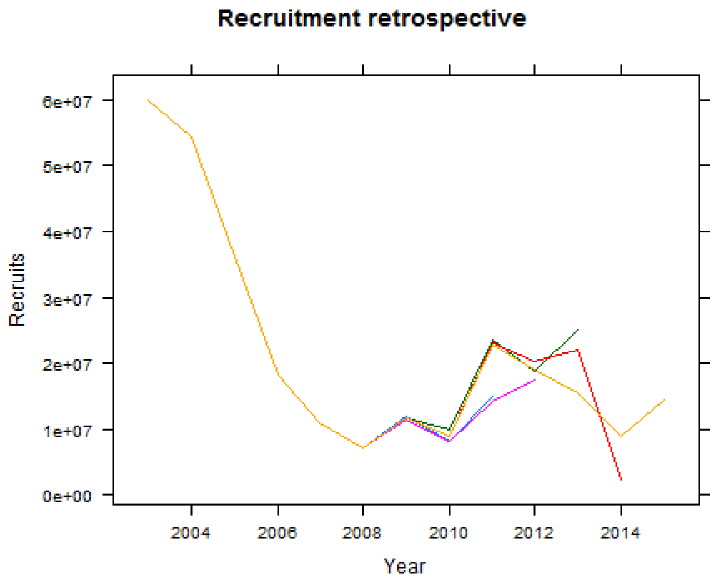

Recruitment retrospective
Recruits
6e+07
5e+07
4e+07
3e+07
2e+07
1e+07
0e+00
2004
2006
2008
2010
2012
2014
Year

Figure 7.2.1.6. Sardine in GSA 6. Retrospective analysis for SSB, F and R.

The exploitation rate trend was constructed using E=0.4 as a reference point (Table 7.2.1.5, Fig. 7.2.1.7). Results also indicate variability in recent years. Exploitation rate values since 2007 to 2015 are estimated to be above the reference point (except 2012), that indicate unsustainable exploitation.

Table 7.2.1.5. Sardine in GSA 6. Exploitation rate (E) along the data series (2003-2015). Reference point E=0.4.

	Fbar(0-2)	M	E (F/Z)	E=0.4
2003	0.50	1.06	0.32	0.40
2004	0.40	1.06	0.28	0.40
2005	0.29	1.06	0.22	0.40
2006	0.60	1.06	0.36	0.40
2007	0.86	1.06	0.45	0.40
2008	1.90	1.06	0.64	0.40
2009	1.62	1.06	0.61	0.40
2010	1.26	1.06	0.55	0.40
2011	1.56	1.06	0.60	0.40
2012	0.64	1.06	0.38	0.40
2013	1.39	1.06	0.57	0.40
2014	2.92	1.06	0.73	0.40
2015	1.77	1.06	0.63	0.40

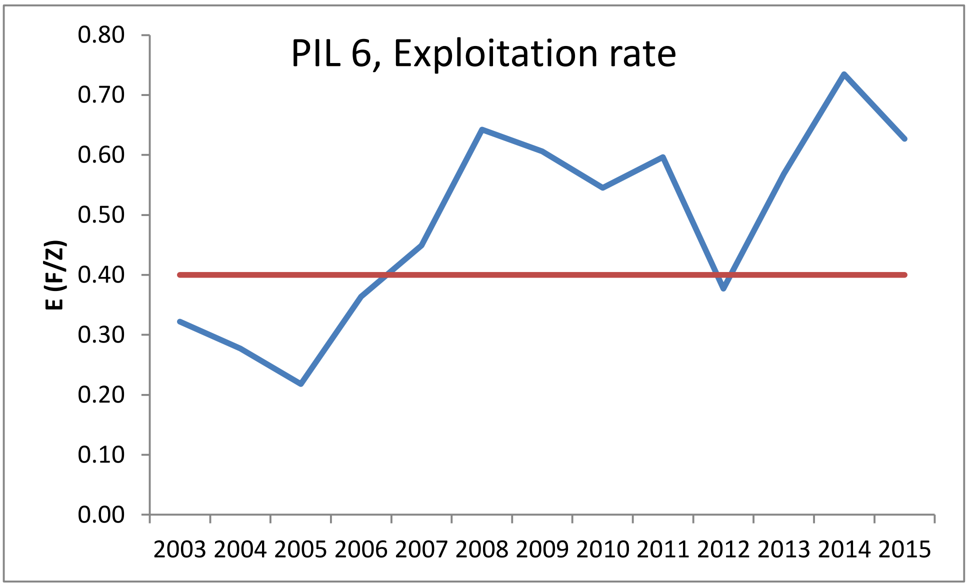


Figure 7.2.1.7. Sardine in GSA. Exploitation rate trend considering F0-2 plotted against the reference point E=0.4.

7.2.2. Reference points

No value of MSY can be proposed for EWG 16-13 for Sardine in GSA 6. The time series is too short to allow the current stock to be set in its historic context, and further exploration was not carried out.

E =0.4 (Patterson 1992) is used as a precautionary exploitation reference point.

7.2.3. Short term forecasts

No short term forecasts have been conducted for EWG 16-13 for Sardine in GSA 6, due to instability in the assessment, particularly in F and R, making short term forecasts particularly unreliable. In order to obtain a basis for catch advice recent harvest rates based on SSB and total biomass are compared to the exploitation rate E=F/(F+M. Based on this approach catch advice for E=0.4 (Patterson 1992) can be computed with respect to most recent SSB. Figure 7.2.1.8 shows the relationship between HR and E (Figure 7.2.1.7) based on the most recent 6 years. The fit is forced through the origin as the intercept is not significantly different from zero, and conceptually zero HR should be equivalent to zero E. The fit to SSB is very slightly better than the fit to total biomass, though the Total biomass is preferred as it includes recruitment and thus more information about the future. The results at E=0.4 are close to the linear relationship. The relationship is not as strong as for anchovy in GSA 17-18, but the resulting factor is very close to observations at E=0.4 and is likely to be substantially more reliable than the use of the assessment based on trends alone, as this approach does take account of more recent biomass and also utilizes E to set the catch advice. The resulting catch options based on different options for E and total biomass in 2015 are given in Table 7.2.3.1, the option for E=0.4 gives a catch of 6214 t.

Table 7.2.3.1 Relationship between HR and E and resulting catch options based on total biomass in 2015.

Exploitation Rate	Harvest Ratio on total biomass	Catch options related to E
0	0.000	0
0.2	0.019	3190
0.4	0.038	6380
0.6	0.057	9571
0.8	0.076	12761
1	0.095	15951

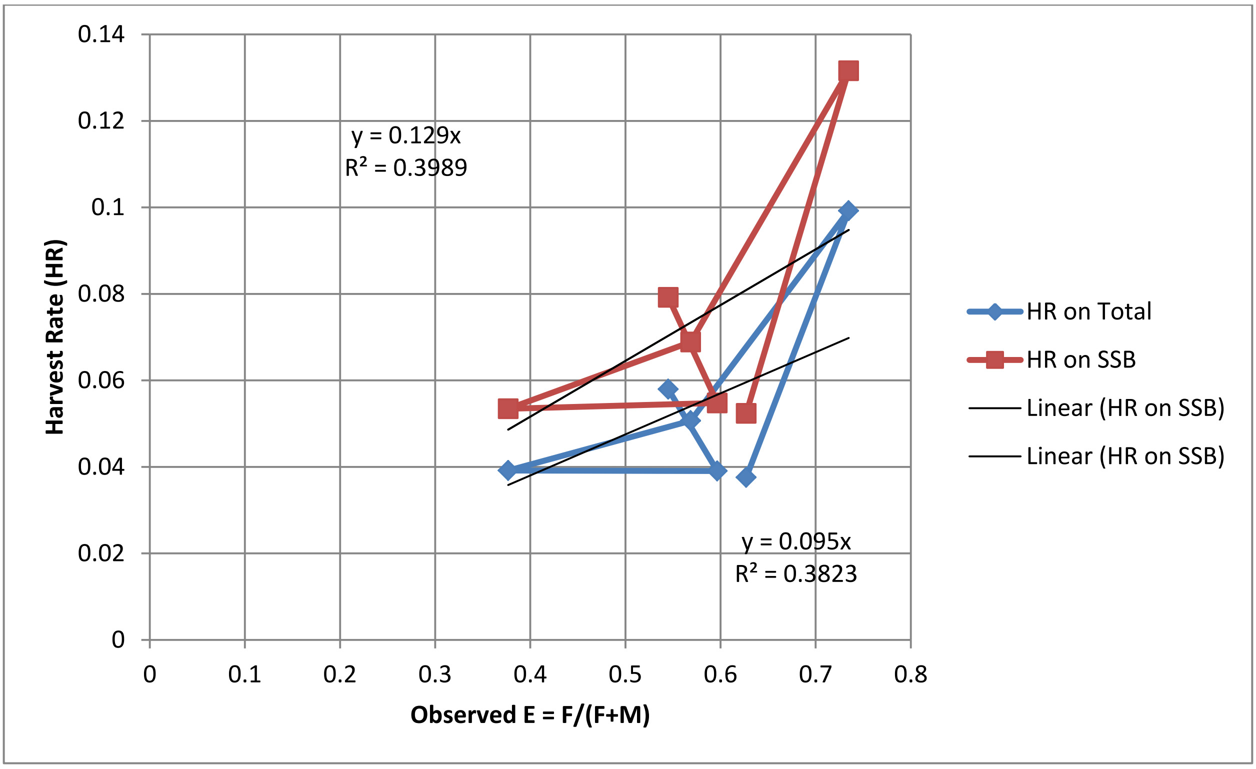


Figure 7.2.3.1. Sardine in GSA 6**.** Relationship between HR based on SSB and on total biomass based on most recent 6 years of observations. The fit is forced through the origin as the intercept is not significantly different from zero, and conceptually zero HR should be equivalent to zero E. The fit to SSB is very slightly better than the fit to total biomass but the total biomass contains more information on the future. The results at E=0.4 are close to the linear relationship. Neither relationship is strong, see text.

7.2.4. Quality and proposals for future assessments

EWG 16-13 has conducted assessment of sardine in GSA 6, with catch at age data provided by DCF and XSA analytical model. Due to instability of F vector on the last three years, short term predictions are uncertain and propose and MSY value.

It could be useful revise length-age keys used in GSA 6 for sardine to construct catch at age matrix in DCF. It seems unlike that age class 0 begins in 10 cm.

On the next assessment experts could use another methodology like production models to explore more reliable results and advice.

7.3 STOCK ASSESSMENT OF EUROPEAN ANCHOVY IN GSA 7

7.3.1 Assessment

Methods: XSA and a4a

The European Anchovy stock in GSA 7 was assessed the last time during STECF 15-06. In this WG FLR libraries were employed in order to carry out an XSA and an a4a based assessments. We first used a simple age based XSA and then used a4a to test for different models of F, q and the variance depending on year and age using as input data the period 2005-2015 for the catch data and for the tuning file.

Input data

Input data for the assessments are described in Section 6.3

The growth parameters used for VBGF were L_{inf} = 16.02, k = 0.58, t_0 =-1.38.

Total catches and catch numbers at age collected through the DCF were used as input data. Age distribution of the gears with no numbers at age distributions was assumed to be the same as the French mid-water trawls. SOP correction was applied to GSA 7 catch numbers at age.

Input data were the same for XSA and a4a.

Catches (t)

2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
2765.8	2319.9	4384.1	4232.5	2479.6	2313.3	1903.8	1576.7	2483.9	2234.8	1108.4

Catch numbers-at-age matrix (thousands)

Age/Years	**0**	**1**	**2**	**3+**
2005	320.995	64942.531	73908.597	10818.967

2006	9219.695	117114.927	8045.817	625.635
2007	62085.592	98023.784	76566.539	18620.138
2008	0.001	242025.893	60268.853	9130.120
2009	17747.488	136731.287	53821.591	416.103
2010	23757.065	128848.528	63214.347	2038.798
2011	3661.001	103416.270	52174.651	3409.818
2012	0.001	74745.098	68590.813	5777.709
2013	6464.978	92485.889	124164.551	16847.675
2014	2563.376	98164.423	81335.269	5650.543
2015	16055.873	55474.457	42862.013	5058.902

Weights-at-age (kg)

Age/Years	0	1	2	3+
2005	0.005	0.015	0.021	0.022
2006	0.008	0.017	0.029	0.035
2007	0.010	0.017	0.021	0.026
2008	0.006	0.012	0.019	0.020
2009	0.006	0.011	0.016	0.019
2010	0.007	0.010	0.013	0.018
2011	0.007	0.010	0.015	0.018
2012	0.006	0.009	0.012	0.014
2013	0.010	0.010	0.010	0.015
2014	0.005	0.011	0.013	0.015
2015	0.004	0.008	0.012	0.017

Maturity and natural mortality vectors.

Age	0	1	2	3+
Maturity	0.39	0.67	0.86	0.95
M	1.24	0.90	0.77	0.71

PELMED numbers at age for GSA 7

Age/Years	0	1	2	3
2005	0.001	521377.718	413363.170	22891.482
2006	149550.943	1451380.880	95637.832	7098.626
2007	5.400	74945.613	1021930.447	56427.949
2008	0.001	1091210.878	338437.588	12851.079
2009	96031.098	2505588.837	438736.306	0.001
2010	39614.309	2453713.433	330242.837	0.001
2011	0.001	816207.537	4104352.238	27706.079
2012	0.001	4748833.120	389873.209	3596.338
2013	53706.047	2585363.972	46792.324	0.001
2014	74485.390	2303968.000	1305912.000	133734.200
2015	72070.130	4495021.000	570282.300	3560.913

Table 7.3.1.1.1.1 lists the input parameters to the XSA, namely landings, catch number at age, weight at age, maturity at age, natural mortality at age and the tuning series at age.

Results of assessments

Sensitivity analyses for the XSA model were carried out to explore which parameter values were the most suitable. Models with different age classes were also tested (0-3+ / 1-3+). None of them was judged satisfactory due to the instability of the retrospective analysis, as well as to the unrealistic Fishing mortality results they produced.

Following this attempt, a combination of a4a models was performed (combination of different f, q and variance models in function of age and years resulting in 1792 models). The 5 best models (according to a combination of AIC, BIC and residuals) were examined more closely.

The parameterisation of the best models did not allow a retrospective analysis possibly due to the limited amount of years in the time series. SO to test the stability of the a4a modelling approach the same approach to model selection was used again with the same data except removing the last year. The results of this trial are shown in the Figure 7.3.1.

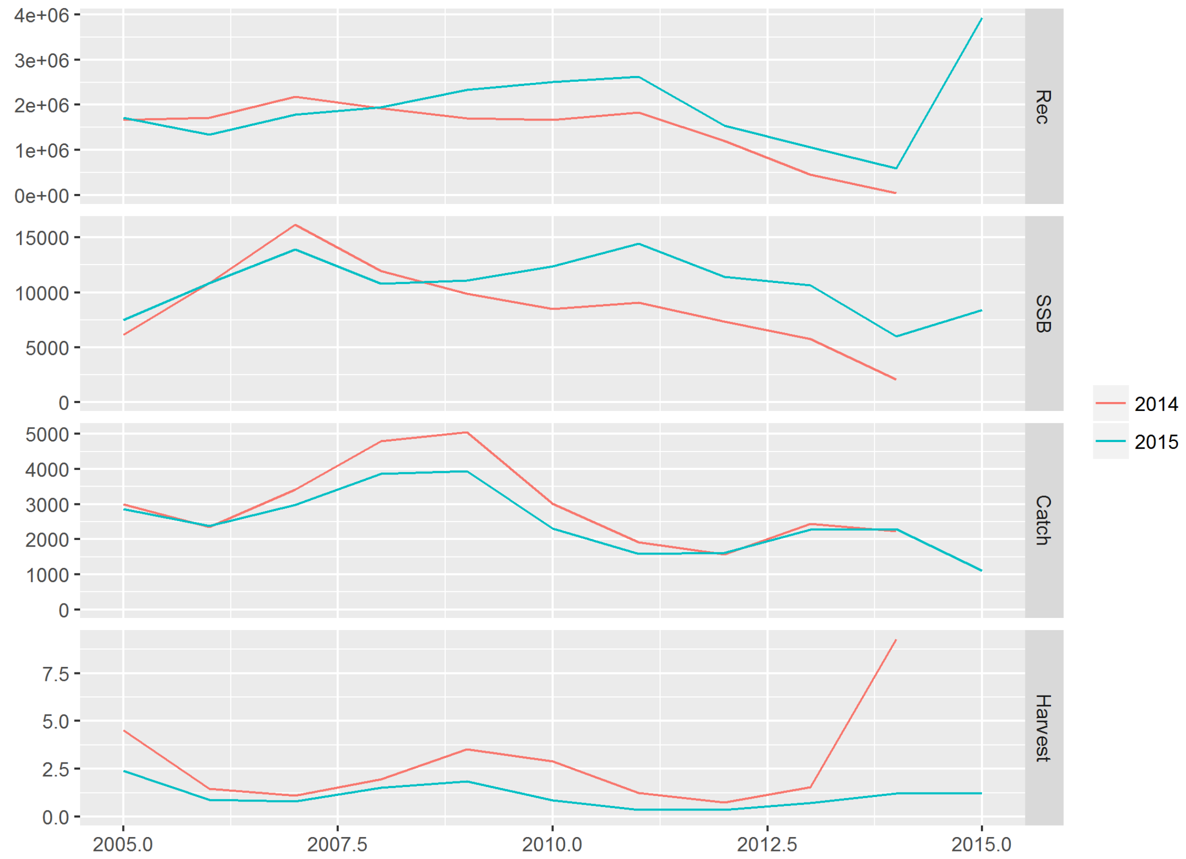


Figure 7.3.1.1. European Anchovy in GSA 7. a4a summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

The retrospective analysis showed too much instability in the model results and in particular of the fishing mortality and thus none of these models were accepted. The EWG 16-13 concluded that these age structured models were not suitable to assess this stock with the current data availability.

Method 2: (ASPIC)

A surplus production model (ASPIC V.5.34.9, Prager 1999) was attempted on anchovy in GSA 7 using a long time series of landings made available to the EWG in combination with the acoustic biomass index covering the period 1993-2015. The landing series had to be truncated to the period 1916-2015 as ASPIC can run with only 99 years of data. DCF data was added for 2015 only while the rest of the time series is from IFREMER.

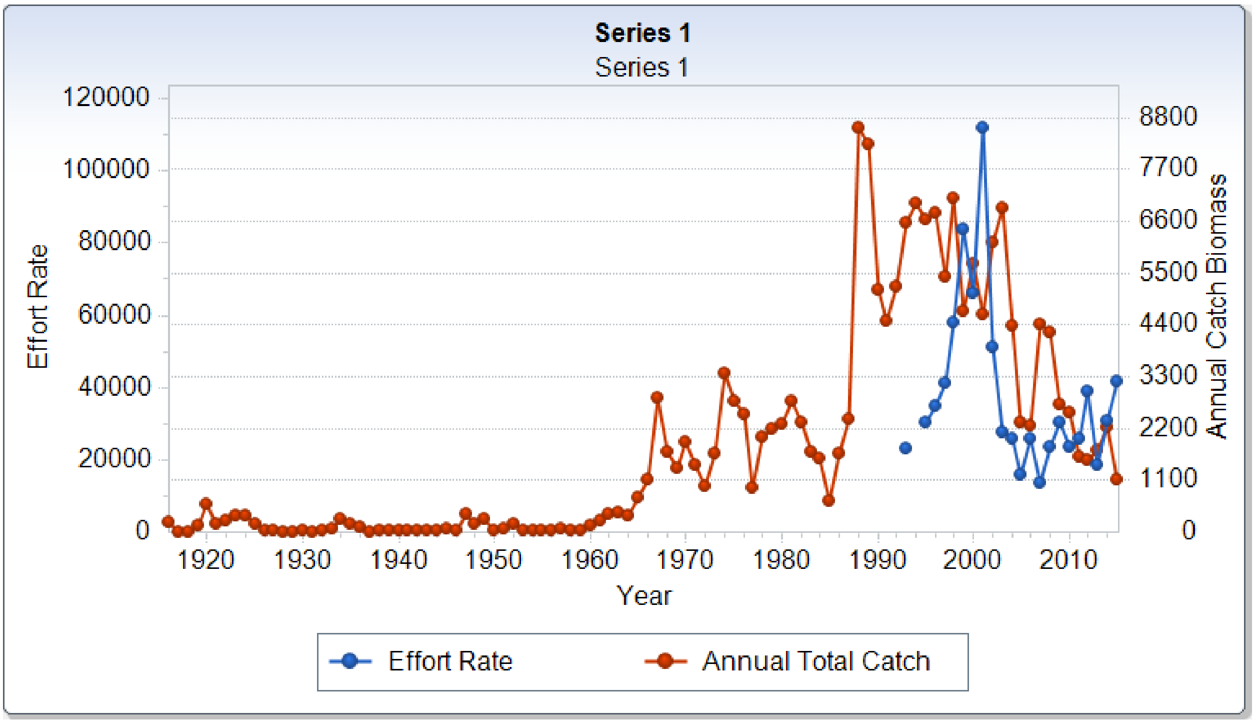


Figure 7.3.1.2. European Anchovy in GSA 7. Time series of data for the surplus production model fitting (ASPIC)

The main set up of the data was with Landings and the acoustic biomass index as CPUE. Model fitting was attempted in different modes "FIT", "BOT". In FIT program mode, ASPIC fits the model and computes estimates of parameters and other quantities of management interest, including time trajectories of fishing intensity and stock biomass. In BOT program mode, ASPIC fits the model and computes bootstrapped confidence intervals on estimated quantities. Conditioning was always on Yield, which is usually preferable on statistical grounds to compute residuals in the more imprecise quantity (CPUE index) as recommended by ASPIC user manual.

Different model shapes and optimization control were attempted for deriving the best performing model.

LOGISTIC Fit the logistic (Schaefer) model.
GENGRID Fit the generalized model at grid of values or at one specified value.
FOX Fit the Fox model (a special case of GENFIT, below).
GENFIT Fit the generalized model and estimate its exponent directly.

All the models attempted with a logistic (Schaefer fit) or a Fox model either did not fit or hit the bounds on MSY or q were rejected and are not reported here. Models fitted with the generalized fit (Pella-Tomlinson) were the only ones able to run. Different initial conditions on the parameters B0/K, MSY, K and q, were attempted with multiple runs hitting the bounds on the Bmsy/K. Overall the model had difficulties fitting the early part of the series. Only one model run (m14) converged normally, without hitting the bound on Bmsy/K and the results look promising.

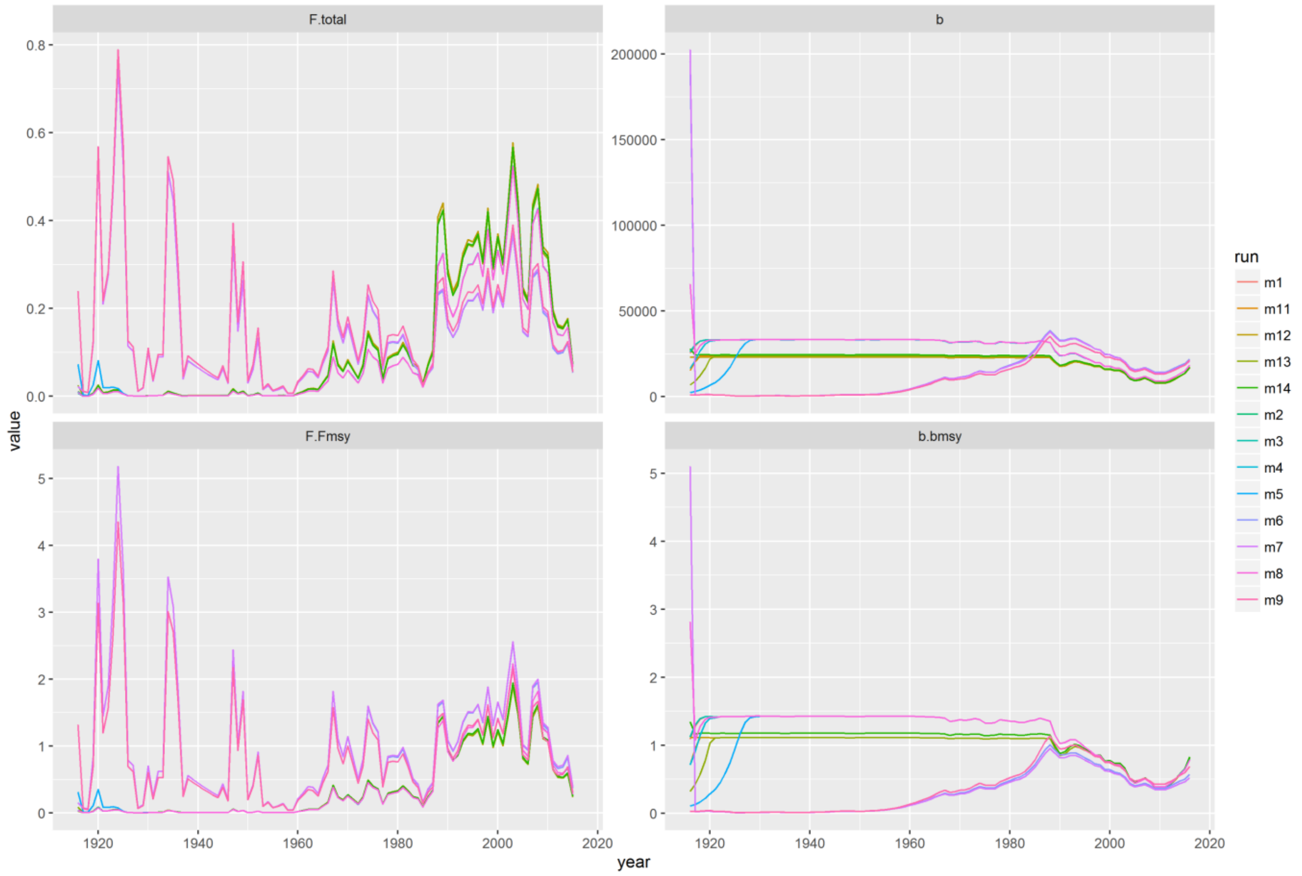


Figure 7.3.1.4. European Anchovy in GSA 7. Comparison of ASPIC model runs for F total, biomass (b), F/Fmsy and B/Bmsy

Model run 14, is presented here as an exploratory assessment as there was not time during the meeting to explore its stability, the retrospective patterns, etc. Details of model setup are below:

CONTROL PARAMETERS (FROM INPUT FILE) Input file: s:\...stecf med 2016\ewg16_13\pro_models_sa7\ane_sa7_v14.inp

---

Operation of ASPIC: Fit generalized (Pella-Tomlinson) model at grid of model shapes.

Number of years analyzed: 100 Number of bootstrap trials: 0

Number of data series: 1 Bounds on MSY (min, max): 4.000E+01 8.169E+07

Objective function: Least squares Bounds on K (min, max): 3.000E+02 8.169E+08

Relative conv. criterion (simplex): 1.000E-08 Monte Carlo search mode, trials: 0 100

Relative conv. criterion (restart): 3.000E-08 Random number seed: 72881716

Relative conv. criterion (effort): 1.000E-04 Identical convergences required in fitting: 8

Maximum F allowed in fitting: 3.000 Number of steps for numerical integration: 12

Bounds factor for generalized fit: 8.000 Bounds on phi (%): 35 90

RESULTS OF GRID SEARCH FOR EXPONENT -- GENERALIZED MODEL

Exponent	Bmsy/K	Err	B1/K	MSY	K	q1	SSE	AIC_c	Best	Prob>F
2.00	0.50	0	3.18650	3.986E+03	6.939E+04	1.461E+00	4.91681E+00	-2.563E+01	(Ref)	
0.91	0.35	0	0.00166	4.517E+03	3.550E+05	9.271E-01	4.85112E+00	-2.291E+01	-	
1.19	0.40	0	0.00286	5.410E+03	1.659E+05	1.551E+00	4.73966E+00	-2.342E+01	-	
1.54	0.45	0	0.00417	6.691E+03	1.728E+05	1.575E+00	4.63008E+00	-2.393E+01	-	
2.00	0.50	0	3.18650	3.986E+03	6.939E+04	1.461E+00	4.91681E+00	-2.563E+01	-	
2.60	0.55	0	4.42566	4.563E+03	5.300E+04	1.866E+00	4.81660E+00	-2.306E+01	-	
3.39	0.60	0	4.97346	4.947E+03	4.420E+04	2.096E+00	4.70362E+00	-2.359E+01	-	
4.48	0.65	0	3.61069	5.088E+03	7.292E+04	1.293E+00	4.63942E+00	-2.389E+01	-	
6.04	0.70	0	2.52864	5.639E+03	8.640E+04	1.117E+00	4.65125E+00	-2.383E+01	-	
8.40	0.75	0	0.01936	5.582E+03	5.862E+04	1.372E+00	4.55500E+00	-2.429E+01	-	

12.22 0.80 0 1.30781 5.856E+03 2.691E+04 2.542E+00 4.37533E+00 -2.518E+01 -

19.17 0.85 0 1.14453 6.067E+03 2.443E+04 2.643E+00 4.32577E+00 -2.543E+01 * 0.13424

34.65 0.90 0 1.16025 5.890E+03 8.506E+04 8.687E-01 4.73929E+00 -2.342E+01 -

*** NOTE: F-statistic is 2.4594 with 1 and 18 degrees of freedom.**

*** NOTE: Non-logistic model with best fit used for following reports.**

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS) error code 0

Normal convergence

Number of restarts required for convergence: 7

GOODNESS-OF-FIT AND WEIGHTING (NON-BOOTSTRAPPED ANALYSIS)

Weighted Weighted Current Inv. var. R-squared

Loss component number and title SSE N MSE weight weight in CPUE

Loss(-1) SSE in yield 0.000E+00

Loss(0) Penalty for B1 > K 0.000E+00 1 N/A 0.000E+00 N/A

Loss(1) Series 1 4.326E+00 22 2.163E-01 1.000E+00 1.000E+00 0.138

..

TOTAL OBJECTIVE FUNCTION, MSE, RMSE: 4.32576586E+00 2.403E-01 4.902E-01

Estimated contrast index (ideal = 1.0): **0.8201** **C* = (Bmax-Bmin)/K**

Estimated nearness index (ideal = 1.0): **1.0000** **N* = 1 - |min(B-Bmsy)|/K**

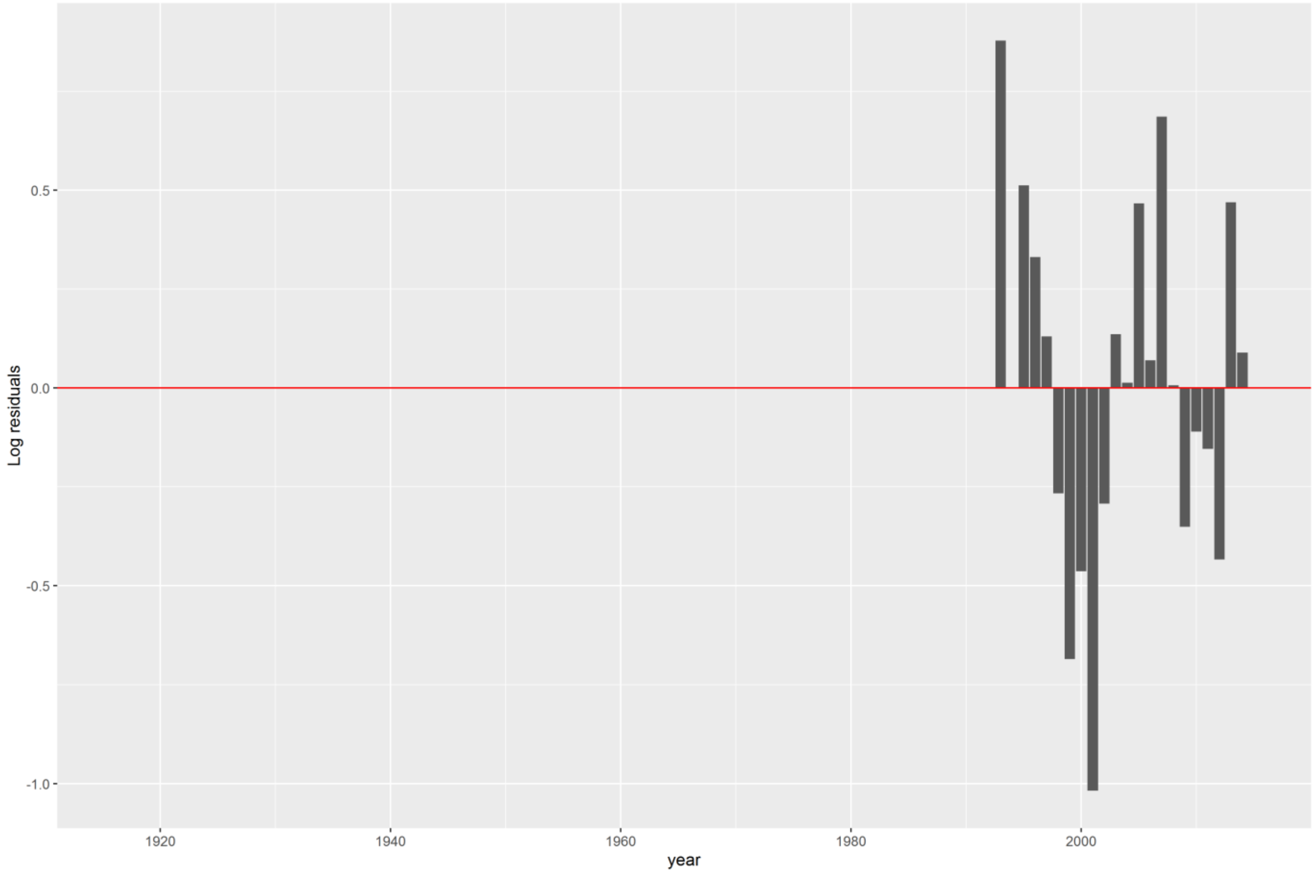


Figure 7.3.1.5. European Anchovy in GSA 7. Log residuals for model (m14)

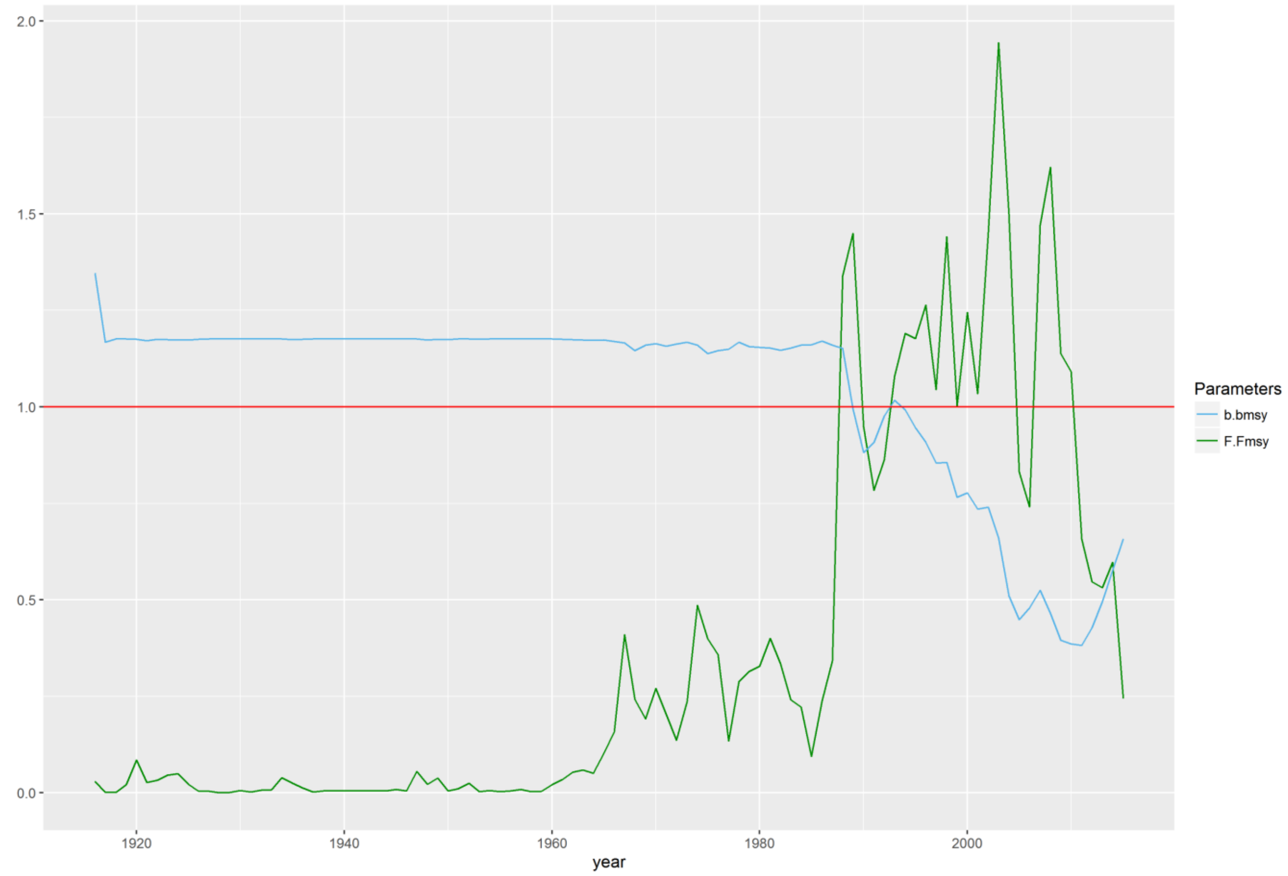


Figure 7.3.1.6. European Anchovy in GSA 7. F/Fmsy and B/Bsy from model fit (m14)

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

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Parameter Estimate User/pgm guess 2nd guess Estimated User guess

B1/K Starting relative biomass (in 1916) 1.145E+00 1.000E+00 3.430E-01 1 1

MSY Maximum sustainable yield 6.067E+03 5.844E+03 1.525E+03 1 1

K Maximum population size 2.443E+04 5.844E+04 9.148E+03 1 1

phi Shape of production curve (Bmsy/K) 0.8500 0.000E+00 0.000E+00 1 1

--------- Catchability Coefficients by Data Series ---------------

q(1) Series 1 2.643E+00 1.000E+00 3.993E-01 1 1

MANAGEMENT and DERIVED PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Logistic formula	General formula
MSY	Maximum sustainable yield	6.067E+03	----	----
Bmsy	Stock biomass giving MSY	2.076E+04	K/2	K*n**(1/(1-n))
Fmsy	Fishing mortality rate at MSY	2.922E-01	MSY/Bmsy	MSY/Bmsy
n	Exponent in production function	19.1730	----	----
g	Fletcher's gamma	1.241E+00	----	[n**(n/(n-1))]/[n-1]
B./Bmsy	Ratio: B(2016)/Bmsy	8.315E-01	----	----
F./Fmsy	Ratio: F(2015)/Fmsy	2.443E-01	----	----
Fmsy/F.	Ratio: Fmsy/F(2015)	4.094E+00	----	----
Y.(Fmsy)	Approx. yield available at Fmsy in 2016	5.043E+03	MSY*B./Bmsy	MSY*B./Bmsy
	...as proportion of MSY	8.312E-01	----	----
Ye.	Equilibrium yield available in 2016	5.313E+03	4*MSY*(B/K-(B/K)**2)	g*MSY*(B/K-(B/K)**n)

…as proportion of MSY	**8.756E-01**	**----**	**----**

--------- Fishing effort rate at MSY in units of each CE or CC series ---------

fmsy(1) Series 1 1.105E-01 Fmsy/q(1) Fmsy/q(1)

From the exploratory run of model 14 it appears that the stock of anchovy is respectively at F(2015)/Fmsy = 0.244 and B(2016)/Bmsy= 0.831.

Model 14 is promising and should be explored further in the future, there are several reasons that could explain the fitting problems:

- There are no indexes prior to 1993 and this could complicate fitting the early part of the series, incorporating additional CPUEs or effort could improve the model fit.
- The stock boundaries might be mis-pecified as anchovy could be part of the stock in GSA 1-5-6-7-9 as hypothesized in STOCKMED, it is worth exploring a combined assessment.

Method 3: Data-limited approach

Following the ICES approach on data limited stocks we compared the last two years of biomass index with the previous three years. As shown in Figure 7.3.1.7 the biomass is increasing in the last two years.

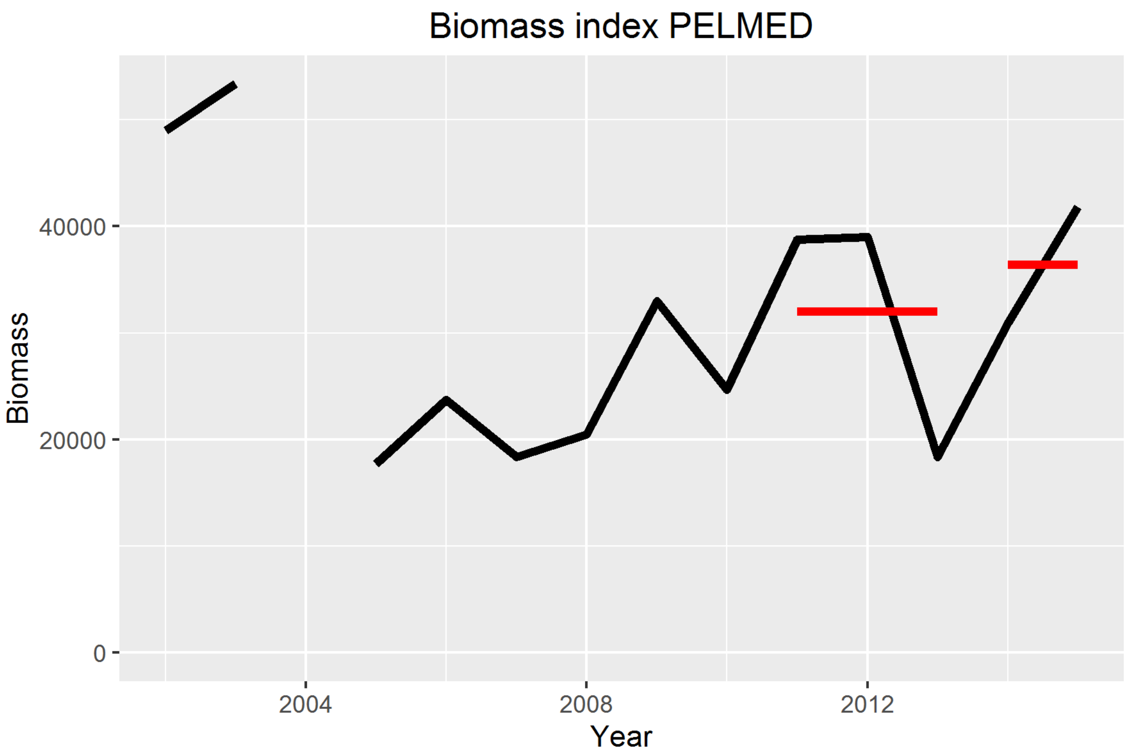


Figure 7.3.1.7. European Anchovy in GSA 7. Biomass index estimated by direct acoustic method from PELMED survey. In red the mean of the last two years compared to the previous three years.

The change in biomass over the last five years was used to provide an index for change (1.14). Following the ICES approach because this index is less than 1.2 the index value is used to multiply the catch to provide an initial catch advice. Because the exploitation rate is unknown and the state of the stock relative to B_{msy} is unknown a precautionary buffer (catch multiplier of 0.8) is applied. The final factor is a change of catch of 0.9. Based on from the average of the last three years (1942 t) the catch advice which is applicable for two years is 1764 t.

7.3.2. Reference points

No reference points were estimated.

7.3.3. Short term forecast

No short term predictions were performed.

Short term predictions 2016-2018 by fleet

No short term predictions by fleet were performed.

7.3.4. Data quality

Data from DCF 2015 as submitted through the Official data call in 2016 were used. There were a numbers of data deficiencies and errors in the data submitted through DCF. Detailed information can be found in section 6.3.

The most critical issues appear to be the missing age structure data in 2004 in both landings and survey data.

7.4. STOCK ASSESSMENT OF SARDINE IN GSA 7

7.4.1. Assessment

Method 1: XSA and a4a

The data series of demographic structure of sardine landed in GSA 7 has discontinuities as regards both size and age. In particular, 2011 is missing for size distributions, while 2004, 2005 and 2011 for age distributions. A further limitation is caused by the survey PELMED used for tuning, the abundance indices for age/size are available only since 2006. To evaluate the potential for assessment FLR libraries were employed in order to carry out a XSA and an a4a base assessment.

However, the results obtained were unreliable, it was considered that the major issue was the missing data years, confirming the impossibility of using non-continuous time series with these assessment methods.

METHOD 2: (ASPIC)

A surplus production model (ASPIC V.5.34.9, Prager 1999) was also attempted on sardine in GSA 7 thanks to the long time series of landings made available to the EWG in combination with the acoustic biomass index covering the period 1993-2015. The landing series had to be shortened to 1916-2015 as ASPIC can run with only 99 years of data. DCF data was added for 2015 only while the rest of the time series is from IFRMER.

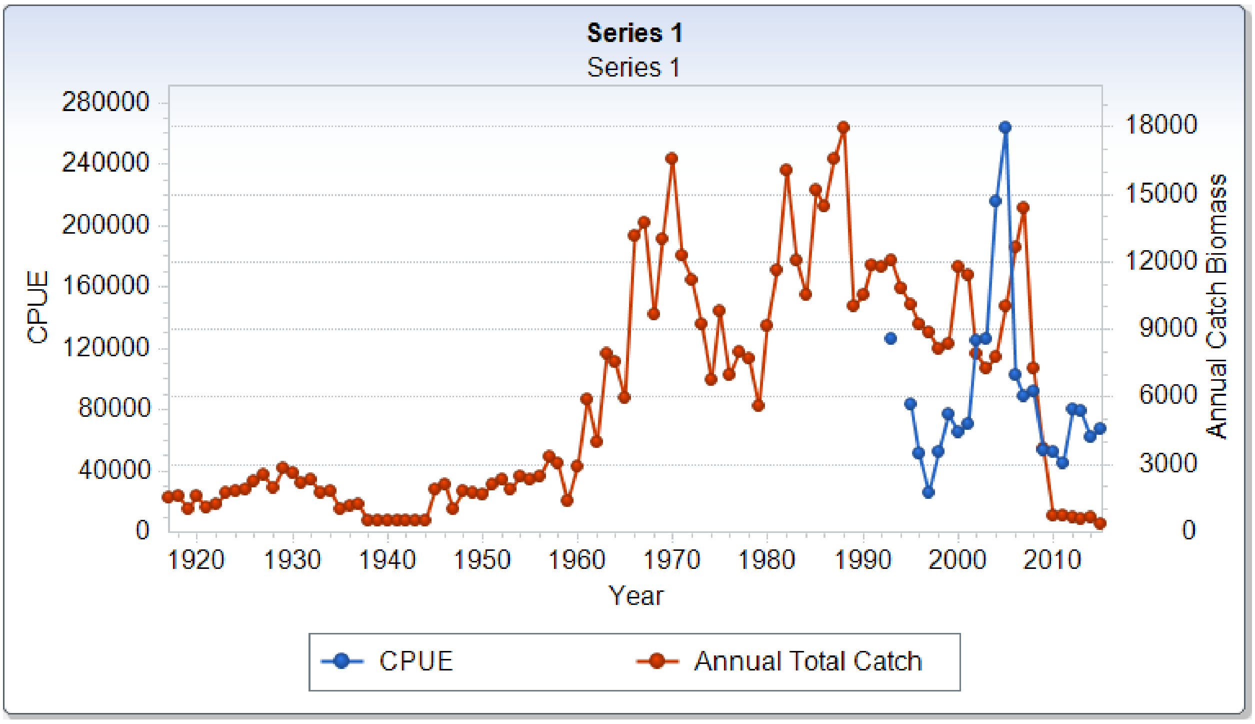


Figure 7.4.1.1. Sardine in GSA 7. Time series of data for the surplus production model fitting (ASPIC).

The main set up of the data was with Landings and the acoustic biomass as CPUE index. Model fitting was attempted in different modes "FIT", "BOT". In FIT program mode, ASPIC fits the model and computes estimates of parameters and other quantities of management interest, including time trajectories of fishing intensity and stock biomass. In BOT program mode, ASPIC fits the model and computes bootstrapped confidence intervals on estimated quantities. Conditioning was always on Yield, which is usually preferable on statistical grounds to compute residuals in the more imprecise quantity (CPUE Index) as recommended by ASPIC user manual.

Different model shapes and optimization control were attempted for deriving the best performing model.

LOGISTIC Fit the logistic (Schaefer) model.
GENGRID Fit the generalized model at grid of values or at one specified value.
FOX Fit the Fox model (a special case of GENFIT, below).
GENFIT Fit the generalized model and estimate its exponent directly.

All the models attempted with a logistic (Schaefer fit) or a Fox model did either not fit or hit the bounds on MSY or q and are not reported here. Under the generalized fit, several runs were defined with distinct time series: 1916-2015, 1950-2015, 1970-2015.

Models fitted with the generalized fit (Pella-Tomlinson) were the only formulations able to run but no model, irrespective of the initial guess parameters B0/K, MSY, K and q, returned meaningful results. There are several reasons that could explain the fitting problems:

- The time series of landings and acoustic biomass are intrinsically different.
- Little time was available to attempt further runs and data combinations.
- There are no indexes prior to 1993 and this could complicate fitting the early part of the series.

- Lack of time series of effort data from the French purse seine fishery and mid water trawling prevented building an effort index.
- The stock boundaries might be mis-pecified as sardine could be part of the stock in GSA 1-5-6 as hypothesized but with high uncertainty in STOCKMED.

Method 3: Data-limited approach

Following the ICES approach on data limited stocks, the last two years (2014-2015) of biomass index coming from PELMED survey were compared with the previous three years (2011-2013) (Fig. 7.4.1.2.). The biomass estimated over the last five years was used to provide an index of change (1.03).

As the index is below 1.2, the value is used to multiply the catch to provide an initial catch advice. As the exploitation rate is unknown and the state of the stock related to Bmsy is unknown, therefore a precautionary buffer (0.8) is also applied. The resulting catch advice taken from the baseline based average of the last three years (685.7 tons) is 565 tons.

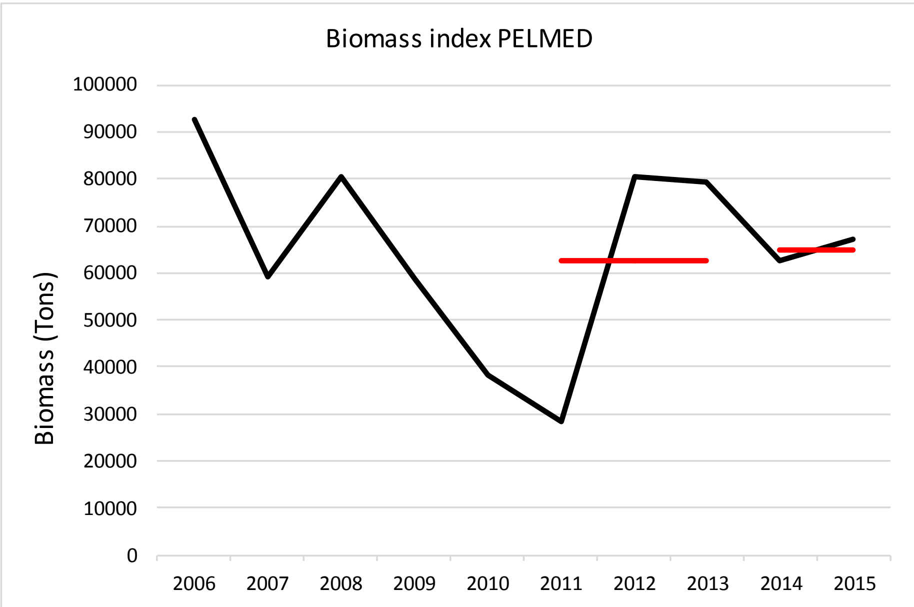


Figure 7.4.1.2. Sardine in GSA 7. Biomass index estimated from acoustic PELMED survey. In red the mean of the last two years compared with that of the previous three years.

7.4.2 Reference points

No reference points were estimated.

7.4.3 Short term forecasts

No short term predictions were performed.

7.4.4 Quality and proposals for future assessments

Data utilised for the analyses come from the DCF official data call performed in 2016. Some errors and deficiencies have been detected and the detailed list is reported in section 10 (Data quality check). The main issues are related to the missing length structure data (2011), age structure data (2004, 2005 and 2011), and survey data (2002-2005).

7.5 STOCK ASSESSMENT OF EUROPEAN ANCHOVY IN GSAs 17-18

7.5.1 Assessment

Methods: SAM (State-space Assessment Model)

The stock of anchovy in GSAs 17-18 was assessed using the State-space Assessment Model (SAM) (Nielsen *et al*., 2012) in FLR environment with data from 1975 to 2015. The SAM environment is encapsulated into the Fisheries Library in R (FLR) (Kell *et al*., 2007) in the form of the package "FLSAM". The state-space assessment model (SAM) is an assessment model which is used for several assessments within ICES. The model allows selectivity to evolve gradually over time. It has fewer model parameters than full parametric statistical assessment models, with quantities such as recruitment and fishing mortality modelled as random effects.

A tuning fleet (acoustic surveys covering respectively the western and eastern GSA 17, and the western GSA 18) from 2009 to 2015 was used in the assessment.

Since the spawning takes place mostly in spring-summer (Zorica *et al*., 2013), previous assessments (STECF EWG 15-11) were carried out taking into account a conventional birth date on the first of June (split-year), as in Santojanni *et al*. (2003). Consequently, all data were shifted by 6 months in order to have each year compounded by the time interval ranging from the first of June, up to May 31st of the following year; the tuning indices were shifted as well.

Following the suggestions by STECF EWG 14-09, the present assessment was based on the calendar-year data. This approach is expected to simplify calculations, limiting the errors, and it will allow using the most recent survey index available. In addition a new mean weight-at-age matrix was estimated using DCF data, and applied to the whole time series of data.

Assessment was performed with version 0.99-3 of FLSAM, together with version 2.5 of the FLR library (FLCore).

Input data

A revision of the historical dataset for anchovy in the Adriatic Sea was carried out in 2015: the main changes concern the use of one ALK to split length-frequency distributions of the eastern side of the Adriatic into numbers at age and the use of calendar year data, instead of using the split year assumption.

The growth parameters were not re-estimated during this meeting, but the same parameters as in previous GFCM 2015 stock assessment were used (Table 7.5.1.1).

Table 7.5.1.1. European Anchovy in GSAs 17-18. VBGF and length-weight parameters used.

Growth parameters	**L_{inf}**	**k**	**t_0**
Sex combined	19.4	0.57	-0.5
Length-weight	**a**	**b**	
Sex combined	0.0032	3.2339	

The following tables list the input parameters to the SAM model used to assess anchovy stock in GSAs 17-18: namely landings, catch numbers-at-age, mean weight-at-age, maturity-at-age, natural mortality-at-age and the tuning fleet.

Anchovy in GSAs 17-18. Total landings (tons) of anchovy by year.

Year	**landings (t)**	**year**	**landings (t)**
1975	22049	1996	30304
1976	28001	1997	39040
1977	35565	1998	32294
1978	54624	1999	29383
1979	50378	2000	37952
1980	61323	2001	33984
1981	33422	2002	26721
1982	36425	2003	31172
1983	27201	2004	38859
1984	28211	2005	57301
1985	45198	2006	60803
1986	16446	2007	65317
1987	4848	2008	49486
1988	11624	2009	52578
1989	14287	2010	53689
1990	14363	2011	44487

1991	21371	2012	36045
1992	14557	2013	28043
1993	14562	2014	31085
1994	21424	2015	39449
1995	35665		

Anchovy in GSAs 17-18. Input data for the SAM assessment. Catch numbers-at-age matrix (thousands).

	Age0	Age1	Age2	Age3	Age4
1975	430648	749107	470727	113334	60468
1976	507658	809598	575822	197555	133225
1977	774435	1042408	569084	250641	208942
1978	674115	1566199	1345814	690815	264697
1979	583595	1344564	1121438	672708	331904
1980	351635	1120003	1336027	969035	439978
1981	332249	819860	831535	490096	178932
1982	311704	685312	814725	580881	354901
1983	227081	493031	586802	438512	286329
1984	236257	516831	614008	449517	293671
1985	464562	744755	731908	558138	731432
1986	229970	214816	165878	132845	201758
1987	106273	93943	72369	45412	29387
1988	417223	313590	149799	65500	36939
1989	499470	271594	175433	65511	17740
1990	368635	361682	173301	48917	12232
1991	592446	448869	251175	99191	29723
1992	231141	275707	222310	86621	24522
1993	311538	277088	220264	83879	22353
1994	663884	497616	243395	66510	13819
1995	759879	832506	475690	146153	31489
1996	621749	614139	425306	156948	38205
1997	981207	874372	519983	142674	29227
1998	555739	681283	509993	154245	33093
1999	893241	787210	403261	86806	15101
2000	567428	1391811	677642	222211	43433
2001	316349	1274167	635553	183512	34161
2002	195093	1032317	545043	135359	25560

2003	559617	1632217	484924	56876	1525
2004	1102230	1622879	1056196	156683	12257
2005	831389	2112146	1071110	147850	1820
2006	639152	1127593	1987490	312469	31474
2007	321157	1055166	2273515	730590	126856
2008	365198	787742	1761498	481249	75439
2009	612299	2308814	1305859	135746	20472
2010	479828	2090268	1639046	124209	15520
2011	553912	1606921	1133430	94394	18640
2012	672596	1419628	1119387	33839	4213
2013	315233	1057152	841890	52631	1612
2014	461127	1384033	901014	69338	2342
2015	176705	1377566	1309163	71139	600

Anchovy in GSAs 17-18. Mean weight-at-age vector in the catches for the entire time series (1975-2015).

Period	**Age**	**0**	**1**	**2**	**3**	**4**
1975-2015	Weight (kg)	0.009	0.012	0.015	0.018	0.025

Anchovy in GSAs 17-18. Proportion of mature specimens-at-age.

PERIOD	**Age**	**0**	**1**	**2**	**3**	**4**
1975-2015	Prop. Matures	0.5	1.0	1.0	1.0	1.0

Anchovy in GSAs 17-18. Natural mortality vector by age from Gislason et al. (2010).

Period	**Age**	**0**	**1**	**2**	**3**	**4**

1975-2015	M	2.36	1.10	0.81	0.69	0.64

Anchovy in GSAs 17-18. Numbers (thousands) at-age from MEDIAS surveys in GSAs 17 and 18.

	Age groups				
Years	**0**	**1**	**2**	**3**	**4**
2009	52852942	32097627	19621138	2005357	16760
2010	22567025	45045186	22371362	2358104	8487
2011	30090969	26104275	19005731	1370068	15265
2012	52438326	36533583	14871379	467886	10542
2013	24079266	24508544	15626335	2199144	13962
2014	22946486	17248015	15083813	1541899	129
2015	6549465	16895326	11590281	396244	741

Results

SAM outputs are listed in table 7.5.1.2. Tables 7.5.1.3 and 7.5.1.4 show the fishing mortality-at-age by year and the stock numbers-at-age by year (in thousand), respectively.

Table 7.5.1.2. European Anchovy in GSAs 17-18. Main results of the anchovy SAM assessment.

Year	**Recruits Age 0 (Thousands) Mean**	**Recruits Age 0 (Thousands) Low**	**Recruits Age 0 (Thousands) High**	**Total biomass (tonnes) Mean**	**Total biomass (tonnes) Low**	**Total biomass (tonnes) High**	**Spawning biomass (tonnes) Mean**	**Spawning biomass (tonnes) Low**	**Spawning biomass (tonnes) High**	**Landings (tonnes) Mean**
1975	184839789	123052740	277651253	1908828	1293170	2817592	1057058	723643	1544092	23365
1976	22351744	15394562	32453047	234782	163960	336195	131849	928110	187308	30822

	0	3	4	5	7	4	3		0	
1977	251260297	175553992	359614363	2681803	1906059	3773266	1525755	1094877	2126201	40782
1978	219091498	154934220	309815898	2450984	1772904	3388407	1441219	1053879	1970922	53423
1979	182817693	130571144	255970100	2099060	1539197	2862565	1256700	932267	1694038	57011
1980	142949217	103251591	197909576	1682851	1252249	2261522	1023767	770821	1359719	55381
1981	117623570	86038171	160804259	1383324	1043932	1833056	840708	642327	1100359	46028
1982	93924328	68957850	127930026	1112366	846474	1461780	679424	524624	879900	40741
1983	58879292	43518191	79662570	741181	572142	960162	470241	368233	600507	34544
1984	33834786	24466515	46790184	451802	348078	586435	295966	232546	376683	29941
1985	23700341	17106242	32836327	304980	231893	401101	195830	151705	252789	24125
1986	20095370	14618722	27623748	237756	179192	315461	145219	111011	189969	13412
1987	21900061	16227502	29555547	241108	183023	317628	140225	107732	182517	8599
1988	28976624	21699974	38693354	305590	233636	399704	172129	133310	222251	10021
1989	32801998	24672317	43610461	347319	267106	451622	196222	153034	251598	11599
1990	31832553	24013165	42198161	344897	267000	445519	198194	155813	252102	12516
1991	31421408	23749518	41571575	341806	265595	439886	197205	155773	249658	13758
1992	33733434	25536046	44562284	361855	281510	465132	206489	163410	260924	12539
1993	44857439	34137710	58943316	467428	363806	600564	260928	206253	330097	13579
1994	53650428	41084686	70059399	562418	441019	717234	315527	251399	396013	17717
1995	54135461	41599371	70449338	581287	459070	736042	331705	266536	412807	22925
1996	52483007	40312978	68327030	568638	450023	718518	326766	263465	405277	24662
1997	58879292	45371667	76408278	625934	495348	790946	354690	285671	440385	27092
1998	60128831	46261045	78153797	643064	508675	812959	365858	294666	454250	26823
1999	63085405	48418862	82194586	674010	532266	853501	383464	308525	476605	28453
2000	55284327	42123182	72557594	605615	476991	768924	351161	282247	436901	31351
2001	57771146	44240269	75440438	617849	486493	784673	352216	282375	439332	29792
2002	78687904	60161237	102919862	809361	632386	1035862	447307	355050	563536	27474
2003	11880570	91065246	15499651	120621	941820	154483	658685	521470	832004	32112

	7		6	8		9				
2004	174773254	132323257	230841434	1774448	1370373	2297671	969950	760376	1237287	44400
2005	145691219	110348092	192354311	1589611	1240592	2036821	918962	730127	1156635	54885
2006	105476633	80001953	139063108	1213477	956500	1539493	727231	584676	904545	59576
2007	86184422	65316680	113719108	984609	775446	1250190	587129	472056	730254	57240
2008	97172664	74616364	126547666	1042362	822718	1320645	594812	477783	740506	48874
2009	94206525	72069854	123142601	1015610	799266	1290514	581869	466169	726283	48243
2010	76821876	59332751	99466156	850007	676534	1067961	496332	401785	613127	51380
2011	75602507	58529625	97655487	815046	646639	1027312	466494	375763	579132	46397
2012	74179619	57164155	96259902	793334	625846	1005646	451802	361739	564290	40498
2013	62146186	46734649	82639935	680103	528546	875119	393564	312086	496315	37609
2014	51495243	36320207	73010600	569777	417282	778001	332369	249255	443196	35739
2015	29326438	15986302	53798557	349410	209475	582823	214272	135756	338198	30333

Year	**Landings (tonnes) Low**	**Landings (tonnes) High**	**Yield / SSB (ratio) Mean**	**Yield / SSB (ratio) Low**	**Yield / SSB (ratio) High**	**Mean F ages 1-2 Mean**	**Mean F ages 1-2 Low**	**Mean F ages 1-2 High**	**Mean F ages 0-1**	**SoP (%)**
1975	18003	30324	0.022	0.025	0.020	0.179	0.107	0.301	0.052	1.075
1976	25248	37628	0.023	0.027	0.020	0.173	0.108	0.279	0.050	1.073
1977	33690	49367	0.027	0.031	0.023	0.166	0.106	0.261	0.051	1.070
1978	44108	64706	0.037	0.042	0.033	0.189	0.127	0.280	0.056	1.180
1979	47191	68875	0.045	0.051	0.041	0.194	0.133	0.285	0.058	1.168
1980	45594	67270	0.054	0.059	0.049	0.209	0.145	0.303	0.059	1.063
1981	38025	55714	0.055	0.059	0.051	0.207	0.143	0.298	0.059	1.159
1982	33644	49336	0.060	0.064	0.056	0.217	0.153	0.308	0.062	1.171
1983	28445	41951	0.073	0.077	0.070	0.229	0.164	0.320	0.069	1.171
1984	24235	36992	0.101	0.104	0.098	0.274	0.201	0.372	0.092	1.170

1985	18564	31351	0.123	0.122	0.124	0.355	0.242	0.520	0.127	1.161
1986	11067	16254	0.092	0.100	0.086	0.319	0.222	0.458	0.111	0.888
1987	6766	10929	0.061	0.063	0.060	0.276	0.190	0.401	0.094	0.980
1988	8264	12150	0.058	0.062	0.055	0.320	0.230	0.446	0.114	1.033
1989	9467	14212	0.059	0.062	0.056	0.344	0.249	0.475	0.117	0.851
1990	10268	15257	0.063	0.066	0.061	0.347	0.255	0.474	0.123	0.807
1991	11264	16805	0.070	0.072	0.067	0.376	0.277	0.512	0.128	0.806
1992	10307	15255	0.061	0.063	0.058	0.378	0.278	0.514	0.114	0.755
1993	11079	16644	0.052	0.054	0.050	0.382	0.282	0.518	0.110	0.798
1994	14509	21635	0.056	0.058	0.055	0.389	0.293	0.517	0.123	0.811
1995	18677	28140	0.069	0.070	0.068	0.447	0.343	0.582	0.142	0.777
1996	20283	29985	0.075	0.077	0.074	0.480	0.368	0.626	0.146	0.771
1997	22197	33067	0.076	0.078	0.075	0.531	0.410	0.688	0.162	0.789
1998	21975	32740	0.073	0.075	0.072	0.563	0.433	0.731	0.157	0.764
1999	23196	34901	0.074	0.075	0.073	0.545	0.422	0.703	0.170	0.879
2000	25153	39077	0.089	0.089	0.089	0.659	0.525	0.827	0.205	0.986
2001	23673	37493	0.085	0.084	0.085	0.794	0.619	1.017	0.218	0.946
2002	21959	34375	0.061	0.062	0.061	0.846	0.651	1.099	0.196	0.959
2003	25644	40213	0.049	0.049	0.048	0.733	0.580	0.926	0.174	1.072
2004	35753	55139	0.046	0.047	0.045	0.678	0.533	0.864	0.145	1.260
2005	43769	68825	0.060	0.060	0.060	0.581	0.443	0.761	0.122	0.911
2006	47386	74901	0.082	0.081	0.083	0.572	0.433	0.755	0.109	0.920
2007	45747	71620	0.097	0.097	0.098	0.698	0.551	0.885	0.116	1.014
2008	39182	60963	0.082	0.082	0.082	0.930	0.738	1.171	0.131	1.010
2009	38712	60121	0.083	0.083	0.083	1.021	0.838	1.244	0.178	1.073
2010	40941	64480	0.104	0.102	0.105	1.243	1.037	1.490	0.210	1.066
2011	37350	57637	0.099	0.099	0.100	1.538	1.280	1.849	0.212	0.987
2012	32610	50293	0.090	0.090	0.089	1.315	1.101	1.571	0.211	1.140
2013	29847	47390	0.096	0.096	0.095	1.229	1.017	1.485	0.206	1.051
2014	28644	44592	0.108	0.115	0.101	1.249	1.020	1.529	0.222	1.158
2015	23288	39509	0.142	0.172	0.117	1.328	0.914	1.928	0.244	1.000

Table 7.5.1.3. European Anchovy in GSAs 17-18. F-at-age estimated from 1975 to 2015.

	Year						
Age	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**
0	0.006	0.006	0.007	0.008	0.008	0.007	0.008
1	0.099	0.093	0.095	0.103	0.108	0.110	0.111
2	0.260	0.254	0.238	0.274	0.281	0.309	0.302
3	0.339	0.367	0.415	0.504	0.542	0.579	0.535
4	0.339	0.367	0.415	0.504	0.542	0.579	0.535
	1982	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**
0	0.009	0.012	0.019	0.030	0.027	0.022	0.031
1	0.115	0.126	0.165	0.223	0.195	0.167	0.198
2	0.319	0.331	0.382	0.486	0.442	0.385	0.442
3	0.579	0.618	0.694	0.801	0.700	0.599	0.668
4	0.579	0.618	0.694	0.801	0.700	0.599	0.668
	1989	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
0	0.034	0.033	0.035	0.024	0.023	0.029	0.033
1	0.200	0.212	0.222	0.204	0.196	0.217	0.252
2	0.488	0.483	0.531	0.552	0.568	0.561	0.642
3	0.710	0.711	0.810	0.841	0.870	0.884	1.048
4	0.710	0.711	0.810	0.841	0.870	0.884	1.048
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
0	0.033	0.035	0.029	0.029	0.023	0.015	0.011
1	0.260	0.288	0.285	0.311	0.387	0.421	0.381
2	0.700	0.775	0.841	0.779	0.931	1.166	1.310
3	1.152	1.198	1.278	1.267	1.571	1.884	2.289
4	1.152	1.198	1.278	1.267	1.571	1.884	2.289
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
0	0.012	0.014	0.014	0.014	0.012	0.012	0.015
1	0.335	0.276	0.231	0.203	0.220	0.249	0.341
2	1.131	1.081	0.931	0.940	1.176	1.610	1.701
3	1.963	2.165	1.704	1.661	1.946	2.212	2.206

4	1.963	2.165	1.704	1.661	1.946	2.212	2.206
	2010	**2011**	**2012**	**2013**	**2015**		
0	0.017	0.018	0.020	0.017	0.017		
1	0.403	0.406	0.402	0.396	0.471		
2	2.084	2.670	2.228	2.062	2.184		
3	2.217	2.515	2.666	2.723	3.534		
4	2.217	2.515	2.666	2.723	3.534		

Table 7.5.1.4. European Anchovy in GSAs 17-18. Stock numbers-at-age (thousands) from 1975 to 2015.

	year						
age	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**
0	184840000	223520000	251260000	219090000	182820000	142950000	117620000
1	11769000	17262000	21062000	23677000	20542000	17124000	13430000
2	2856200	3537700	5235600	6426900	7124100	6131800	5106400
3	572060	978720	1215900	1850600	2176000	2404900	1990700
4	372130	345590	467900	567500	743410	864580	930060
	1982	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**
0	93924000	58879000	33835000	23700000	20095000	21900000	28977000
1	11051000	8877200	5531700	3118900	2126500	1826700	2041100
2	4016800	3295300	2649800	1573800	810980	571490	518140
3	1682900	1301500	1062400	817490	426770	227980	172820
4	874140	733070	562420	417070	282940	179510	114580
	1989	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
0	32802000	31833000	31421000	33733000	44857000	53650000	54135000
1	2649800	2993600	2913900	2827800	3115800	4180700	4925800
2	557380	723600	805320	773750	760700	859410	1131400
3	148600	151600	199590	210240	197400	190610	220360
4	75132	55994	51948	56670	58279	54231	51380
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
0	52483000	58879000	60129000	63085000	55284000	57771000	78688000
1	4935700	4780200	5346800	5542700	5774700	5050500	5336100
2	1270600	1270600	1183500	1342400	1364100	1297600	1088200
3	265930	280130	260410	225260	276790	240150	178800
4	48339	50262	50413	43739	38446	33124	20994
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
0	118810000	174770000	145690000	105480000	86184000	97173000	94207000
1	7429700	11095000	16486000	13606000	9752200	8008400	9156700
2	1207400	1776200	2808000	4412700	3741500	2594700	2088600

3	129060	173510	267530	495340	776070	517100	229120
4	10131	9864	10511	25540	50061	59516	31793
	2010	**2011**	**2012**	**2013**	**2015**		
0	76822000	75603000	74180000	62146000	51495000		
1	8710200	7152700	7004100	6769900	5821100		
2	2180400	1906900	1591200	1551900	1512100		
3	170250	120810	58163	76344	87816		
4	14522	10180	5331	2223	2590		

The average fishing mortality for ages 1-2 (Figure 7.5.1.1) started increasing in 1994, reaching the maximum value of 1.54 in 2011. The estimate for 2015 is equal to 1.32. Spawning stock biomass fluctuates from the highest values in 1978 to a minimum in 1987. After that the stock was constantly increasing: in 2005, it reached the highest value registered in the last decade, but since than SSB is decreasing. Recruitment (Age 0) fluctuates from a minimum value in 1986, to a maximum value in 1978. From 1986 the estimated recruitment is constantly increasing to reaching in 2002 the highest value in last decade, and with constant decrease thereafter until 2015.

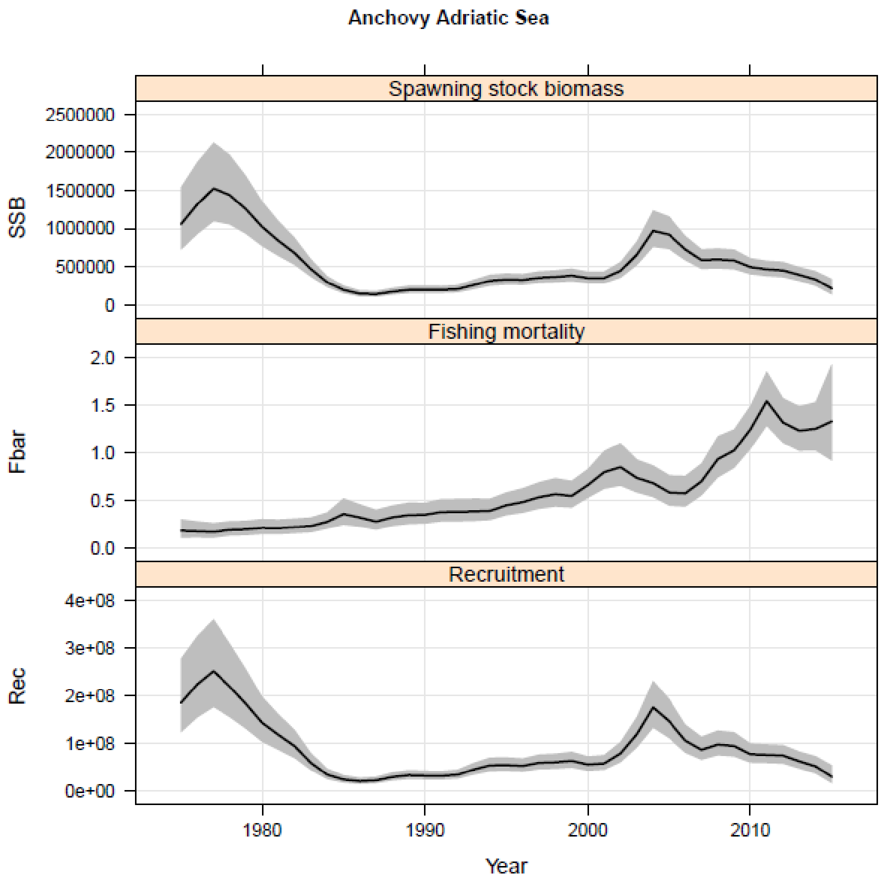


Figure 7.5.1.1. European Anchovy in GSAs 17-18. Stock Biomass (SSB) in tons (on top). F (age 1 to 2) (middle); recruitment (as thousands individuals)(bottom); 95% confidence intervals are shown.

Due to the very short time series of the tuning index (2009-2015), the retrospective analysis was run on 1 year only. The outputs are shown in Figure 7.5.1.2, and describe a rather consistent behaviour of the assessment model.

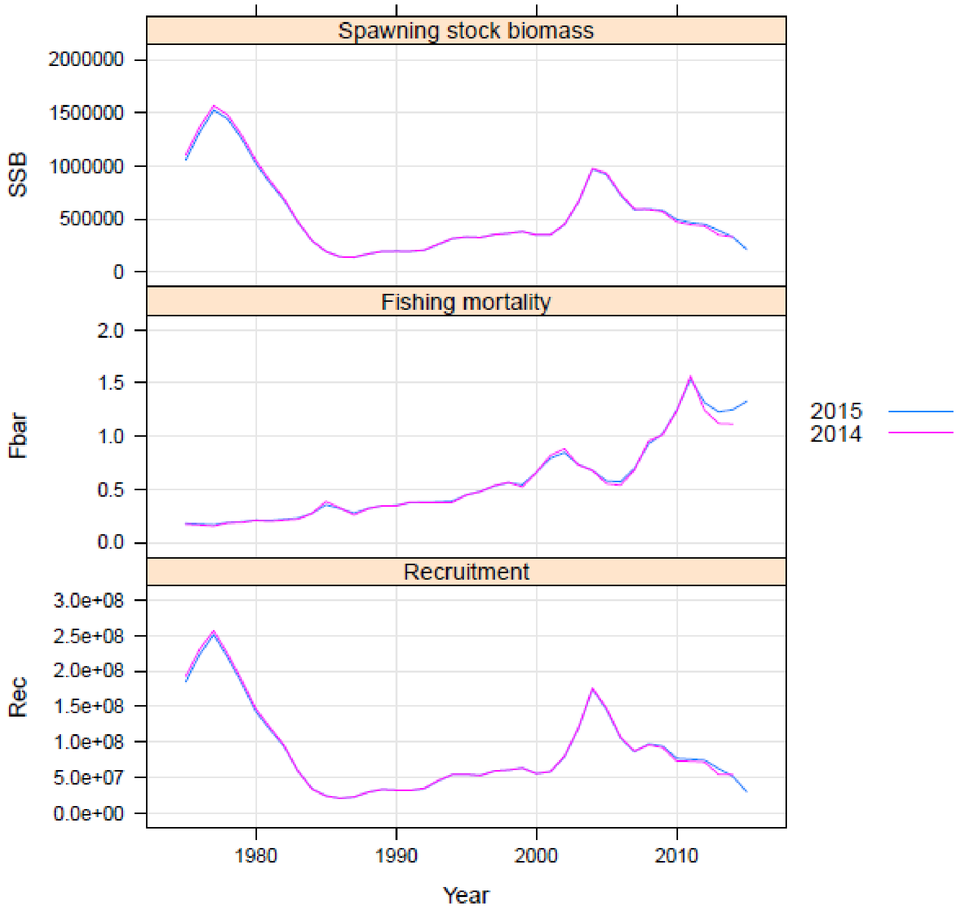


Figure 7.5.1.2. European Anchovy in GSAs 17-18. Retrospective analysis. Stock Biomass (SSB) in tons (on top). F (age 1 to 2) (middle); recruitment (as thousands individuals)(bottom).

Selection pattern (F/F_{bar}) by age class is plotted in Figure 7.5.1.3. The plots show a rather constant pattern in selectivity in all the pentads in the time series of data.

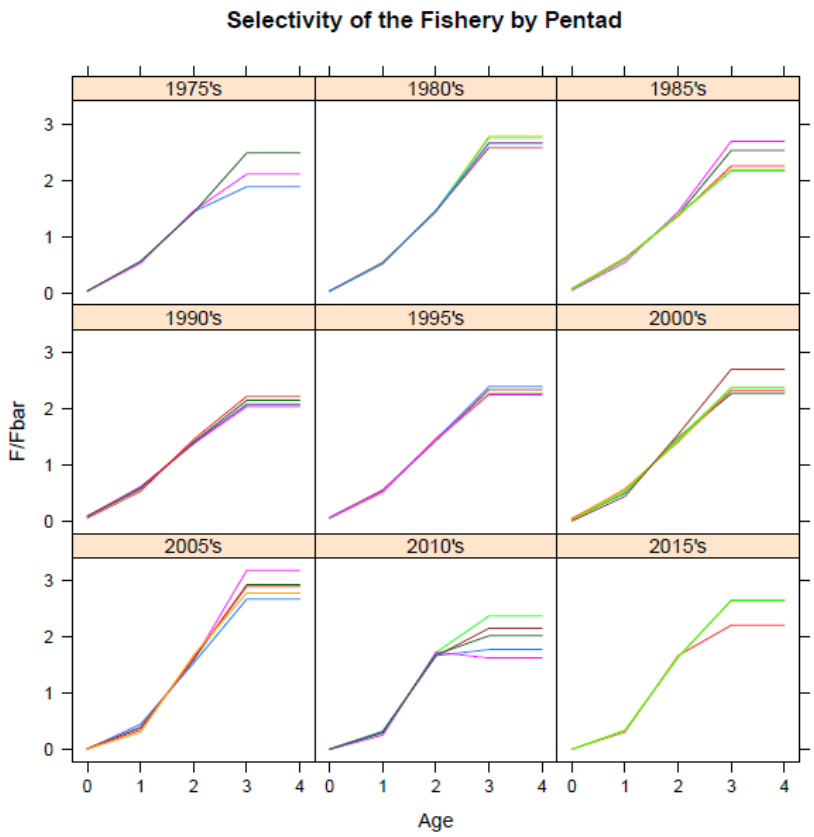


Figure 7.5.1.3. European Anchovy in GSAs 17-18. Selectivity at age by pentads as estimated by the SAM model.

In general, catch residuals did not show any trend. As concerns survey data, only age 4 was showing some patterns in the residuals. In the figures below only age 1 and 4 are shown as example of the good fitting in the catches, and of the overall acceptable fitting of the tuning index, with the only exception of age 4 (Figure 7.5.1.4 a, b, c, d).

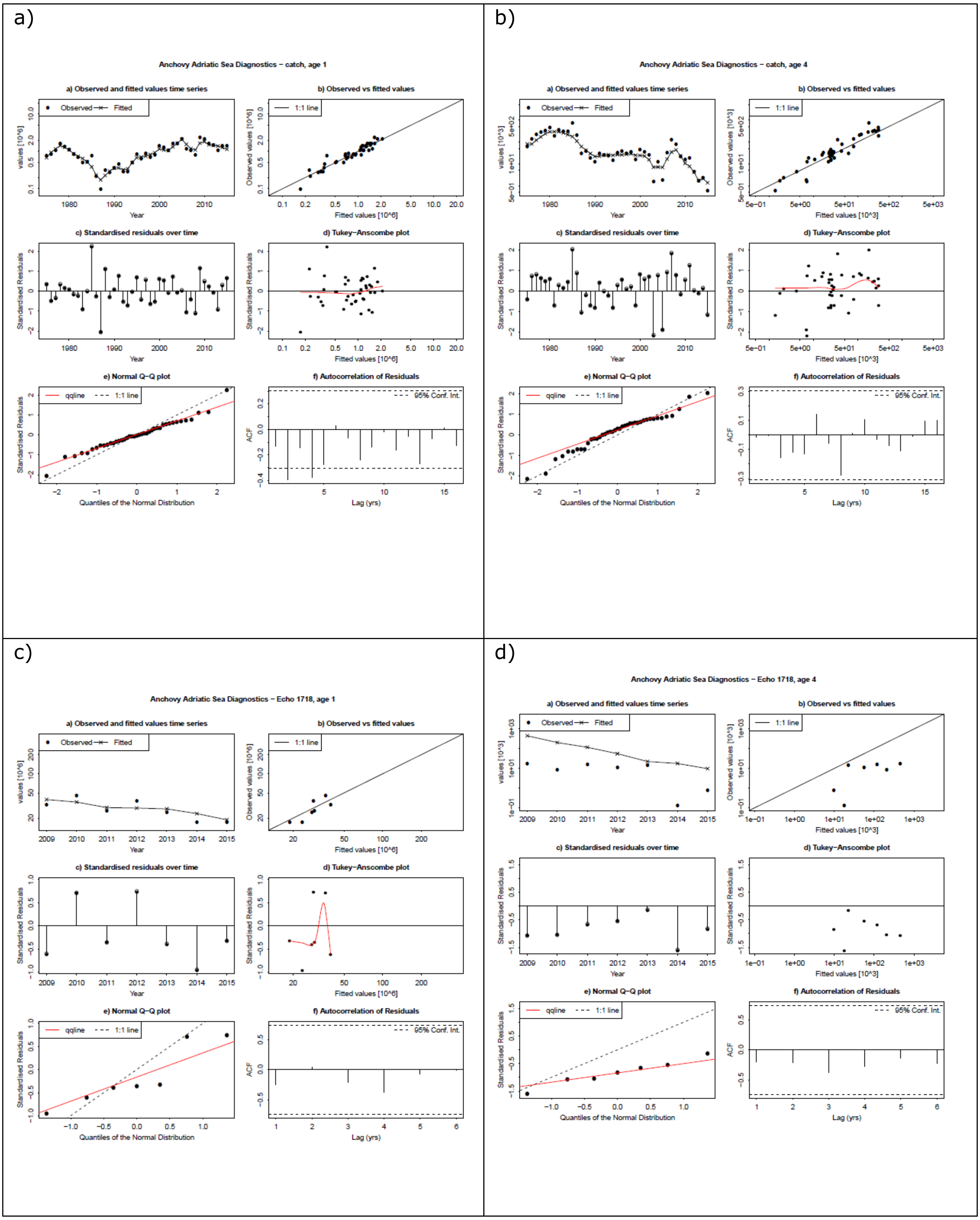


Figure 7.5.1.4. European Anchovy in GSAs 17-18. Diagnostic in catch and survey age structure residuals (age 1 and 4) for respectively: a) catches age 1; b) catches age 4; c) echo survey age 1; d) echo survey age 4.

Observation variances by input data (Figure 7.5.1.5.) showed that model is overfitting the catch data, and among the survey data, age 4 is practically not used as the variability is very high.

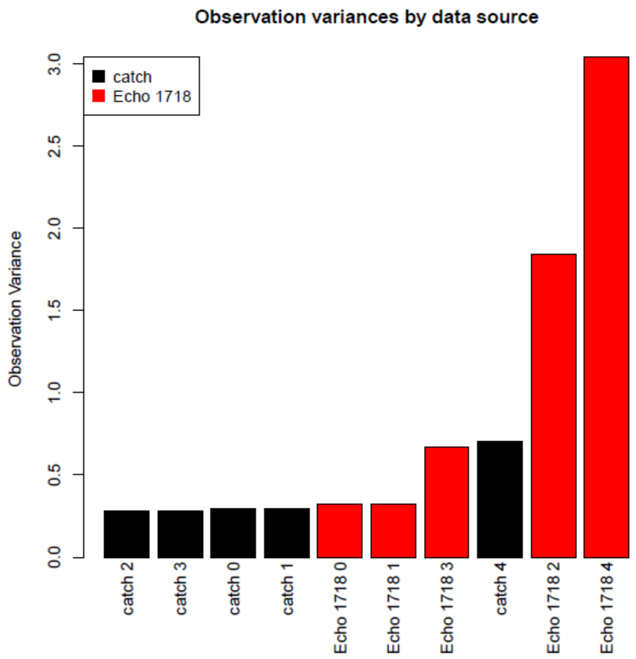


Figure 7.5.1.5. European Anchovy in GSAs 17-18. Plot of the observation variances by input data.

7.5.2 Reference points

STECF EWG 16-13 was not able to estimate and provide a reliable reference point in terms of F_{MSY}. However, a number of exploratory analyses were carried out.

Following the methods used by STECF EWG 15-11, Eqsim (ICES, 2015) was used to estimate anchovy stock in GSAs 17-18 reference point (F_{MSY}) on the basis of a Hockey-stick stock-recruitment model with fixed breakpoint at the mean SSB (approximately 850,000 tonnes) (Figure 7.5.2.1);

The observed catches fall above the simulated median yield curve (Figure 7.5.2.2), however, it is important to note that the observed catches are not equilibrium points that can be sustained indefinitely at the fishing mortality rates observed. This is borne out in the simulations where the estimated long-term sustainable yields are considerably lower for higher fishing mortality (Figure 7.5.2.2).

Different values of the reference points (and ranges based on 5% reduction in MSY, estimated using the eqsim_range function in the msy package) are simulated depending on whether the mean or median catches are used:

- On the basis of mean simulated catches: Fmsy = 0.65; Flower = 0.40, Fupper = 1.00;

- On the basis of median simulated catches: Fmsy = 0.65; Flower = 0.44, Fupper = 0.86;

ICES (2015) recommends that where the catches are skewed the median provides a more robust estimate of the reference points. From a practical perspective it can be taken that half the catches will be above and half below this point, whereas the mean can be driven by occasional large catches but the typical annual expectation could be considerably lower than the mean expectation.

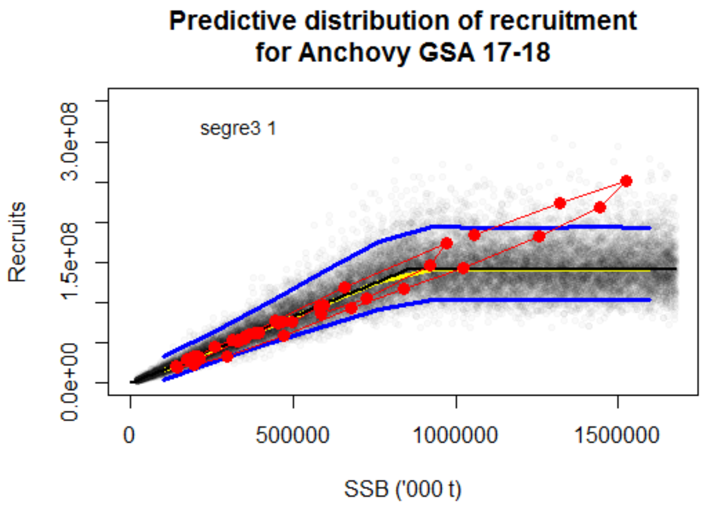


Figure 7.5.2.1. European Anchovy in GSAs 17-18. Segmented hockey-stick with a fixed breakpoint at the a mid range SSB = 850 000(tonnes).

These simulations identify the FMSY, but they raise precautionary issues, normally limited to less than Fp0.5 (shown in the figure at F= 0.4., however, this is conditional on the choice of Blim. This is a complex issue for this stock, as it requires determining if the recruitment is dependent on SSB over the whole range as the points in figure 7.5.2.1 imply or if this relationship is die to environmentally driven correlated recruitment which for a short lives stock results in a biomass to R relationship rather than a very strong dependence of R on SSB.

The value of B_{lim} (biological safeguard) value for anchovy in the analysis above has been set to B_{loss}, the lowest observed SSB in the time series of data (1975-2015; 140,000 tonnes). By definition, the area to the left of the breakpoint is where recruitment is impaired and therefore the breakpoint can be considered a natural choice for B_{lim}. However, given that the breakpoint is fixed as opposed to estimated, alternatives for B_{lim} are presented. Mace (1994) highlights the use of the SR curve to define a threshold SSB as the point at which recruitment is half that of the maximum. For the fixed segmented fit, this corresponds to mean SSB (around 850,000 tonnes).

Assigning B_{pa} = 1.4 x B_{lim}, results in a B_{pa} lower than the breakpoint.

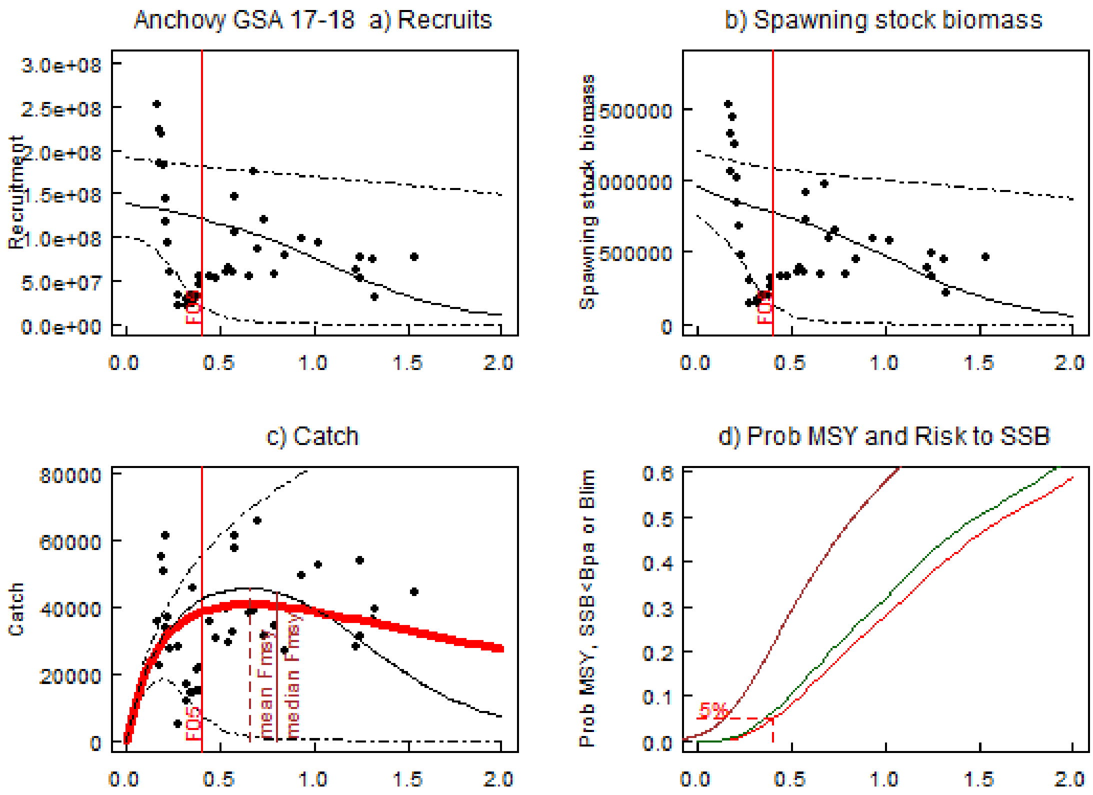


Figure 7.5.2.2. European Anchovy in GSAs 17-18. EqSim simulations using a fixed breakpoint (mean SSB) hockey-stick model. Note that arbitrary B_{lim} values were used to allow the plotting routines to work and hence the probabilities associated with SSB (bottom-right plot) should not be interpreted.

A proxy for F_{MSY} based on M can be obtained by the relationship between F and M , however as both F and M vary with age in this assessment comparison is more complex. F_{bar} can be compared with an equivalent M_{bar} using the selection pattern in the fishery to weight the M at age. I.e. an empirical approach based on the natural mortality vector by age (used as input data in the SAM assessment) is weighted by the recent selection pattern) by age from the SAM assessment(F/F_{bar} averaged over last 3 years, based on this approach a value of F = M = 0.72 was obtained as the maximum level of F to be exerted on the stock.

Estimates of F_{MSY} obtained from the present assessment and in previous working groups are shown in Table 7.5.2.1.

Table 7.5.2.1 European Anchovy in GSAs 17-18. Reference points, values and their technical basis.

Reference point	Value	Technical basis	Source
F_{MSY}	0.50	Eqsim	STECF EWG 14-09
F_{MSY}	0.30	Eqsim	STECF EWG 15-11
F_{MSY}	0.55	Eqsim	GFCM WGSASP 2015
F_{MSY}	0.72	F=M	Present assessment (Mean M weight by recent selection at F)
F_{MSY}	0.65	Eqsim	Present assessment maximum yield only
F_{MSY}	0.40	Eqsim	Present assessment limited by Precautionary considerations Fp0.5 based on Blim=140000 t

7.5.3 Short-term forecasts

Short-term prediction results are shown in the following table (Table 7.5.3.1). No indication about the F_{MSY} level is provided due to the uncertainty in estimating an appropriate reference point.

In the absence of MSY reference point advice is given based on precautionary considerations E=F/(F+M) = 0.4 (Patterson 1992), for this stock M varies by age (see above Table), for comparison with F mean M is taken as the weighted M over the selection in the fishery based on recent (last 3 years selection pattern, Table 7.5.1.3) and results in mean M = 0.73 giving F=0.484 for E=0.4 resulting in a catch of 12118

Table 7.5.3.1. Anchovy in GSAs 17-18. Short-term forecasts results showing catch options at different level of F.

Rationale	Ffactor	Fbar	Catch 2015	Catch 2016	Catch 2017	Catch 2018	SSB 2017	SSB 2018	Change SSB 2017-2018(%)	Change Catch 2015-2017(%)
Zero catch	0.00	0.00	39449	21348	0	0	270523	288081	6.5	-100.0
E = 0.4	0.38	0.48	39449	21348	9965	14344	270523	281465	4.0	-74.7
Status quo	1.00	1.27	39449	21348	21036	24050	270523	275006	1.7	-46.7
Different Scenarios	0.10	0.13	39449	21348	2975	5160	270523	286025	5.7	-92.5
	0.20	0.25	39449	21348	5664	9111	270523	284226	5.1	-85.6
	0.30	0.38	39449	21348	8113	12233	270523	282636	4.5	-79.4
	0.40	0.51	39449	21348	10362	14772	270523	281217	4.0	-73.7
	0.50	0.63	39449	21348	12441	16889	270523	279941	3.5	-68.5

	0.60	0.76	39449	21348	14377	18696	270523	278783	3.1	-63.6
	0.70	0.89	39449	21348	16189	20269	270523	277724	2.7	-59.0
	0.80	1.01	39449	21348	17894	21661	270523	276749	2.3	-54.6
	0.90	1.14	39449	21348	19506	22912	270523	275847	2.0	-50.6
	1.10	1.39	39449	21348	22494	25096	270523	274219	1.4	-43.0
	1.20	1.52	39449	21348	23888	26068	270523	273479	1.1	-39.4
	1.30	1.65	39449	21348	25224	26978	270523	272781	0.8	-36.1
	1.40	1.77	39449	21348	26507	27835	270523	272120	0.6	-32.8
	1.50	1.90	39449	21348	27744	28647	270523	271492	0.4	-29.7
	1.60	2.03	39449	21348	28937	29420	270523	270895	0.1	-26.6
	1.70	2.16	39449	21348	30089	30160	270523	270325	-0.1	-23.7
	1.80	2.28	39449	21348	31206	30871	270523	269780	-0.3	-20.9
	1.90	2.41	39449	21348	32287	31555	270523	269258	-0.5	-18.2
	2.00	2.54	39449	21348	33337	32217	270523	268758	-0.7	-15.5

7.5.4. Quality of assessment and comparison with past assessments

Compared to previous assessments carried out by STCF EWGs (STECF EWG 14-09 and STECF EWG 15-11) and GFCM WGSASP 2015, the SAM assessment of anchovy in GSAs 17-18 run at STECF EWG 16-13 shows similar trend in terms of SSB, fishing mortality, and recruitment. However, the major difference is represented by the absolute values of SSB estimated by the present assessment model, which are 2-3 times higher than those obtained by previous assessments. Also fishing mortality shows slightly higher values in the last five years compared to previous results.

While the assessment carried out at STECF EWG 14-09 was based on a split-year approach, the following assessments used a calendar year approach. Therefore, while It is very hard to understand what is determining those inconsistencies, especially those in terms of SSB, as the present assessment is based on the same input data (e.g., maturity and M vectors) as the previous models. Also selection patterns were similar to those of previous assessments, with some minor differences in the plus group. The only differences in input information are represented by mean weights-at-age and the tuning fleet. Mean weights-at-age used in the present assessment were derived from DCF data, while those of previous assessments were reconstructed from historical data analysis. However, differences in mean weight-at-age is not responsible for an increase in SSB of 2-3 times, as only in few cases discrepancies slightly higher than 10% were observed between landings and stock total weights derived from mean weights.

As concerns the tuning information, a single tuning fleet was used in the present assessment, combining the data from the acoustic surveys carried out in GSA 17 West, GSA 17 East, and GSA 18 West (from 2009 onwards), while they were kept as separated tuning fleets in previous models. It is worth mentioning that using a single tuning fleet for the whole Adriatic greatly improved the internal consistency of the survey. The use of a single survey is methodologically more consistent, as the now the catch and survey are both representative of the full region,

previously the split survey will have contained the same overall signal but by separating it into two indices it was interpreted by the model as potentially conflicting signals. In addition, both assessment and survey experts dealing with the stock during EWG 16-13 noted that the assessment carried out at GFCM WGSASP 2015 was listed as using information from Croatian acoustic surveys in GSA 17 East from 2004, while no acoustic survey was carried in GSA 17 East before 2009.
In the view of all these considerations, it is still difficult to find a possible explanation to the high SSB values provided by the present SAM model. However, very high values are present only at the beginning of the time series of data used in the assessment (1975-2015), where no tuning information was available. In contrast, it is worth highlighting that SSB values of the last years (2010-2015) obtained by the present assessment are in close agreement, both in terms of trend and absolute values, with the estimates coming from the acoustic surveys carried out in the Adriatic Sea. This does not apply to the results of previous assessments which always show lower values than those from acoustic surveys.

7.6. STOCK ASSESSMENT OF SARDINE IN GSAs 17-18

7.6.1. Assessment

Methods: SAM (State-space Assessment Model)
The stock of sardine was assessed using the State-space Assessment Model (SAM) (Nielsen *et al*., 2012) in FLR environment with data from 1975 to 2015. The SAM environment is encapsulated into the Fisheries Library in R (FLR) (Kell et al., 2007) in the form of the package "FLSAM". The state-space assessment model (SAM) is an assessment model which is used for several assessments within ICES. The model allows selectivity to evolve gradually over time. It has fewer model parameters than full parametric statistical assessment models, with quantities such as recruitment and fishing mortality modelled as random effects. A combined tuning index (acoustic survey covering the western and eastern sides in GSA 17 from 2009 to 2015, as well as acoustic survey covering the west part of the GSA 18 from 2009 to 2015) was used in the assessment. All the analyses were performed with version 0.99-3 of FLSAM, together with version 2.5 of the FLR library (FLCore).

Input data

A revision of the historical dataset for sardine in the Adriatic Sea was carried out in 2015. The growth parameters were not re-estimated during this meeting, but the same parameters as in previous GFCM 2015 stock assessment were used (Table 7.6.1.1.).

Table 7.6.1.1. Sardine in GSAs 17-18. VBGF and length-weight parameters used.

Growth parameters	L_{inf}	**k**	t_0
Sex combined	19.8	0.38	-1.785
Length-weight	**a**	**B**	

Sex combined	0.0058	3.119	

The following tables list the input parameters to the SAM model used to assess sardine stock in GSAs 17-18: namely landings, catch numbers-at-age, mean weight-at-age, maturity-at-age, natural mortality-at-age and the tuning fleet.

Sardine in GSAs 17-18. Total landings (tons) of sardine by year.

Year	Landings (t)	Year	Landings (t)
1975	33887	1996	44310
1976	46985	1997	38522
1977	54576	1998	36139
1978	44820	1999	27949
1979	41362	2000	26107
1980	48593	2001	24138
1981	93559	2002	24101
1982	84688	2003	21620
1983	83927	2004	26930
1984	92724	2005	20907
1985	75521	2006	20475
1986	79547	2007	21984
1987	73428	2008	27584
1988	68191	2009	34164
1989	71098	2010	34214
1990	61882	2011	54816
1991	54138	2012	58733
1992	40050	2013	71643
1993	45885	2014	82539
1994	39143	2015	77182
1995	41129		

Sardine in GSAs 17-18. Input data for the SAM assessment. Catch numbers-at-age matrix (thousands).

	Age0	Age1	Age2	Age3	Age4
1975	243402	298582	325819	275518	210626
1976	288885	392667	433664	391797	319938
1977	305496	429888	488887	429373	380798
1978	298792	385455	395466	321493	355903
1979	242457	304043	337730	323086	298893
1980	262242	333524	349875	383351	410000
1981	418373	646523	817784	830662	675897
1982	356889	581375	716111	785042	502172
1983	537549	737652	845175	731972	429213
1984	486037	733577	875729	878944	541174
1985	427791	558627	644782	804652	511643
1986	503281	623765	557120	659007	785430
1987	553893	756859	705386	535650	615365
1988	424205	626267	746063	528254	531291
1989	445678	639110	841380	645590	404742
1990	368874	504315	639186	686310	264410
1991	196352	288844	372766	728851	325271
1992	198353	254614	279939	477571	268278
1993	167553	247738	314135	488284	374099
1994	93117	155966	227664	424059	338937
1995	83787	125114	146722	480739	425474
1996	121144	182358	224492	438273	491891
1997	95126	196367	273559	387322	289317
1998	163894	224572	273142	327834	324843
1999	82777	111571	178034	285320	246206
2000	79774	147586	233764	253628	181209
2001	54422	180206	306267	229855	98652
2002	68803	283572	368282	195993	73899
2003	62546	221345	353722	172859	60470
2004	107076	233455	417320	251148	67361

2005	108307	132947	253790	200857	69001
2006	47407	123874	296209	238675	109847
2007	50077	196841	315205	211150	82348
2008	69486	399085	415618	173332	81353
2009	140394	315911	470321	274592	159389
2010	209720	684275	758370	278093	83650
2011	309634	1023436	898750	388504	129480
2012	385198	1456624	825968	207807	60540
2013	415531	1643097	836241	174200	28809
2014	452091	2170478	1245461	199488	28542
2015	733836	2020126	1234187	125244	4801

Sardine in GSAs 17-18. Mean weight-at-age vector in the catches for the entire time series (1975-2015).

Period	**Age**	**0**	**1**	**2**	**3**	**4**
1975-2015	Weight (kg)	0.016	0.020	0.025	0.032	0.039

Sardine in GSAs 17-18. Proportion of mature specimens-at-age.

PERIOD	**Age**	**0**	**1**	**2**	**3**	**4**
1975-2015	Prop. Matures	0.5	1.0	1.0	1.0	1.0

Sardine in GSAs 17-18. Natural mortality vector by age from Gislason et al. (2010).

Period	**Age**	**0**	**1**	**2**	**3**	**4**
1975-2015	M	1.06	0.83	0.69	0.61	0.48

Sardine in GSAs 17-18. Numbers (thousands) at-age from MEDIAS surveys in GSAs 17 and 18.

	Age groups				
Years	**0**	**1**	**2**	**3**	**4**
2009	3518134	10125840	7242311	2237324	265989
2010	7510341	8211157	3106936	1144051	220857
2011	6951465	20386344	7508390	1469642	152828
2012	6780579	10986920	2250967	437498	177865
2013	11281041	23970740	4911418	227494	4112
2014	2520472	19609021	5689464	272420	0
2015	15596178	13929109	4971235	41382	0

Results

SAM outputs are listed in table 7.6.1.2. Tables 7.6.1.3. and 7.6.1.4. show the fishing mortality-at-age by year and the stock numbers-at-age by year (in thousand), respectively.

Table 7.6.1.2. Sardine in GSAs 17-18. Main results of the sardine SAM assessment.

Year	**Recruits Age 0 (Thousands) Mean**	**Recruits Age 0 (Thousands) Low**	**Recruits Age 0 (Thousands) High**	**Total biomass (tonnes) Mean**	**Total biomass (tonnes) Low**	**Total biomass (tonnes) High**	**Spawning biomass (tonnes) Mean**	**Spawning biomass (tonnes) Low**	**Spawning biomass (tonnes) High**	**Landings (tonnes) Mean**
1975	40305561	33224135	48896329	1257958	1087734	1454820	934718	811841	1076192	35348
1976	41243332	34681616	49046514	1276969	1112794	1465366	946949	828551	1082264	48050
1977	40507593	34285981	47858193	1264263	1109555	1440542	940343	828283	1067564	53852
1978	43837492	37377280	51414274	1300163	1149009	1471201	949794	843025	1070085	46305

1979	49575137	42403396	57959845	1409859	1252072	1587530	1013581	906095	1133817	40823
1980	55118722	46868715	64820926	1559694	1385002	1756419	1119060	1003327	1248144	48436
1981	59709399	50619055	70432218	1708284	1513377	1928293	1231816	1102429	1376388	91126
1982	57655719	48420535	68652317	1708284	1502607	1942114	1246687	1107854	1402917	80580
1983	45809406	39614555	52972996	1548814	1391801	1723539	1182333	1061542	1316868	84626
1984	36179384	31192088	41964096	1317175	1198666	1447401	1027871	937375	1127103	92967
1985	33464643	28695805	39025993	1150837	1049069	1262477	882929	810826	961444	80258
1986	36143222	31187797	41886015	1113479	1011642	1225568	824886	757439	898338	85050
1987	40873807	35416443	47172103	1153141	1042938	1274989	826537	754780	905116	82043
1988	41657834	35772793	48511032	1178791	1059813	1311126	845768	768756	930495	75811
1989	38763902	32675529	45986710	1154295	1027352	1296922	844922	761549	937423	77111
1990	34414894	29051923	40767867	1073033	948792	1213543	798109	711939	894708	64023
1991	31264693	26271290	37207195	993511	872726	1131011	743408	658000	839901	54339
1992	28092129	23803257	33153772	918962	808542	1044461	693842	612815	785583	41357
1993	21747296	18717287	25267813	794923	710080	889902	621568	554580	696646	45252
1994	18906191	16139195	22147577	682829	610150	764165	531256	476803	591928	37235
1995	15728737	13695863	18063350	584201	529734	644268	458172	414911	505944	39458
1996	13137746	11494024	15016531	491885	452438	534771	386544	355854	419880	43695
1997	10365567	9041176	11883961	392385	363796	423221	309279	288407	331662	36026
1998	9722954	8512376	11105692	334369	309853	360825	256786	240137	274590	36316
1999	9454487	8293884	10777499	294196	271172	319174	218600	203668	234627	26903
2000	10231687	8997694	11634916	292436	268632	318349	210449	195472	226574	25235
2001	11769241	10331793	13406679	313640	287128	342599	219476	203395	236830	23435
2002	12261809	10732033	14009644	334035	305117	365693	235861	218015	255169	24909

2003	11341737	9930407	12953648	327420	299643	357773	236807	218921	256154	22404
2004	11490142	10024423	13170170	330380	301670	361823	238470	220229	258222	26984
2005	11559290	10046024	13300504	327420	297320	360568	235155	215918	256106	20032
2006	11923240	10490212	13552029	337055	308923	367747	241832	223378	261811	22561
2007	13811332	12141903	15710296	371387	340125	405522	260928	241767	281608	22675
2008	14827587	13117257	16760924	404335	372410	438998	285786	265900	307161	27861
2009	15112005	13450845	16978315	421258	390276	454699	300139	280870	320730	35561
2010	15665948	13987200	17546180	433220	402634	466129	308045	289533	327740	47667
2011	17192779	15371311	19230085	451351	418907	486307	313953	294919	334216	64796
2012	19697455	17579044	22071151	483594	446466	523809	326113	304830	348883	64926
2013	21856305	18805320	25402284	531788	478690	590775	356825	327250	389072	67778
2014	20978318	16462361	26733093	539825	455294	640049	372131	322706	429124	88168
2015	23700341	16778170	33478393	572633	434041	755477	383080	298525	491585	87029

Year	**Landings (tonnes) Low**	**Landings (tonnes) High**	**Yield / SSB (ratio) Mean**	**Yield / SSB (ratio) Low**	**Yield / SSB (ratio) High**	**Mean F ages 1-3 Mean**	**Mean F ages 1-3 Low**	**Mean F ages 1-3 High**	**Mean F ages 0-1**	**SoP (%)**
1975	33404	37406	0.038	0.041	0.035	0.086	0.071	0.103	0.020	1.034
1976	45477	50769	0.051	0.055	0.047	0.112	0.095	0.132	0.027	1.029
1977	50913	56962	0.057	0.061	0.053	0.127	0.108	0.150	0.029	0.995
1978	43451	49346	0.049	0.052	0.046	0.109	0.093	0.129	0.026	1.038
1979	38284	43530	0.040	0.042	0.038	0.097	0.084	0.113	0.020	0.977
1980	45610	51437	0.043	0.045	0.041	0.113	0.098	0.130	0.019	0.985
1981	85826	96753	0.074	0.078	0.070	0.218	0.190	0.250	0.030	0.994
1982	76130	85290	0.065	0.069	0.061	0.190	0.165	0.218	0.027	0.944
1983	80119	89387	0.072	0.075	0.068	0.174	0.150	0.202	0.036	1.009
1984	88118	98083	0.090	0.094	0.087	0.191	0.165	0.220	0.046	1.009
1985	75531	85281	0.091	0.093	0.089	0.179	0.153	0.208	0.046	1.057
1986	76343	94751	0.103	0.101	0.105	0.222	0.196	0.252	0.054	1.083
1987	76883	87549	0.099	0.102	0.097	0.258	0.228	0.293	0.058	1.127
1988	71337	80566	0.090	0.093	0.087	0.281	0.241	0.328	0.043	1.108
1989	73148	81288	0.091	0.096	0.087	0.299	0.258	0.347	0.042	1.089

1990	60173	68120	0.080	0.085	0.076	0.231	0.202	0.264	0.037	1.038
1991	51245	57620	0.073	0.078	0.069	0.197	0.170	0.228	0.024	1.002
1992	38898	43971	0.060	0.063	0.056	0.138	0.116	0.165	0.023	1.024
1993	42564	48109	0.073	0.077	0.069	0.156	0.134	0.181	0.025	0.996
1994	35069	39535	0.070	0.074	0.067	0.139	0.117	0.164	0.020	0.948
1995	36755	42361	0.086	0.089	0.084	0.163	0.141	0.189	0.019	0.960
1996	39300	48582	0.113	0.110	0.116	0.230	0.205	0.258	0.032	1.002
1997	33800	38399	0.116	0.117	0.116	0.239	0.206	0.277	0.041	0.934
1998	32968	40003	0.141	0.137	0.146	0.308	0.280	0.340	0.060	1.027
1999	25104	28831	0.123	0.123	0.123	0.328	0.297	0.363	0.035	0.957
2000	23833	26720	0.120	0.122	0.118	0.423	0.378	0.473	0.041	0.967
2001	22171	24772	0.107	0.109	0.105	0.455	0.413	0.500	0.044	0.967
2002	23452	26457	0.106	0.108	0.104	0.463	0.420	0.511	0.055	1.043
2003	21155	23727	0.095	0.097	0.093	0.385	0.348	0.425	0.045	1.025
2004	25436	28626	0.113	0.115	0.111	0.411	0.372	0.455	0.052	1.020
2005	18999	21121	0.085	0.088	0.082	0.298	0.265	0.334	0.034	0.950
2006	21278	23923	0.093	0.095	0.091	0.358	0.322	0.397	0.028	1.102
2007	21469	23948	0.087	0.089	0.085	0.328	0.293	0.368	0.040	1.027
2008	26022	29831	0.097	0.098	0.097	0.342	0.308	0.379	0.065	1.022
2009	33227	38058	0.118	0.118	0.119	0.504	0.459	0.553	0.057	1.034
2010	44843	50670	0.155	0.155	0.155	0.571	0.523	0.623	0.116	1.408
2011	60902	68939	0.206	0.207	0.206	0.989	0.932	1.049	0.179	1.193
2012	60281	69928	0.199	0.198	0.200	1.079	1.019	1.142	0.239	1.106
2013	62633	73346	0.190	0.191	0.189	1.101	1.031	1.176	0.237	0.937
2014	81167	95773	0.237	0.252	0.223	1.876	1.780	1.978	0.277	1.082
2015	80382	94226	0.227	0.269	0.192	1.948	1.445	2.627	0.290	1.130

Table 7.6.1.3. Sardine in GSAs 17-18. F-at-age estimated from 1975 to 2015.

	Year						
Age	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**
0	0.010	0.011	0.012	0.011	0.008	0.008	0.011

1	0.030	0.042	0.045	0.042	0.031	0.030	0.049
2	0.076	0.098	0.123	0.097	0.087	0.082	0.159
3	0.151	0.196	0.214	0.189	0.173	0.228	0.445
4	0.151	0.196	0.214	0.189	0.173	0.228	0.445
	1982	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**
0	0.010	0.019	0.022	0.021	0.023	0.022	0.017
1	0.043	0.054	0.071	0.072	0.085	0.093	0.069
2	0.134	0.143	0.146	0.155	0.175	0.245	0.242
3	0.392	0.324	0.355	0.310	0.406	0.437	0.533
4	0.392	0.324	0.355	0.310	0.406	0.437	0.533
	1989	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
0	0.019	0.017	0.011	0.011	0.012	0.008	0.009
1	0.066	0.057	0.038	0.035	0.037	0.032	0.029
2	0.221	0.158	0.100	0.084	0.096	0.079	0.071
3	0.610	0.479	0.451	0.296	0.333	0.305	0.389
4	0.610	0.479	0.451	0.296	0.333	0.305	0.389
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
0	0.015	0.015	0.026	0.015	0.013	0.008	0.009
1	0.050	0.067	0.093	0.056	0.069	0.080	0.101
2	0.113	0.180	0.227	0.203	0.279	0.383	0.445
3	0.528	0.470	0.605	0.725	0.921	0.901	0.843
4	0.528	0.470	0.605	0.725	0.921	0.901	0.843
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
0	0.009	0.015	0.015	0.007	0.006	0.008	0.015
1	0.081	0.088	0.053	0.050	0.073	0.122	0.100
2	0.346	0.383	0.262	0.288	0.315	0.407	0.423
3	0.728	0.763	0.578	0.736	0.597	0.498	0.988
4	0.728	0.763	0.578	0.736	0.597	0.498	0.988
	2010	**2011**	**2012**	**2013**	**2015**		
0	0.022	0.029	0.032	0.031	0.036		
1	0.210	0.330	0.446	0.443	0.519		

2	0.628	1.038	1.108	1.189	1.821		
3	0.873	1.599	1.682	1.672	3.289		
4	0.873	1.599	1.682	1.672	3.289		

Table 7.6.1.4. Sardine in GSAs 17-18. Stock numbers-at-age (thousands) from 1975 to 2015.

	Year						
Age	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**
0	40305561	41243332	40507593	43837492	49575137	55118722	59709399
1	15006590	13825151	14175136	13646587	14872137	17175594	19153576
2	6212041	6407630	5745917	5903170	5592853	6274473	7429729
3	2610363	2908070	2937296	2502999	2692552	2525627	2954973
4	1886059	2237792	2455891	2530684	2400050	2490515	2317501
	1982	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**
0	57655719	45809406	36179384	33464643	36143222	40873807	41657834
1	20542367	20521835	15448153	11994995	11172880	12139802	13964096
2	7912861	8692751	8788899	6181058	4789804	4403895	4737405
3	3169233	3474635	3820913	3929411	2626073	1998685	1691286
4	1933805	1957150	2244515	2436322	2771779	2118036	1556577
	1989	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
0	38763902	34414894	31264693	28092129	21747296	18906191	15728737
1	14461493	13203599	11594020	10864379	9781467	7268060	6596172
2	5757420	5980412	5411300	4852478	4652894	4155736	3002633
3	1835817	2329118	2586976	2460807	2255766	2130783	1951288
4	1092523	889131	1116825	1326428	1620103	1608801	1616866
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
0	13137746	10365567	9722954	9454487	10231687	11769241	12261809
1	5449312	4474924	3502544	3191495	3217129	3453850	4147432
2	2882014	2264807	1821189	1347821	1309296	1301464	1376425
3	1397227	1329083	946002	720716	543074	494351	441529
4	1426879	969950	849158	573779	362217	204638	159373

	2003	2004	2005	2006	2007	2008	2009
0	11341737	11490142	11559290	11923240	13811332	14827587	15112005
1	4256680	3890312	3886424	3867040	4110273	4833107	5168019
2	1651179	1744537	1527282	1612022	1594387	1671112	1859838
3	434956	594812	597793	588893	608043	583617	556822
4	144495	156217	195243	252711	227067	259108	295670
	2010	**2011**	**2012**	**2013**	**2015**		
0	15665948	17192779	19697455	21856305	20978318		
1	5142243	5246124	5728705	6615990	7452052		
2	2132915	1812106	1621724	1581683	1856122		
3	613540	587717	318062	267534	241349		
4	178796	187775	87904	42108	32663		

The average fishing mortality for ages 1-3 (F_{bar})(Figure 7.6.1.1.) started increasing in 2009, reaching the maximum value of 1.95 in 2015. Spawning stock biomass fluctuates from the highest values in 1982 to a minimum in 2000. After that the stock was constantly increasing. Recruitment (Age 0) fluctuates from a minimum value in 1999, to a maximum value in 1981. From 1999 the estimated recruitment is constantly increasing.

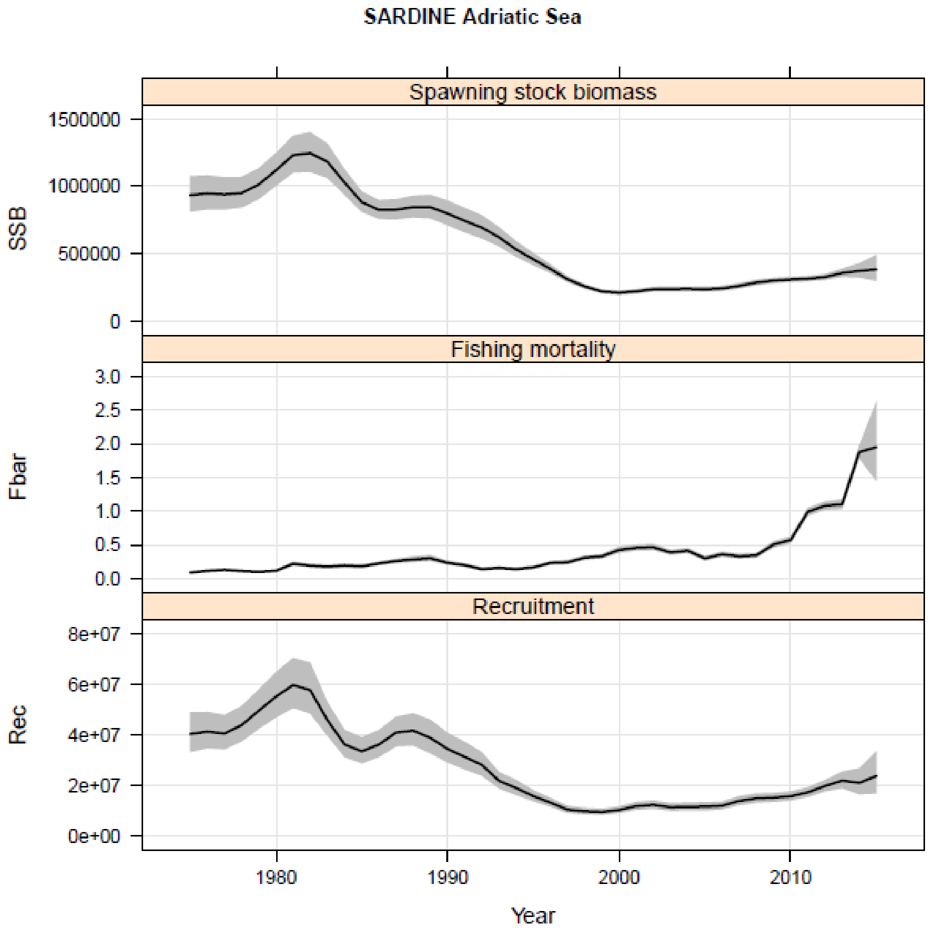


Figure 7.6.1.1. Sardine in GSAs 17-18. Stock Biomass (SSB) in tons (on top). F (age 1 to 3) (middle); recruitment (as thousands individuals)(bottom); 95% confidence intervals are shown.

Due to the very short time series of the tuning index (2009-2015), the retrospective analysis was run on 1 year only. The outputs are shown in Figure 7.6.1.2., and describe a rather consistent behaviour of the assessment model, with the only exception of the great variability and uncertainty in F estimate in the last year.

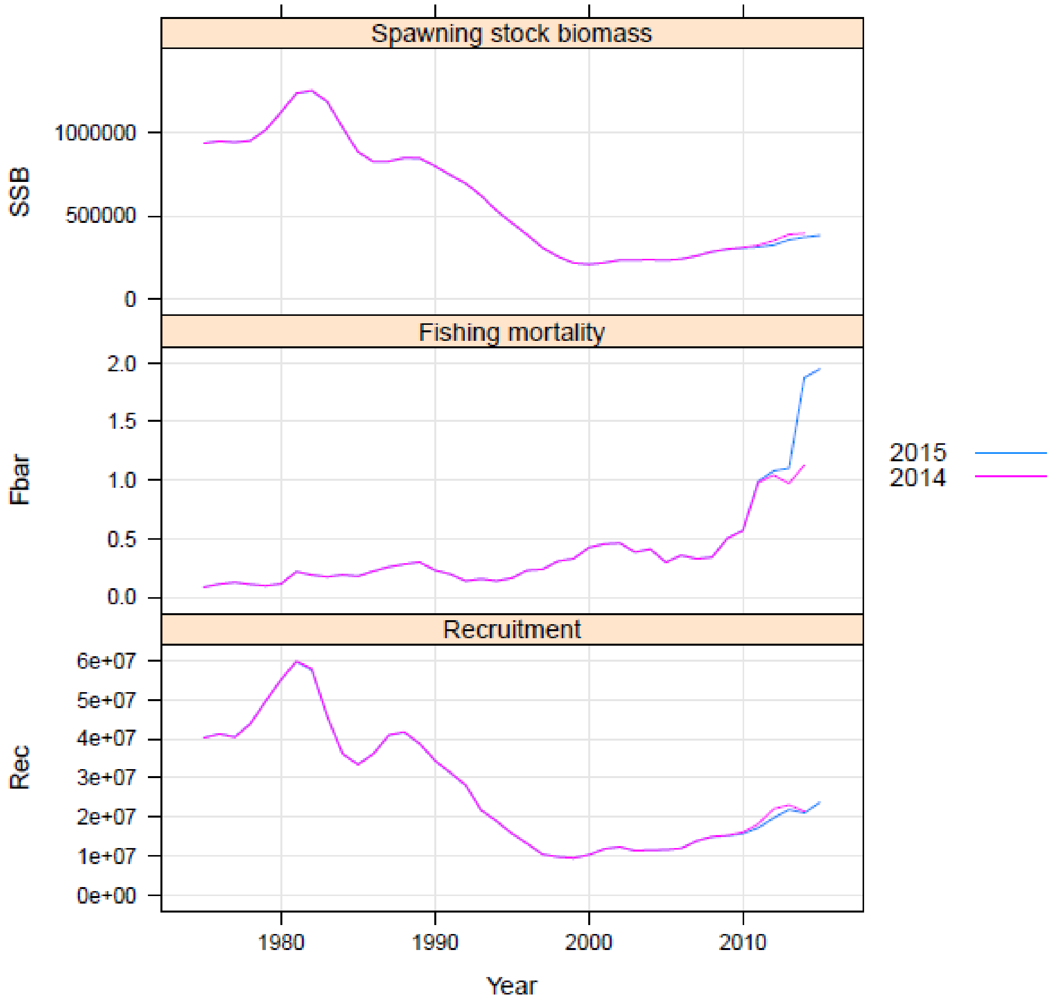


Figure 7.6.1.2. Sardine in GSAs 17-18. Retrospective analysis. Stock Biomass (SSB) in tons (on top). F (age 1 to 2) (middle); recruitment (as thousands individuals)(bottom).

The selection pattern (F/Fbar) by age class is shown in Figure 7.6.1.3. The plots show a rather constant pattern in all the pentads in the time series of data.

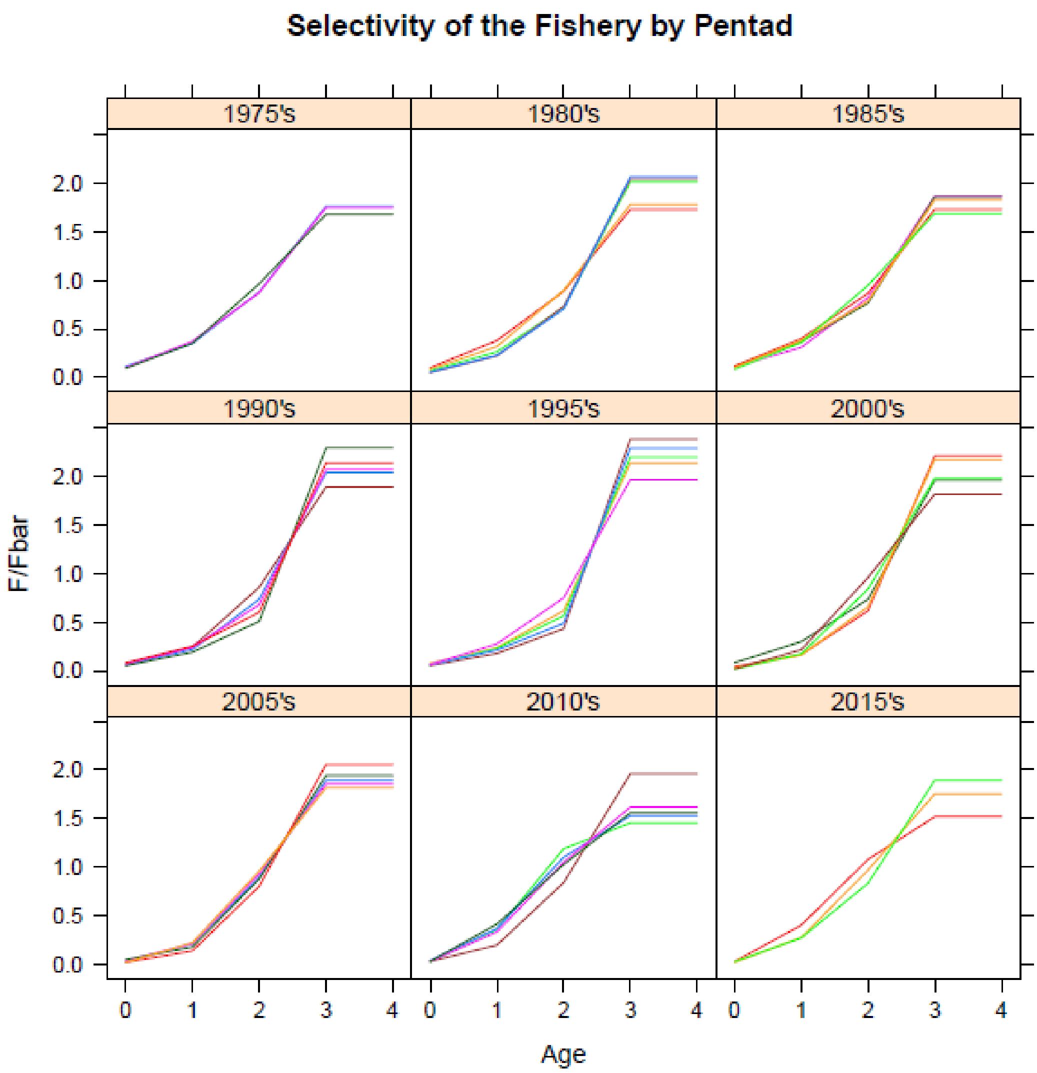


Figure 7.6.1.3. Sardine in GSAs 17-18. Selectivity at age by pentads as estimated by the SAM model.

In general, catch residuals did not show any trend. As concerns survey data, only age 4 was showing some patterns in the residuals. In the figures below only age 1 and 4 are shown as example of the good fitting in the catches, and of the overall acceptable fitting of the tuning index, with the only exception of age 4 (Figure 7.6.1.4 a, b, c, d).

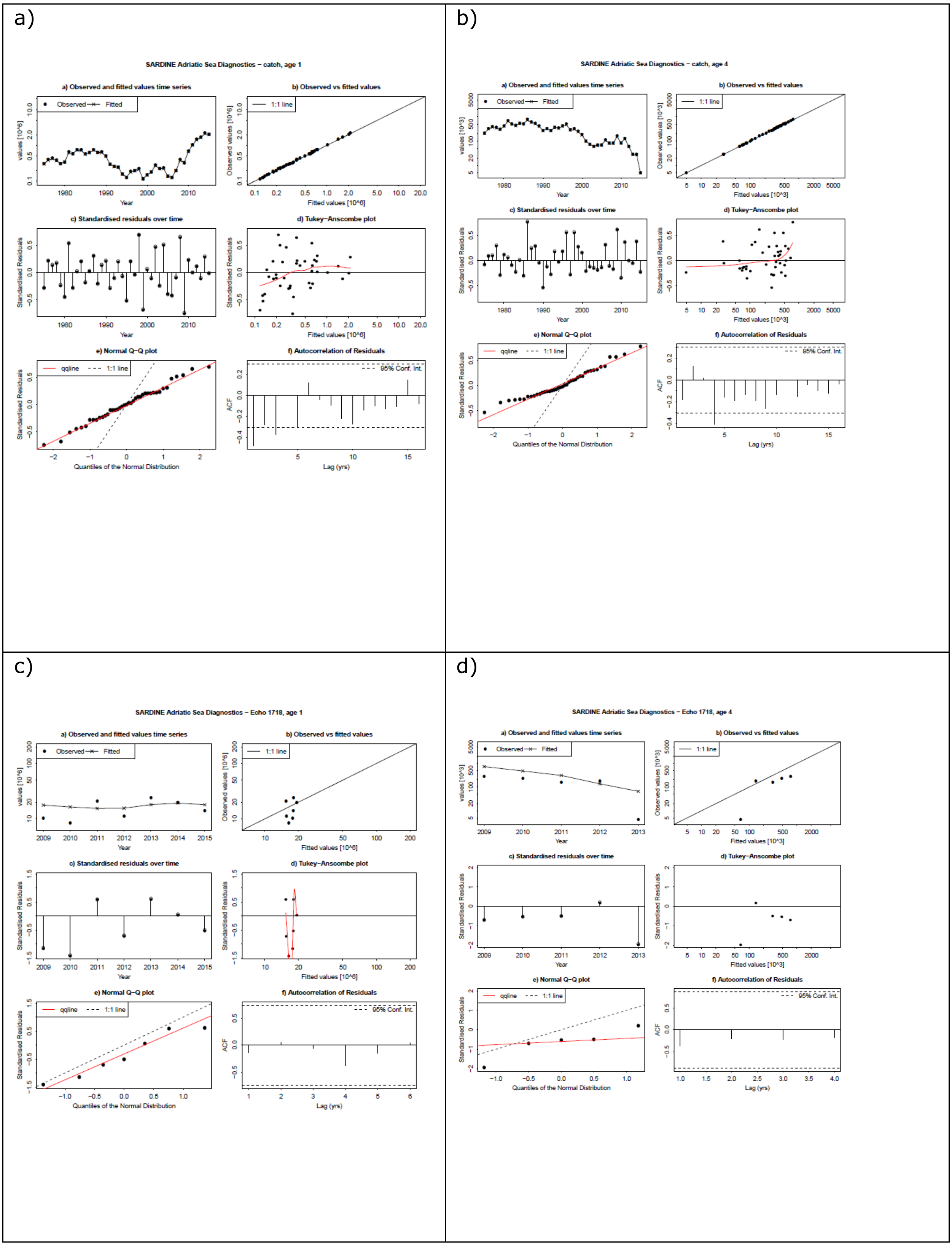


Figure 7.6.1.4. Sardine in GSAs 17-18. Diagnostic in catch and survey age structure residuals (age 1 and 4) for respectively: a) catches age 1; b) catches age 4; c) echo survey age 1; d) echo survey age 4.

Observation variances by input data (Figure 7.6.1.5.) showed that model is overfitting the catch data, and among the survey data, age 4 is practically not used as the variability is very high.

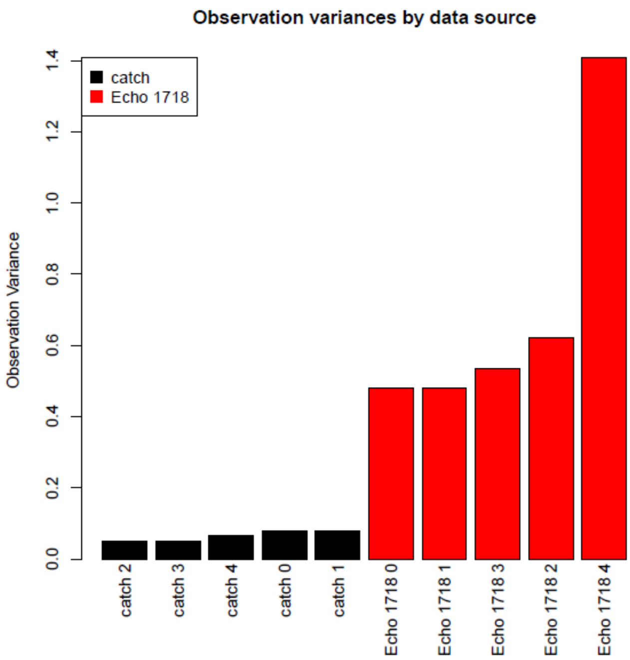


Figure 7.6.1.5. Sardine in GSAs 17-18. Plot of the observation variances by input data.

7.6.2 Reference points

Due to the instability of the assessment, STECF EWG 16-13 was not able to estimate and provide a reliable reference point in terms of F_{MSY}.

Estimates of F_{MSY} obtained by previous assessments are shown in Table 7.6.2.1.

Table 7.6.2.1 Sardine in GSAs 17-18. Reference points, values and their technical basis.

Reference point	Value	Technical basis	Source
F_{MSY}	0.23	Eqsim	STECF EWG 14-09
F_{MSY}	0.08	Eqsim	STECF EWG 15-11
F_{MSY}	0.72	Eqsim	GFCM WGSASP 2015

7.6.3 Short-term forecasts

No short-term forecasts were performed during STECF EWG 16-13 due to the uncertainty in terminal F which is needed to calculate the catch in the intermediate year. Instead catch options are provided bases on exploitation rates and current (2015) biomass. The historic relationship between HR based on both SSB and total biomass (Figure 7.6.3.1.) can be used to estimate catches for selected E based on 2015 biomass. Selected options are provided in Table 7.6.2.2. In the absence of MSY reference points catch advice cannot be based on MSY but precautionary advice can be based on E=0.4 (Patterson 1992) and SSB in 2015 assuming that the SSB does not change substantially to the catch year (2017).

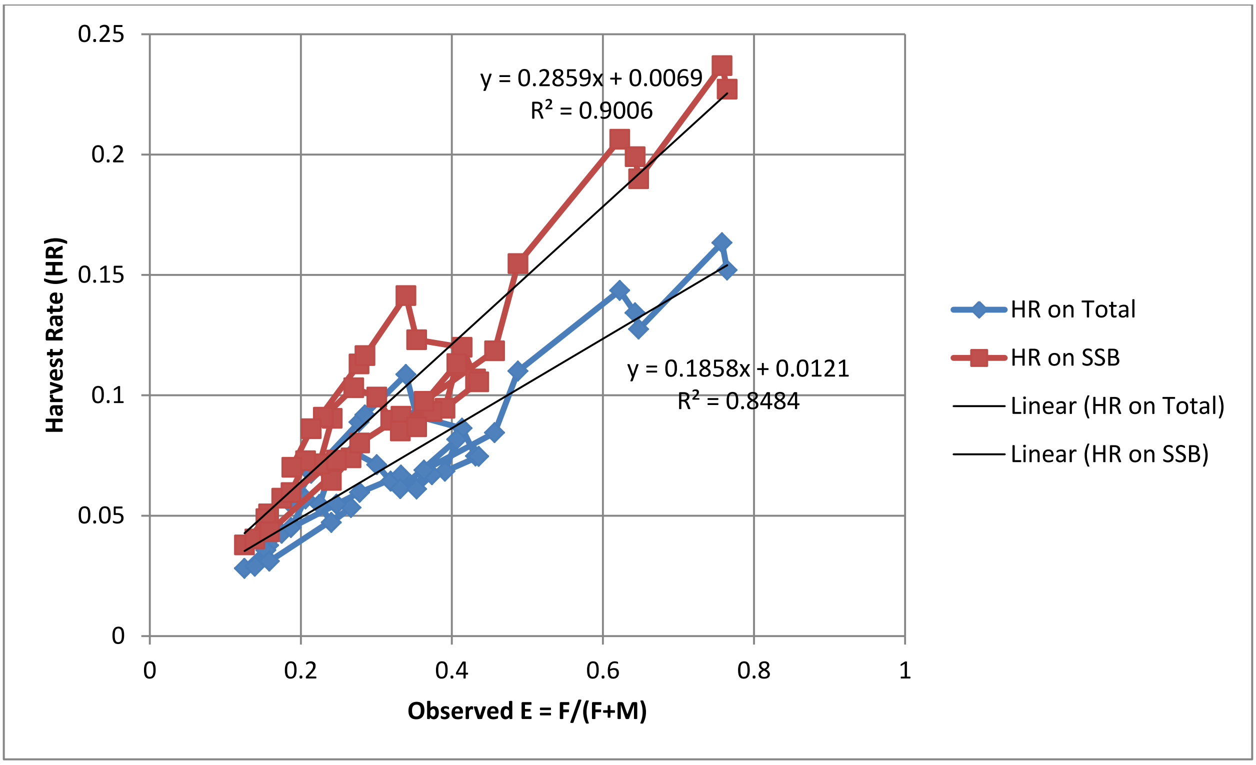


Figure 7.6.3.1.. Sardine in GSAS 17-18. Relationship between Exploitation rate E=F/(F+M) and harvest rate HR based on SSB or biomass. Fitted lines provide estimates of HR for defined values of E

Table 7.6.3.1. Sardine in GSA 17-18. Catch options based on HR relative to total biomass in 2015 and selected Exploitation rates E=F/(F+M), change in catch is relative to catch in 2015.

Exploitation Rate	Harvest Ratio on total biomass	Catch options	Change in catch
0	0.012	0	-100%
0.2	0.049	28208	-68%
0.4	0.086	49487	-43%

0.6	0.124	70766	-19%
0.8	0.161	92045	6%
1	0.198	113324	30%

Comparison with previous assessment

The results of the present assessment in terms of SSB, recruitment and fishing mortality trends and values are rather consistent with the outputs of previous assessments carried out by STCF EWGs (STECF EWG 14-09 and STECF EWG 15-11), and, in particular, with those from the last assessment carried out at GFCM WGSASP 2015.
The only relevant difference is represented by the pattern of fishing mortality in the last two years. The SAM model run at STECF EWG 16-13 with an extra year of data shows a sharp increase in Fbar 2014, reaching values of 1.9 in both 2014 and 2015. The SAM assessment carried out at the last GFCM WGSASP (2015) reported a value of F in 2014 of around 1.
These differences could be due to the use of a single tuning fleet by combining the MEDIAS data provided at the last Data Call (2016) by Italy, Slovenia, and Croatia for GSA 17 West and GSA 18 West, and GSA 17 East. Previous assessments kept the surveys separated to use them as different tuning fleets. In addition, those tuning fleets were including data also from GSA 18 East (Montenegro and Albania), while that information was not available at EWG 16-13. Furthermore, the MEDIAS data submitted by Italy, Slovenia and Croatia were based on a new ageing procedure recently agreed at international level. The application of this new ageing procedure to the data determined a sharp decrease of numbers-at-age in the oldest age groups. The same applies to catch-at-age data from commercial fisheries for the year 2015, which was added to the time series of data (1975-2014) based on a reconstruction of landings and catch-at-age data from historical information analysis.
This might have determined the increase in F produced by the SAM model. The absence of individuals in the oldest age classes was interpreted by the model as a consequence of increased fishing mortality on age classes 1 and 2.
In addition, both assessment and survey experts dealing with the stock during EWG 16-13 noted that the assessment carried out at GFCM WGSASP 2015 was listed as using information from Croatian acoustic surveys in GSA 17 East from 2004, while no acoustic survey was carried in GSA 17 East before 2009.

7.6.4 Quality and proposals for future assessments

An analysis of the available data for sardine stock in GSAs 17-18 detected several issues and strong inconsistencies. All the identified problems are listed below:

- Total landings before 2005 have been split into Length Frequency Distribution using biological data from the Italian side alone: the entire time series before 2005 has been disaggregated into numbers at age using biological data from the western Adriatic area, without taking into account the different length structure in the catches between the western and the eastern catches.

- No information on length or age structure of GSA 18: no biological information are available before 2004 for GSA 18, therefore all the data used for the present assessment had to be reconstructed.

8 Stock assessments (Levels 2-4)

ToR 3. For the stocks given in Annex I-A, or combinations thereof, the STECF-EWG 16-13 is requested to:

ToR 3.1. Assess trends in fishing mortality, stock biomass, spawning stock biomass, and recruitment. Based on the precautionary approach, determine proxies MSY reference points on the exploitation level and the status of the stocks. Different assessment models should be applied as appropriate, including retrospective analyses when the models can produce one. The selection of the most reliable assessment should be explained. Assumptions and uncertainties should be specified.

ToR 3.2. Make any appropriate comments and recommendations to improve the quality of the assessment and/or to upgrade the assessment level and/or improve the quality of the data. Furthermore, advise on the ideal assessment frequency.

8.1 STOCK ASSESSMENT OF ATLANTIC HORSE MACKEREL IN REGION 1 (GSAs 1-5-6-7)

8.1.1 Methods 1 (XSA Assessment)

The Atlantic Horse mackerel was never assessed before on any GSA in an STECF meeting. The data provided to EWG 16-13 has been considered covering more than the mean life span of the species, allowing to makes an attempt of stock assessment with an XSA method. By using the FLR libraries (kell et al.2007) an Extended Survivors Analysis (XSA – Darby and Flatman, 1994) was carried out to assess trends in fishing mortality, stock biomass, spawning stock biomass, and recruitment in the region 1 (GSAs 1, 5, 6, 7).

8.1.2 Input data

The XSA was applied using as input data the DCF official data on the age structure and the landing of commercial catches. As a tuning fleet the data of MEDITS survey were used. For the analysis the timeframe (2005-2015) was the same for both catch and tuning data. The analysis was carried out for sex combined using the following growth parameters:

L_inf	k	t0	L-W: a	L-W: b
45	0.1044	-1.901	0.0099	2.9853

To derive catch numbers at age from the DCF annual size distributions a knife edge slicing technique was applied. For big individuals a 10+ group has been used. A SOP correction was applied to catch numbers at age.

The maturity at age has been derived from the DCF official data.

Natural mortality EWG16-13 taken from the ICES WGHANSA (2013) for the southern horse mackerel stock is reported up in this report (Table 6.7.1.6).

The input parameters (landings, catch number at age, weight at age, maturity at age, natural mortality at age and the tuning series at age) to the XSA were plotted (figure 8.1.2.1-5) and listed (table 8.1.2.1) below.

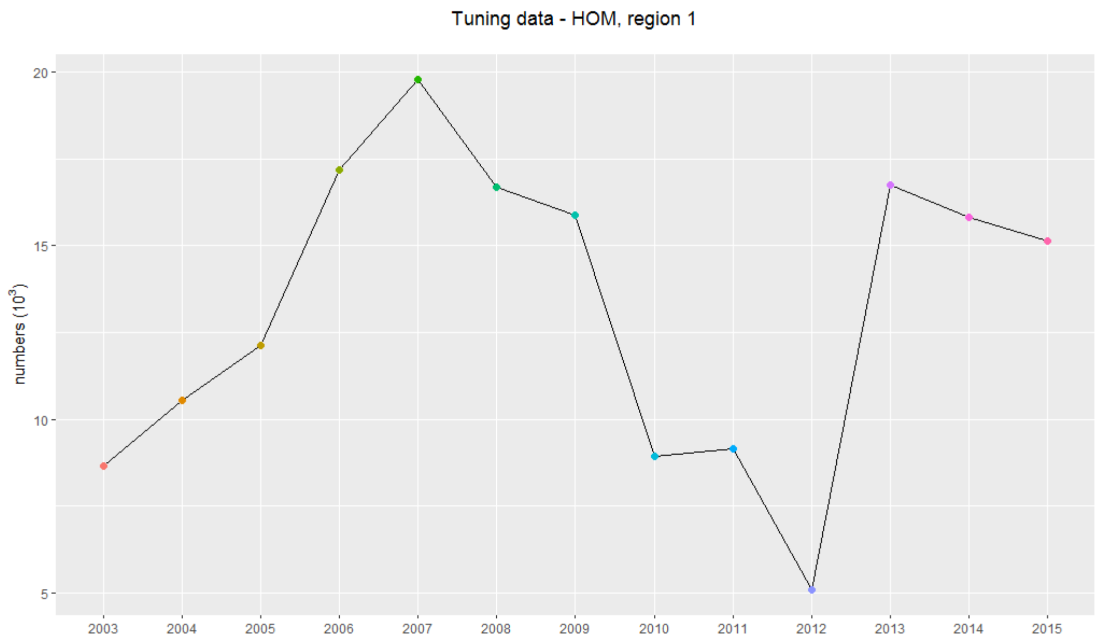
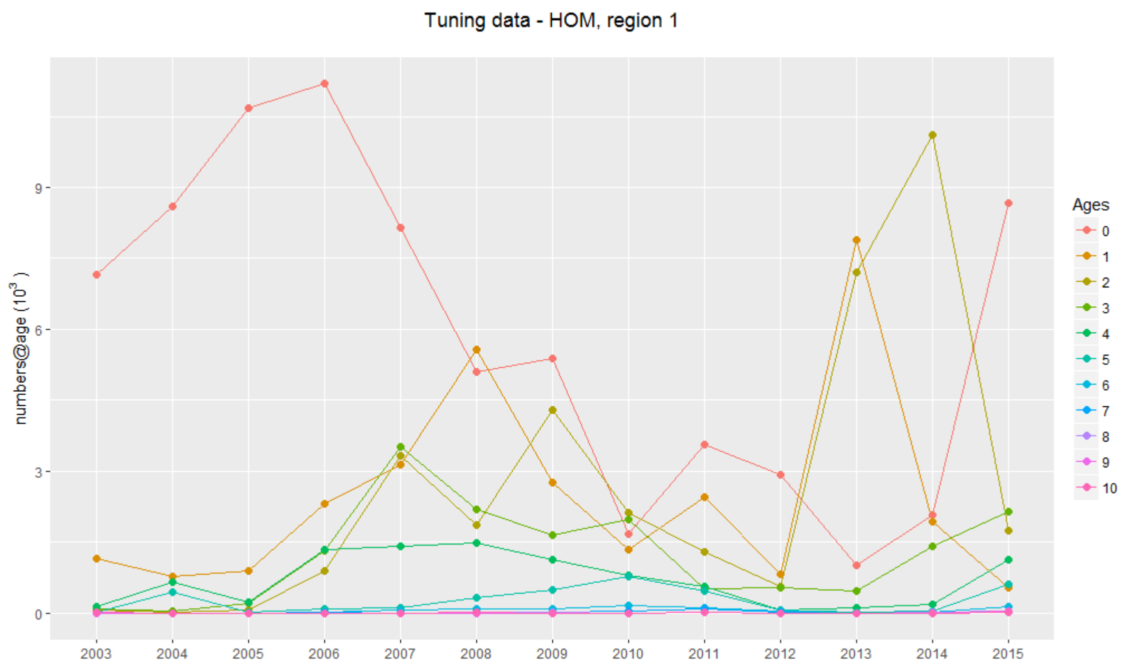
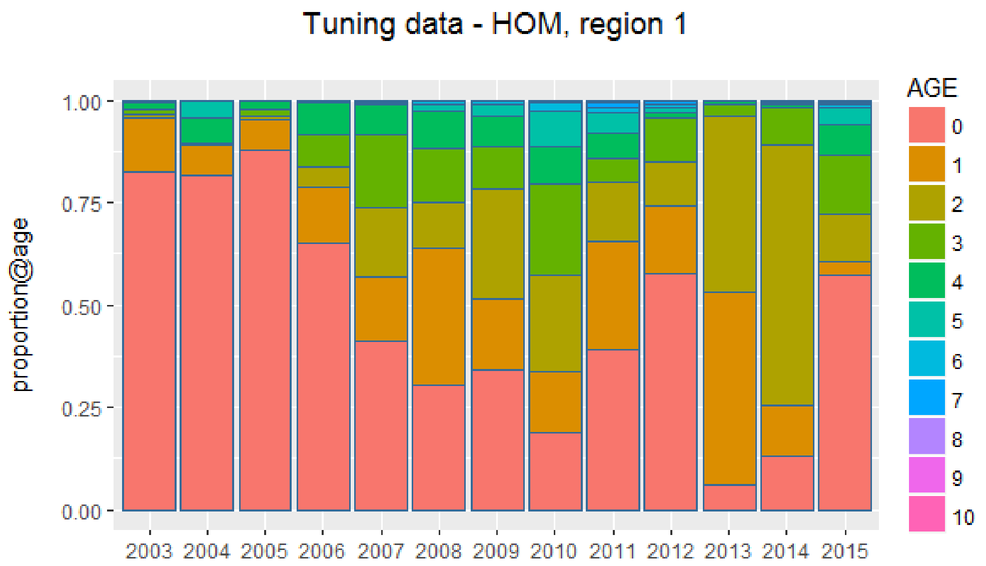


Figure 8.1.2.1. Atlantic Horse Mackerel in GSAs 1-5-6-7. Tuning input data to the XSA model.



a



b

Figure 8.1.2.2. Atlantic Horse Mackerel in GSAs 1-5-6-7. Tuning at age (upper) and proportion by age (lower) as input data to the XSA model.

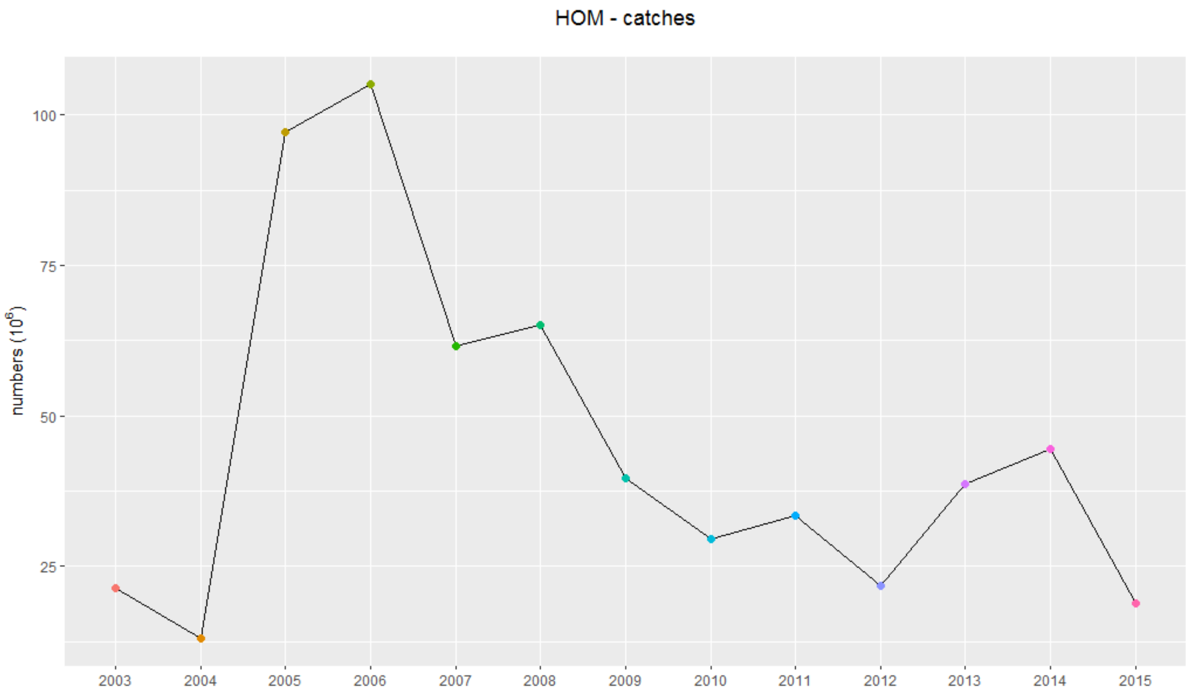


Figure 8.1.2.3. Atlantic Horse Mackerel in GSAs 1-5-6-7. Catch input data to the XSA model.

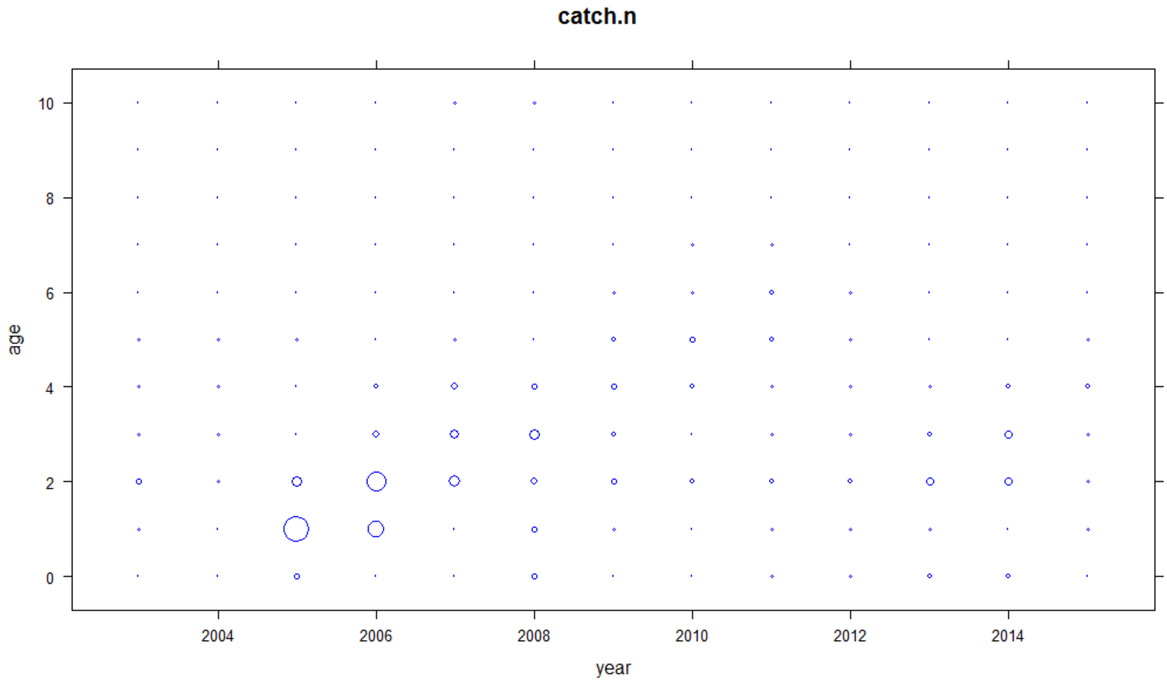


Figure 8.1.2.4. Atlantic Horse Mackerel in GSAs 1-5-6-7. Catch at age input data to the XSA model.

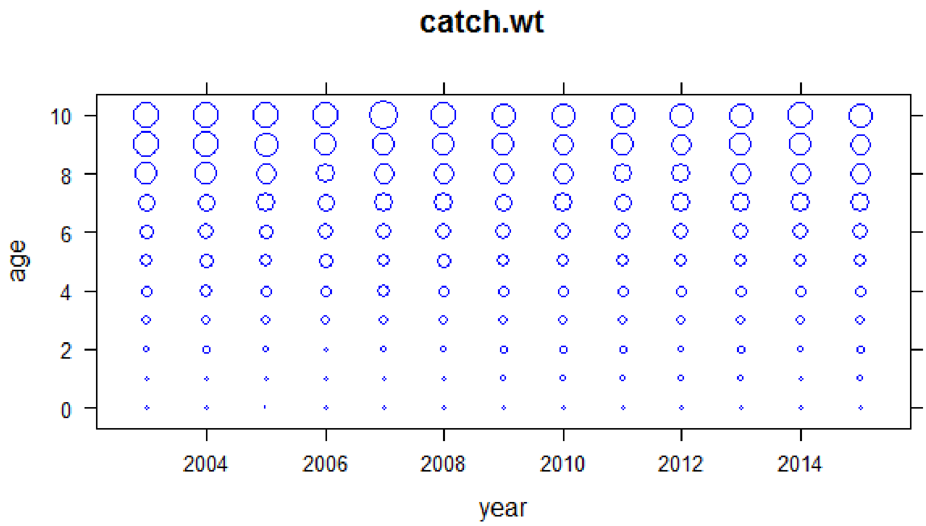


Figure 8.1.2.5. Atlantic Horse Mackerel in GSAs 1-5-6-7. Weight at age input data to the XSA model.

Table 8.1.1.2.1. Atlantic Horse Mackerel in GSAs 1-5-6-7. Input parameters to the XSA model.

TUNING

age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	7148	8602	10683	11191	8160	5095	5396	1667	3577	2938	1010	2074	8662
1	1152	788	908	2306	3129	5563	2760	1336	2448	836	7899	1934	538
2	70	12	69	897	3335	1873	4303	2133	1300	562	7209	10106	1754
3	96	34	222	1317	3524	2195	1649	1988	520	544	473	1415	2149
4	143	658	238	1352	1427	1490	1140	810	572	67	127	179	1136
5	16	440	12	82	118	331	491	780	479	60	26	52	616
6	5	1	2	13	70	82	89	158	120	42	7	32	143
7	11	2	1	12	7	21	20	50	84	29	6	21	35
8	1	1	2	0	4	7	15	4	31	8	2	11	43
9	10	3	1	0	3	7	5	10	15	2	1	6	54
10	17	7	1	1	4	11	6	2	18	3	2	2	20

initial settings

min	max	plusgroup	minyear	maxyear	minfbar	maxfbar
0	10	10	2003	2015	2	6

Mortality and Maturity vectors@age

	0	1	2	3	4	5	6	7	8	9	10
maturity	0.04	0.24	0.76	0.97	1.0	1.00	1.00	1.00	1.00	1.00	1.00
mortality	0.90	0.60	0.40	0.30	0.2	0.15	0.15	0.15	0.15	0.15	0.15

Mean Weight@age (kg) in stock, catch, landings

age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	0.0252	0.0300	0.0204	0.0253	0.0326	0.0219	0.0295	0.0211	0.0212	0.0235	0.0294	0.0315	0.0319
1	0.0315	0.0429	0.0243	0.0310	0.0411	0.0411	0.0568	0.0585	0.0573	0.0453	0.0485	0.0438	0.0520
2	0.0632	0.0697	0.0470	0.0419	0.0531	0.0549	0.0742	0.0735	0.0724	0.0643	0.0692	0.0651	0.0688
3	0.1032	0.1007	0.1078	0.0987	0.1065	0.0988	0.1029	0.1020	0.1048	0.1034	0.0995	0.1003	0.1011
4	0.1243	0.1390	0.1302	0.1270	0.1379	0.1293	0.1252	0.1267	0.1273	0.1278	0.1261	0.1267	0.1270
5	0.1592	0.1752	0.1547	0.1675	0.1520	0.1614	0.1519	0.1558	0.1544	0.1560	0.1497	0.1496	0.1545
6	0.1838	0.2046	0.1840	0.1965	0.1950	0.2005	0.1895	0.1921	0.1901	0.1925	0.1928	0.1990	0.1909
7	0.2142	0.2190	0.2355	0.2228	0.2352	0.2392	0.2296	0.2344	0.2304	0.2354	0.2353	0.2358	0.2422
8	0.2943	0.2868	0.2668	0.2413	0.2630	0.2628	0.2679	0.2619	0.2540	0.2488	0.2595	0.2641	0.2644
9	0.3352	0.3352	0.3028	0.2868	0.2890	0.2932	0.2946	0.2770	0.2834	0.2763	0.2903	0.2941	0.2767
10	0.3405	0.3295	0.3453	0.3373	0.3738	0.3278	0.3126	0.3166	0.3234	0.3231	0.3222	0.3450	0.3240

catch in weight (kg) by year

age \ year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
all	2068000	2141000	3861000	6097000	6512000	5633000	4660000	4020000	4094000	2363000	3306000	4123000	2313000

Catch at age matrix (numbers in thousands)

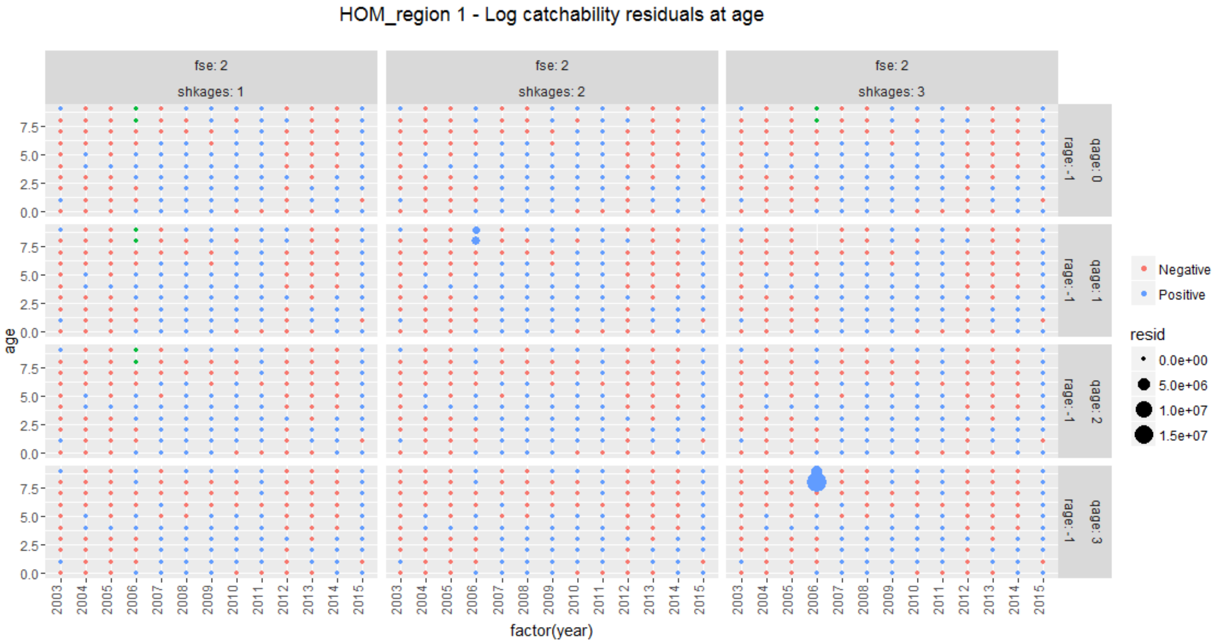
age \ year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	38041	12992	9142514	1350383	19912	9643116	1	30919	2928081	2130973	7393502	4766635	243972
1	2706970	176265	60816047	35145212	906839	8673272	2509554	1055553	4093145	2174890	1924546	415559	2352702
2	9314022	1632311	20834622	45627959	24742447	12252049	10028357	6300235	5258066	4942055	14121247	14358414	2481271
3	2179707	3153955	748696	13395687	17092479	19904447	7024871	1456759	4071373	4136611	7504730	15922050	4147402
4	3355892	2464039	947946	5398312	13434618	10498600	9891223	7027773	3515862	1810562	3981440	5758070	5284906
5	2502876	2312995	1647895	236594	1992469	1184495	5071127	7978672	5118692	2574805	1308707	1093480	1686919
6	491388	445271	1199038	367610	182991	334924	3839696	3767689	5312369	2520639	765890	713678	789540
7	172783	375371	409081	586931	145616	283043	857281	1527262	2095297	877409	720425	549531	546442
8	178416	733655	102313	1355411	209826	292197	372135	315462	754176	367725	672517	411758	585609
9	62733	405233	68707	831391	373907	284394	19690	30821	96696	90954	134030	157171	262932
10	446600	1318176	1139944	733324	2543391	1775925	36670	124283	125675	85828	132217	298565	464329

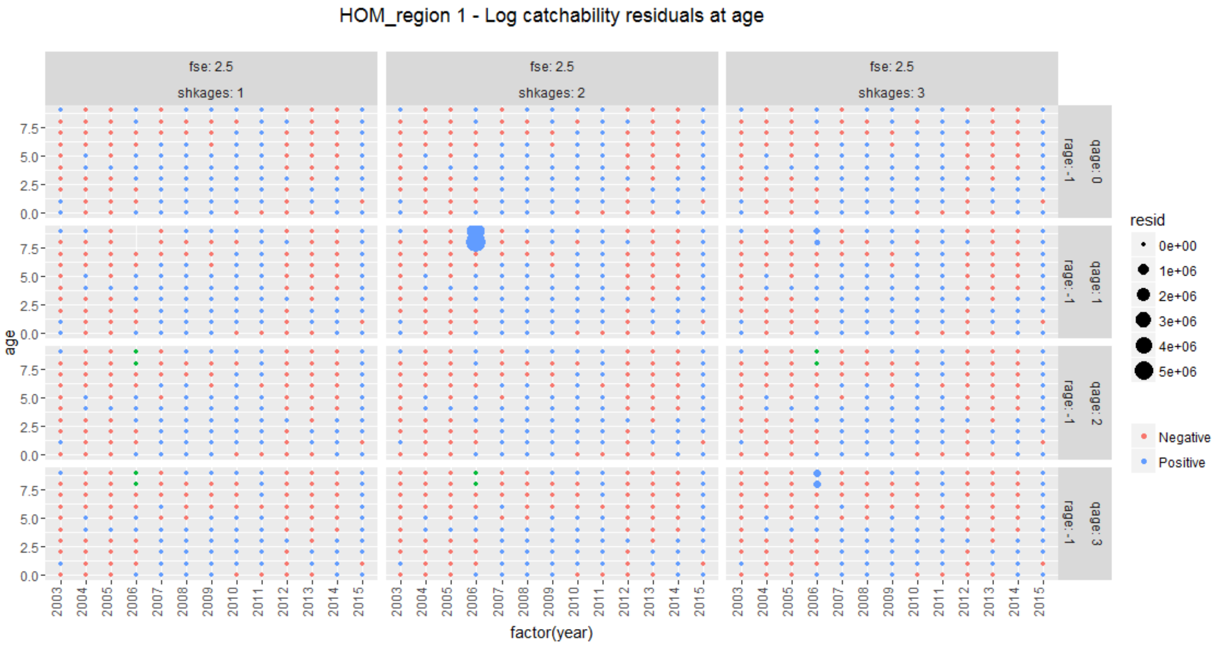
8.1.3 Results

A sensitivity analysis was performed to select the most suitable best parameters to be used in the XSA. Several different runs (n=216) have been carried out, changing all the combination of rage (-1 to 1, step of 1), qage (0 to 3, step of 1), shk.ages (1 to 3, step of 1) and fse (0.5 to 3, step of 0.5). Among all setting runs, only 109 shows finite values with absolute means of residuals ranging from 0.93 to 142229 (mean 7659, 1st quartile 1.13). Only 29 runs are within the first quartile (1.13) of absolute means of residuals (table 8.1.3.1).

Table 8.1.3.1. Results of the sensitivity analysis in terms of min, max and absolute mean values of residuals

run_n	setsens	shkage	fse	rage	qage	minres	maxres	absmean
42	sh1se3r-1q2	sh1	se3	r-1	q2	-4.647	1.697	0.927
5	sh1se2.5r-1q0	sh1	se2.5	r-1	q0	-4.421	1.903	0.930
41	sh1se2.5r-1q2	sh1	se2.5	r-1	q2	-4.659	1.691	0.931
53	sh3se2.5r-1q2	sh3	se2.5	r-1	q2	-4.660	1.690	0.935
4	sh1se2r-1q0	sh1	se2	r-1	q0	-4.461	1.876	0.936
22	sh1se2r-1q1	sh1	se2	r-1	q1	-4.425	1.908	0.936
17	sh3se2.5r-1q0	sh3	se2.5	r-1	q0	-4.422	1.902	0.938
40	sh1se2r-1q2	sh1	se2	r-1	q2	-4.677	1.683	0.939
16	sh3se2r-1q0	sh3	se2	r-1	q0	-4.463	1.875	0.941
10	sh2se2r-1q0	sh2	se2	r-1	q0	-4.462	1.875	0.941
36	sh3se3r-1q1	sh3	se3	r-1	q1	-4.397	1.919	0.945
59	sh1se2.5r-1q3	sh1	se2.5	r-1	q3	-4.925	1.619	0.961
72	sh3se3r-1q3	sh3	se3	r-1	q3	-4.919	1.620	0.963
11	sh2se2.5r-1q0	sh2	se2.5	r-1	q0	-4.421	3.458	0.964
65	sh2se2.5r-1q3	sh2	se2.5	r-1	q3	-4.926	1.619	0.965
64	sh2se2r-1q3	sh2	se2	r-1	q3	-4.962	1.658	0.990
45	sh2se1.5r-1q2	sh2	se1.5	r-1	q2	-4.804	1.749	1.052
3	sh1se1.5r-1q0	sh1	se1.5	r-1	q0	-4.621	2.677	1.053
69	sh3se1.5r-1q3	sh3	se1.5	r-1	q3	-5.078	1.717	1.068
63	sh2se1.5r-1q3	sh2	se1.5	r-1	q3	-5.070	1.762	1.075
57	sh1se1.5r-1q3	sh1	se1.5	r-1	q3	-5.062	2.483	1.083
50	sh3se1r-1q2	sh3	se1	r-1	q2	-4.931	2.179	1.100
32	sh3se1r-1q1	sh3	se1	r-1	q1	-4.655	2.404	1.108
2	sh1se1r-1q0	sh1	se1	r-1	q0	-4.827	3.077	1.108
26	sh2se1r-1q1	sh2	se1	r-1	q1	-4.627	2.702	1.109
136	sh2se2r0q3	sh2	se2	r0	q3	-4.894	2.955	1.114
20	sh1se1r-1q1	sh1	se1	r-1	q1	-4.602	3.293	1.114
142	sh3se2r0q3	sh3	se2	r0	q3	-4.905	2.972	1.122
132	sh1se3r0q3	sh1	se3	r0	q3	-5.030	3.527	1.126


HOM_region 1 - Log catchability residuals at age
fse: 2
shkages: 1
shkages: 2
shkages: 3
qage: 0
qage: 1
qage: 2
qage: 3
rage: -1
age
factor(year)
Negative
Positive
resid
0.0e+00
5.0e+06
1.0e+07
1.5e+07


HOM_region 1 - Log catchability residuals at age
fse: 2.5
shkages: 1
shkages: 2
shkages: 3
qage: 0
qage: 1
qage: 2
qage: 3
rage: -1
age
factor(year)
resid
0e+00
1e+06
2e+06
3e+06
4e+06
5e+06
Negative
Positive

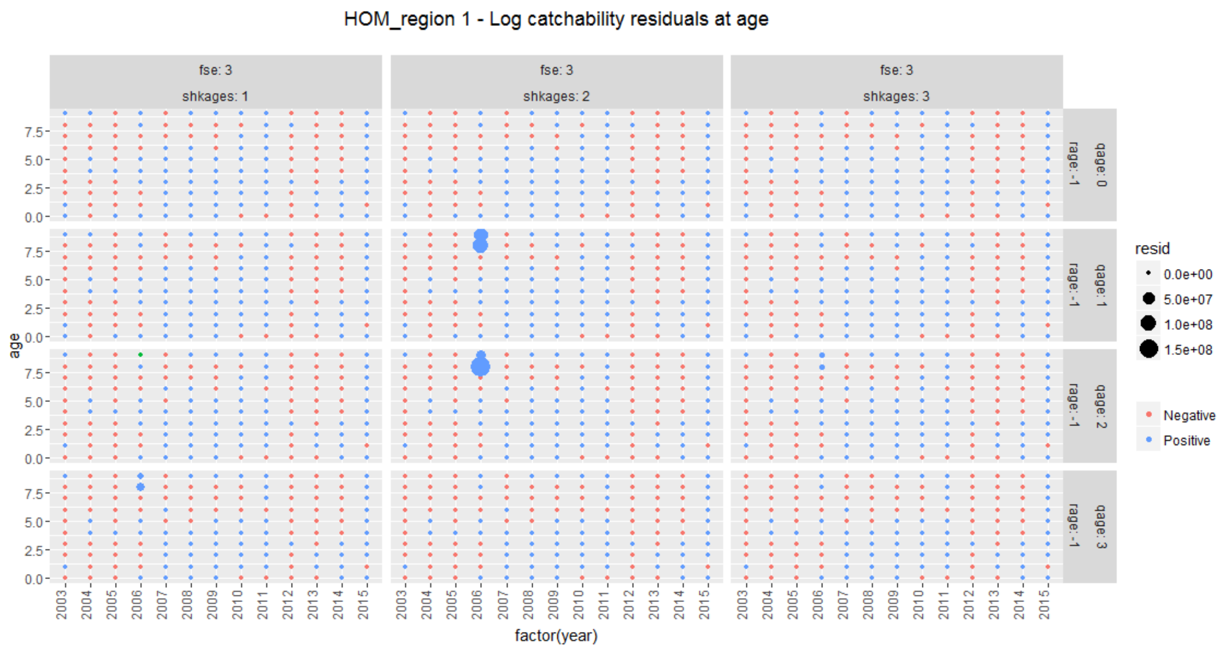


Figure 8.1.3.1. Atlantic Horse Mackerel in GSAs 1-5-6-7. Log residuals of the top XSA runs.

Sensitivity analyses were conducted to assess the effect of the main parameters in the top 28 runs in terms of minimizations of residuals (figure 8.1.3.2) and retrosapectives Figure 8.1.3.3)

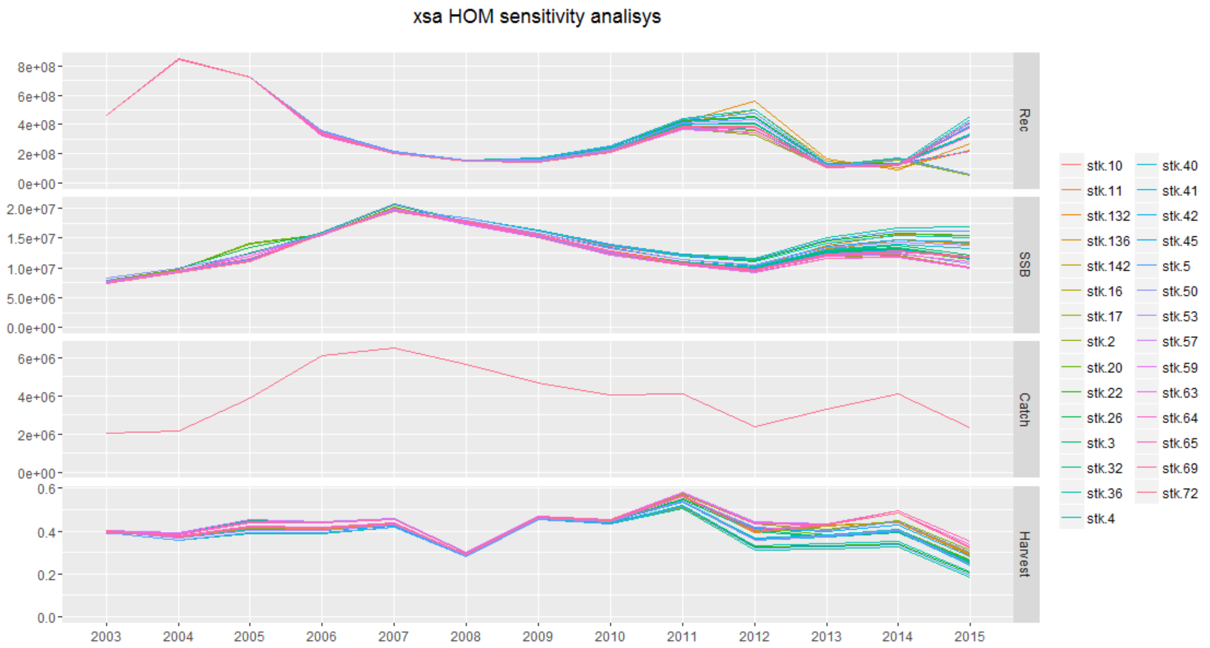


Figure 8.1.3.2. Atlantic Horse Mackerel in GSAs 1-5-6-7. Sensitivity analyses of the 29 top XSA runs.

To select the best setting parameters to be used in the final assessment a retrospective analysis was carried out for all the 28 runs for parameters combinations.

All the retrospective analysis carried out shows high instability particularly for fishing mortality as shown in the figure below for 2 of the 29 runs (Figure 8.1.3.3).

The EWG 16-13 group concluded that these age structured models were not suitable to assess this stock with the current data availability and thus no more analysis were carried out.

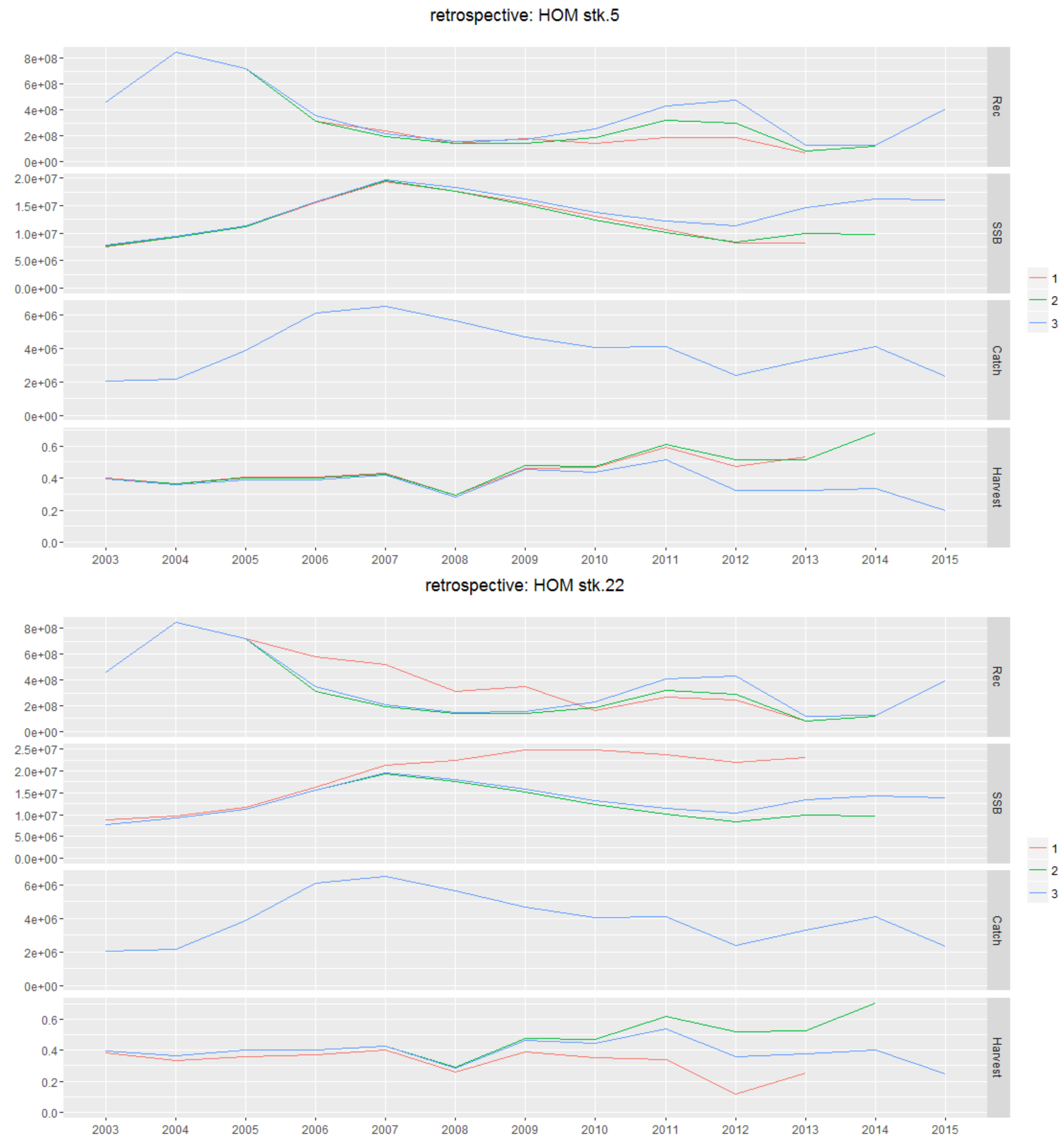


Figure 8.1.1.3.3. Atlantic Horse Mackerel in GSAs 1-5-6-7. Retrospective analyses of two XSA runs.

8.1.4 Method 2: Data-limited approach

Following the ICES approach on data limited stocks, the last two years (1994-2015) of biomass index coming from MEDITS survey were compared with the previous three years (2011-2013) (Fig. 8.1.4.1.). The biomass estimated over the last five years was used to provide an index of change (0.67). As the decrease in the index is more than 0.8 the value of the factor is limited to 0.8 the previous catch to provide an initial catch advice. For this stock the exploitation rate is unknown and the state of the stock relative to B_{msy} is unknown therefore a precautionary buffer (0.8) is applied giving an overall factor of 0.64. The resulting catch advice taken from the average of the last three years (3247 t) is 2078 tonnes

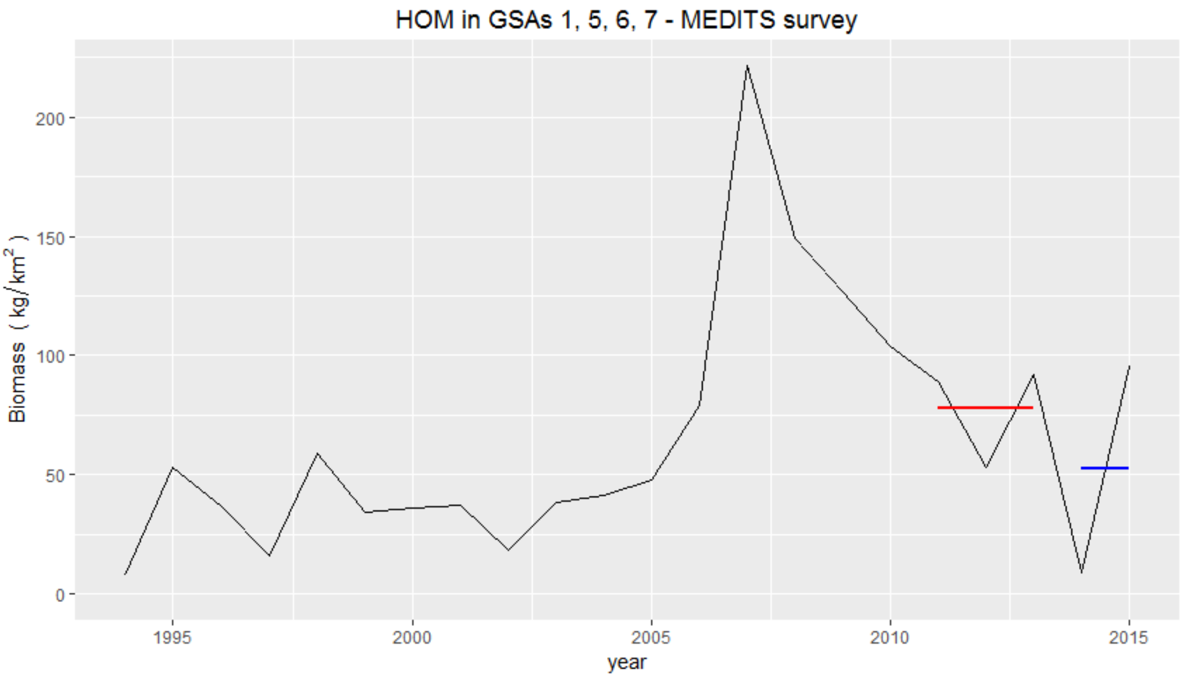


Figure 8.1.5.1.Trend in biomass (black) mean of 2011-2013 (red) and mean of 2014-2015 (blue) for HOM in GSAs 1, 5, 6, 7 (Medits survey data).

8.1.5 Reference point

No MSY reference points have been evaluated for this stock.

8.1.6 Quality and proposals for future assessments

The quality of species separation in fisheries (between *T. trachurus* and *T. mediterraneus*) has been questioned, but no problems are evident in the available data, as a separation between the two species is clearly assumed within the DCF and data are provided separately for both species.The quality of landings data is therefore assumed to be sufficient for the most important gear targeting horse mackerel. If issues do exist, it is possible that they produce a different impact in the landings and discard data, possibly more impacting in the latter. We did not attempt to assess the *T. mediterraneus* stock.

Effort reporting seems to be improving in general in most recent years, with an increase in the number of gear for which days at sea are recorded and transmitted. For those gear for which longer time-series are available, effort is generally unchanged in the most recent years, and in many cases nominally decreased from the previous decade.

It is important to note that although small horse mackerel catches tend to occur with a number of different gear, significant volumes of landings and discards are concentrated in a more restricted group of gears, namely bottom trawling, purse-seining and gillnetting.

Days at sea may not always truly reflect effort in terms of fishing capacity. For the horse mackerel fishery, the most important gear are trawls (OTB), purse-seines and set gill nets (GNS) which are sufficiently different in terms of effort deployment that days at sea may not reflect effort similarly for all.

It would therefore be desirable that specific measures of effort are reported for each fishery, such that better measures of LPUE are available.

As data are presently reported, landings show a moderate decrease after a peak in the middle of the time-series, in the early to mid-2000s.

The frequency of assessment at the moment is perhaps difficult to judge, as this is the first time that an assessment is conducted for horse-mackerel in the Mediterranean. It would be useful to have a group of people who are familiar with the fishery that could strive to check data availability and quality prior to assessments.

8.2 STOCK ASSESSMENT OF ATLANTIC HORSE MACKEREL IN REGION 2 (GSAs 9-10-11)

8.2.1 Methods 1 (Assessment)

The Atlantic Horse mackerel was never assessed before in an STECF meeting. The data provided to EWG 16-13 has been considered covering more than the mean life span of the species, allowing to makes an attempt of stock assessment with an XSA method.
By using the FLR libraries (kell et al.2007) an Extended Survivors Analysis (XSA – Darby and Flatman, 1994) was carried out to assess trends in fishing mortality, stock biomass, spawning stock biomass, and recruitment in the region 2 (GSAs 9, 10, 11).

8.2.2 Input data

The XSA was applied using as input data the DCF official data on the age structure and the landing of commercial catches. As a tuning fleet the data of MEDITS survey were used. For the analysis the timeframe (2007-2015) was set since taking in to account the availability of landing at length or catch at age data. The analysis was carried out for sex combined using the following growth parameters:

L_inf	k	t0	L-W: a	L-W: b
45	0.1044	-1.901	0.0099	2.9853

To derive catch numbers at age from the DCF annual size distributions a knife edge slicing technique was applied. For big individuals a 10+ group has been used. A SOP correction was applied to catch numbers at age.

The maturity at age has been derived from the DCF official data.

Natural mortality EWG16-13 taken from the ICES WGHANSA (2013) for the southern horse mackerel stock as reported in Table 6.8.1.3 of this report.
The input parameters (landings, catch number at age, weight at age, maturity at age, natural mortality at age and the tuning series at age) to the XSA were listed (Table 8.2.2.1) below.

Table 8.2.2.1. Input parameters and data for XSA assessment

```
### TUNING
age  2009 2010 2011 2012 2013 2014 2015
  0   877 1841 5659 1271 1447 1235 4812
  1  1409 2200 1013  988  620 1321 1132
  2   115  804  328 1105  214  627  188
  3   153 1002  162  143   40   96   92
  4    40   30  100   40   19   25   30
  5     7   15   26   18   21   17    8
  6     4    6    5   15   14   11    5
  7     2    7    5    9    5    9    3
  8     1    1    4    7    1    4    1
  9     0    1    4    3    1    1    1
  10    1    1    5    6    0    1    1

### initial settings
      min       max plusgroup   minyear   maxyear   minfbar   maxfbar
        0        10        10      2009      2015         2         6

### Mortality and Maturity vectors@age
             0    1   10    2    3   4    5    6    7    8    9
maturity  0.04 0.24 1.00 0.76 0.97 1.0 1.00 1.00 1.00 1.00 1.00
mortality 0.90 0.60 0.15 0.40 0.30 0.2 0.15 0.15 0.15 0.15 0.15

### Mean Weight@age (kg) in stock, catch, landings
age  2009  2010  2011  2012  2013  2014  2015
  0  0.021 0.021 0.021 0.021 0.021 0.021 0.021
  1  0.078 0.078 0.078 0.078 0.078 0.078 0.078
  2  0.158 0.158 0.158 0.158 0.158 0.158 0.158
  3  0.248 0.248 0.248 0.248 0.248 0.248 0.248
  4  0.336 0.336 0.336 0.336 0.336 0.336 0.336
  5  0.416 0.416 0.416 0.416 0.416 0.416 0.416
  6  0.484 0.484 0.484 0.484 0.484 0.484 0.484
  7  0.541 0.541 0.541 0.541 0.541 0.541 0.541
  8  0.588 0.588 0.588 0.588 0.588 0.588 0.588
  9  0.625 0.625 0.625 0.625 0.625 0.625 0.625
  10 0.654 0.654 0.654 0.654 0.654 0.654 0.654

### catch in weight (kg) by year
age    2009    2010    2011    2012    2013    2014    2015
  all 4583001 7641001 4173000 1901000  955000  564000 6689000

### Catch at age matrix (numbers in thousands)
age  2009      2010      2011      2012      2013      2014      2015
  0   1258648    880577  3055528    304210    677428         2  6455477
  1   7931953   4614719  3856784    811438   1119147     22640 24437505
  2  14444428  22369568  6127549   2211467   1252094    137885 27186364
  3   4493469   8132161  2666949    710874    332081      2192   525239
  4   1029848   2722186  1810644    638520    441713     54518   311543
  5    137875    519442   629176    571357    221723    175153    85636
  6     71064    440516   408792    570056    262327    205766    93010
  7     65034    412713   707457    453303    165762    256959    28660
  8     29584    145024   695263    322253    105335    285542    24010
  9     13323     33738   178319     74417     29755     36410     3781
  10    65124     57802   317250    147163     54226     29759     6573
```

8.2.3 Results

A sensitivity analysis was performed to select the most suitable best parameters to be used in the XSA. Several different runs (n=216) have been carried out, changing all the combination of rage (-1 to 1, step of 1), qage (0 to 3, step of 1), shk.ages (1 to 3, step of 1) and fse (0.5 to 3, step of 0.5).

Among all setting runs, only 99 shows finite values with absolute means of residuals ranging from 0.84 to 1.86e+54 (mean 1.503e+52, 1st quartile 1.05). Only 31 runs are within the first quartile (1.05).of absolute means of residuals (Table 8.2.3.1).

Table 8.2.3.1. Results of the sensitivity analysis in terms of min, max and absolute mean values of residuals

run_n	setsens	shkage	fse	rage	qage	minres	maxres	absmean
18	sh3se3r-1q	sh3	se3	r-1	q0	-2.82384	2.478645	0.84097
17	sh3se2.5r-:	sh3	se2.5	r-1	q0	-2.7769	2.527129	0.84822
16	sh3se2r-1q	sh3	se2	r-1	q0	-2.69724	2.60823	0.862583
6	sh1se3r-1q	sh1	se3	r-1	q0	-2.82257	2.478679	0.862752
10	sh2se2r-1q	sh2	se2	r-1	q0	-2.69587	2.608236	0.87738
72	sh3se3r-1q	sh3	se3	r-1	q3	-3.18581	2.18834	0.906072
60	sh1se3r-1q	sh1	se3	r-1	q3	-3.18458	2.188352	0.907068
66	sh2se3r-1q	sh2	se3	r-1	q3	-3.18524	2.188343	0.910738
9	sh2se1.5r-:	sh2	se1.5	r-1	q0	-2.55762	2.748793	0.915202
65	sh2se2.5r-:	sh2	se2.5	r-1	q3	-3.20079	2.22688	0.925724
59	sh1se2.5r-:	sh1	se2.5	r-1	q3	-3.19985	2.22689	0.926462
54	sh3se3r-1q	sh3	se3	r-1	q2	-3.35648	2.220581	0.960487
11	sh2se2.5r-:	sh2	se2.5	r-1	q0	-2.77602	7.866597	0.960968
47	sh2se2.5r-:	sh2	se2.5	r-1	q2	-3.32726	2.248582	0.96248
53	sh3se2.5r-:	sh3	se2.5	r-1	q2	-3.32806	2.248582	0.962691
40	sh1se2r-1q	sh1	se2	r-1	q2	-3.29502	2.285815	0.974433
41	sh1se2.5r-:	sh1	se2.5	r-1	q2	-3.3263	2.248584	0.977697
52	sh3se2r-1q	sh3	se2	r-1	q2	-3.29769	2.285814	0.979328
51	sh3se1.5r-:	sh3	se1.5	r-1	q2	-3.26789	2.336286	0.99589
24	sh1se3r-1q	sh1	se3	r-1	q1	-3.49321	2.136816	1.00699
30	sh2se3r-1q	sh2	se3	r-1	q1	-3.49388	2.136813	1.008867
45	sh2se1.5r-:	sh2	se1.5	r-1	q2	-3.26587	2.336281	1.009955
22	sh1se2r-1q	sh1	se2	r-1	q1	-3.42412	2.204825	1.01166
23	sh1se2.5r-:	sh1	se2.5	r-1	q1	-3.46472	2.162722	1.017415
36	sh3se3r-1q	sh3	se3	r-1	q1	-3.49444	2.136812	1.021338
33	sh3se1.5r-:	sh3	se1.5	r-1	q1	-3.36449	2.32577	1.021608
42	sh1se3r-1q	sh1	se3	r-1	q2	-3.35524	4.857603	1.028485
46	sh2se2r-1q	sh2	se2	r-1	q2	-3.29648	4.857603	1.042973
27	sh2se1.5r-:	sh2	se1.5	r-1	q1	-3.36253	2.325793	1.046915
3	sh1se1.5r-:	sh1	se1.5	r-1	q0	-2.50882	3.37346	1.050486
14	sh3se1r-1q	sh3	se1	r-1	q0	-2.40438	2.966834	1.054631

Sensitivity analyses were conducted to assess the effect of the main parameters in the top 31 runs in terms of minimizations of residuals (figure 8.2.3.2.1).

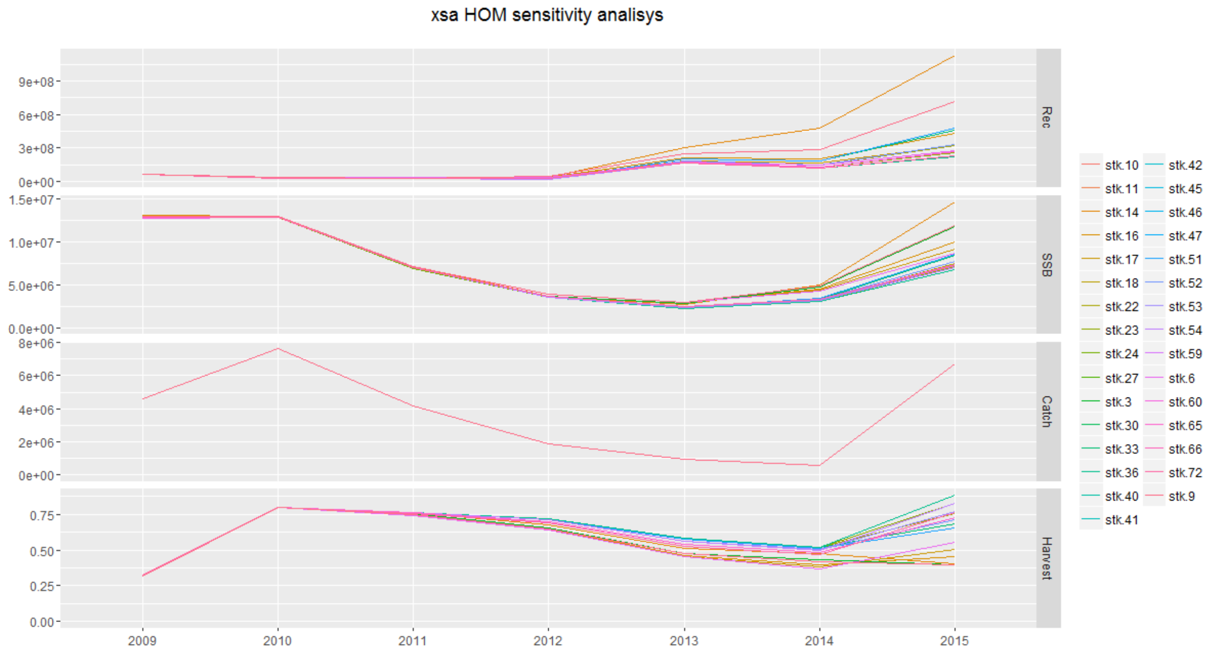


Figure 8.2.3.1. Atlantic Horse Mackerel in GSAs 1-5-6-7. Sensitivity analyses of the 31 top XSA runs.

To select by the diagnostic analysis the best setting parameters to be used in the final assessment a retrospective analysis was carried out for all the 31 runs for parameters combinations. Four runs were examined more in detail. In all of that the recruitment estimation, which always show an increasing trend, looks very instable. A better pattern was observed in the for the retrospective analysis of fishing mortality which was more stable, showing a decreasing trend until 2014, and higher values of F in the last year (2015). Due to the shortness of the time series the option of removing the last year to obtain a better assessment was not taken. Among the final four model the run number 54 was considered the best (Figure 8.2.3.3, control parameters: fse_3, rage_-1, qage_2, shk.yrs_3, shk.ages_3).

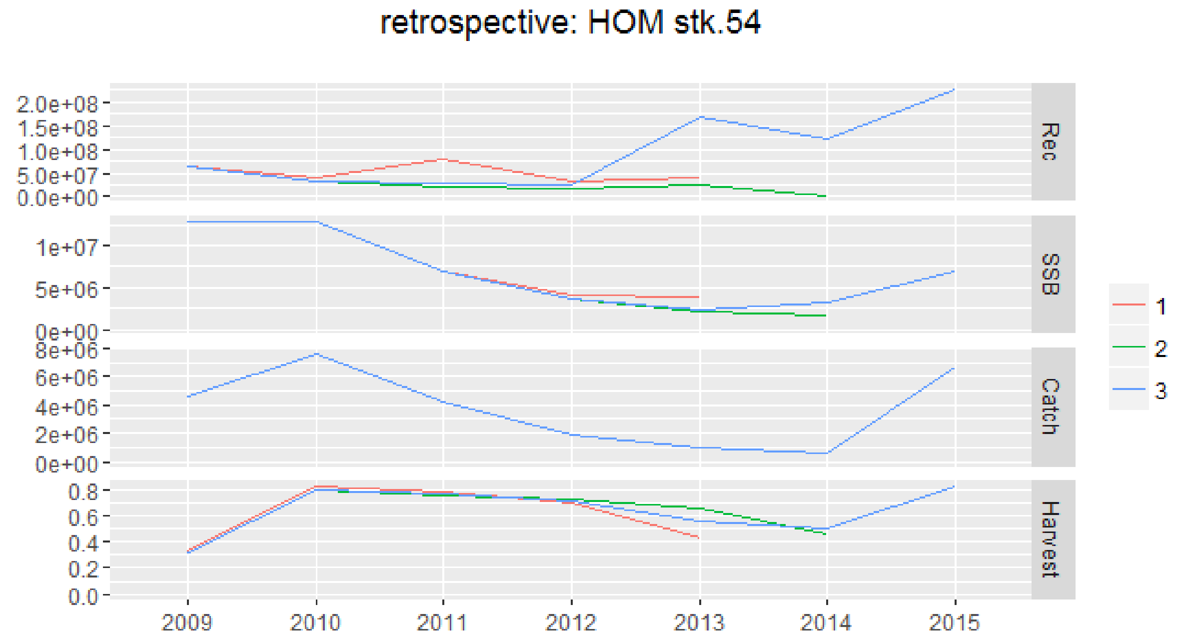


Figure 8.2.3.3. Atlantic Horse Mackerel in GSAs 9-10-11. Some of the retrospective analyses of the best XSA runs.

The XSA results show an increasing trend in recruitment and fishing mortality in the last years in with an estimated F_{curr} of about 0.83 (figure 8.2.3.4, table 8.2.3.2).

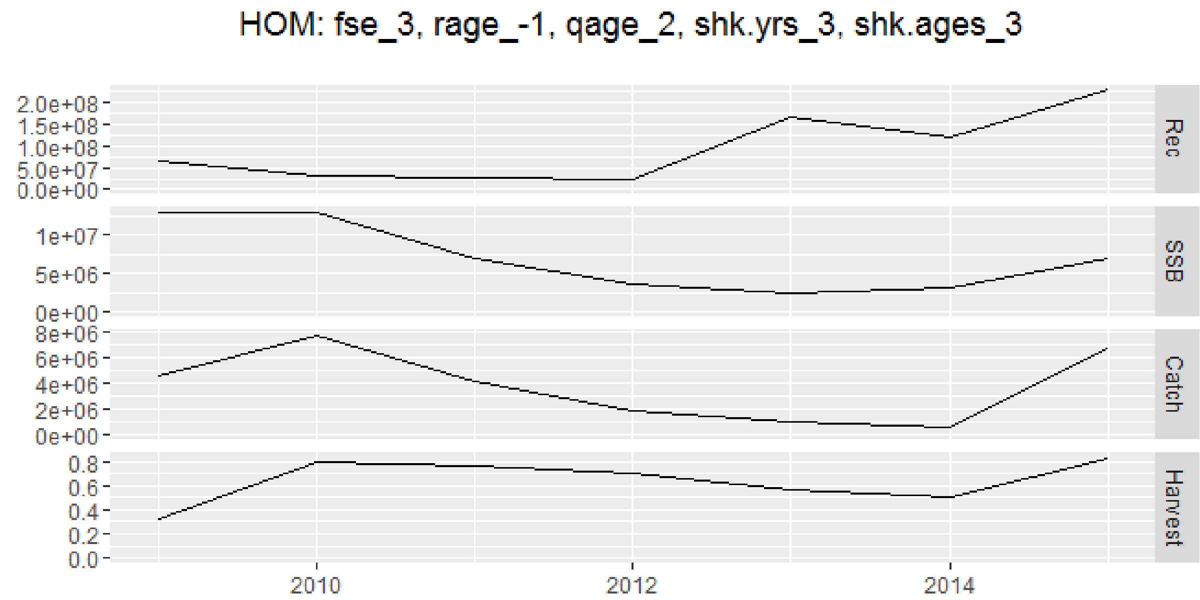


Figure 8.2.3.4. Atlantic horse mackerel in region 2 (GSAs 9-10-11). XSA summary results. SSB and catch are in tons, recruitment in 1000s individuals.

Table 8.2.3.2. Atlantic horse mackerel in region 2 (GSAs 9-10-11). Stock numbers at age (thousands) as estimated by XSA

Log catchability residuals of XSA

age	2009	2010	2011	2012	2013	2014	2015
0	-7.5561e-01	6.8368e-01	2.0571e+00	6.1311e-01	-1.2158e+00	-1.0584e+00	-3.0095e-01
1	-9.8864e-01	5.9512e-01	6.7687e-01	7.0747e-01	2.5694e-01	-1.0582e+00	-2.1645e-01
2	-2.5919e+00	5.4060e-02	1.4209e-01	2.2206e+00	7.1188e-02	9.4791e-01	-1.0194e+00
3	-1.3003e+00	7.9998e-01	-1.7333e-02	4.2240e-01	-2.2559e-02	-2.3587e-01	-4.6670e-01
4	-1.5129e+00	-2.0190e+00	-3.7200e-01	-3.6926e-01	-7.2096e-01	4.4606e-02	-9.9642e-01
5	-3.0656e+00	-1.9748e+00	-1.4680e+00	-1.2469e+00	-2.3275e-01	4.1581e-02	-6.2287e-01
6	-3.3565e+00	-2.8653e+00	-2.5240e+00	-1.3108e+00	-7.6344e-01	4.7045e-01	-1.7184e-01
7	-2.8193e+00	-2.4036e+00	-2.1802e+00	-8.3918e-01	-1.7685e+00	5.0712e-01	5.6021e-01
8	-1.4312e+00	-3.0135e+00	-1.4655e+00	-1.3537e-02	-1.7040e+00	2.8862e-02	4.5014e-01
9	1.2872e+05	-9.2002e-02	-1.3770e-02	1.3248e-02	-5.2566e-02	4.8916e-02	3.2297e-02

XSA summary

	2009	2010	2011	2012	2013	2014	2015
ssb	12935818.30	12924983.7	7029140.60	3649608.30	2415873.50	3234475.1	7036774.80
fbar	0.32	0.8	0.76	0.71	0.56	0.5	0.83
rec	64923676.00	32563939.0	27752786.00	23782861.00	167160053.00	121413603.0	228131220.00
catch	4583000.50	7641000.6	4173000.00	1901000.40	954999.90	564000.0	6688999.90

Fishing mortality by year estimated with XSA

age	2009	2010	2011	2012	2013	2014	2015
0	0.03	0.04	0.19	0.02	0.01	0.00	0.05
1	0.16	0.28	0.53	0.12	0.17	0.00	1.10
2	0.60	1.54	1.22	1.07	0.41	0.04	2.27
3	0.52	1.07	0.97	0.50	0.53	0.00	0.24
4	0.38	0.76	0.79	0.71	0.72	0.16	0.26
5	0.07	0.33	0.38	0.60	0.55	0.69	0.39
6	0.04	0.29	0.44	0.67	0.58	1.60	0.96
7	0.14	0.36	0.98	1.26	0.38	2.17	1.02
8	0.47	0.48	1.96	2.12	1.14	2.80	1.87
9	0.22	1.63	2.07	1.40	1.53	1.89	0.27
10	0.22	1.63	2.07	1.40	1.53	1.89	0.27

Stock in numbers (thousands) estimated by age and year

age	2009	2010	2011	2012	2013	2014	2015
0	64923675.8	32563939.4	27752785.7	23782860.7	167160053.0	121413603.1	228131219.7
1	74022273.3	25593447.4	12678029.1	9335150.0	9475416.7	67530258.7	49363086.0
2	39127513.7	34748149.6	10627313.8	4100674.0	4522110.9	4371134.5	37044619.6
3	12822011.5	14401859.4	4977728.0	2106888.7	938168.0	2006133.7	2817168.4
4	3573195.5	5631215.2	3669744.0	1392127.3	948966.6	409187.2	1484293.7
5	2348946.6	1993640.0	2147313.3	1366193.8	562020.7	377269.7	285684.2
6	1771777.0	1893844.4	1234032.9	1264495.7	645821.2	278033.6	162222.0
7	548465.5	1459053.4	1221361.1	682887.9	559495.8	312491.3	48407.7
8	84438.2	411733.8	872927.1	394896.7	167218.1	327777.9	30571.7
9	72980.6	45230.2	219837.5	106309.6	40922.6	46202.1	17211.3
10	355428.4	75930.8	381460.7	206512.5	73155.1	36898.3	29792.1

8.2.4 Reference point

The mainly exploited ages were from 2 to 6 and for this age range were estimated the corresponding mean F values. These values were used to computed a corresponding value of exploitation rate (E) to compare with exploitation rate reference point (E=0.4) proposed by Patterson (1992) (Figure 8.2.4.1).

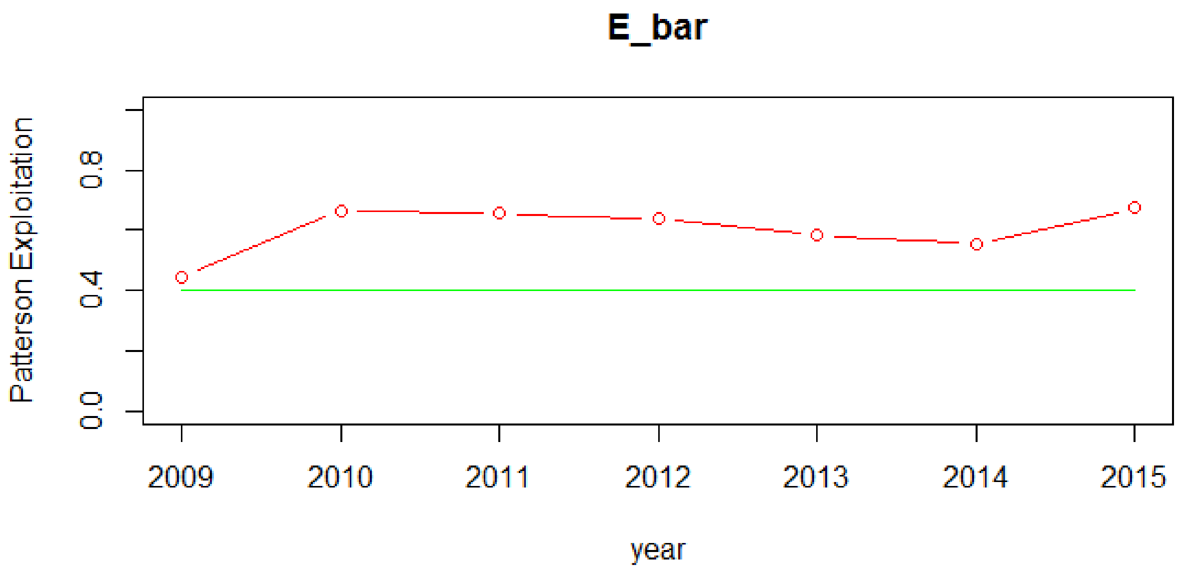


Figure 8.2.4.1. Atlantic horse mackerel in region 2 (GSAs 9-10-11). Trend in the exploitation rate compare to E=0.4.

8.2.5 Conclusions on the assessment

The assessment is unstable, and the selectioin pattern (Table 8.2.3.2) rises rapidly to peak at age two falls immediately and then rises steadly to older ages. It is not sufficiently stable to use for short term forecast but can be used to give an indication of current status of the stock

8.2.6 Reference points

The mainly exploited ages were from 2 to 6 and for this age range were estimated the corresponding mean F values. These values were used to computed a corresponding value of exploitation rate (E) to compare with exploitation rate reference point (E=0.4) proposed by Patterson (1992) (Fig. 8.3.1.5)

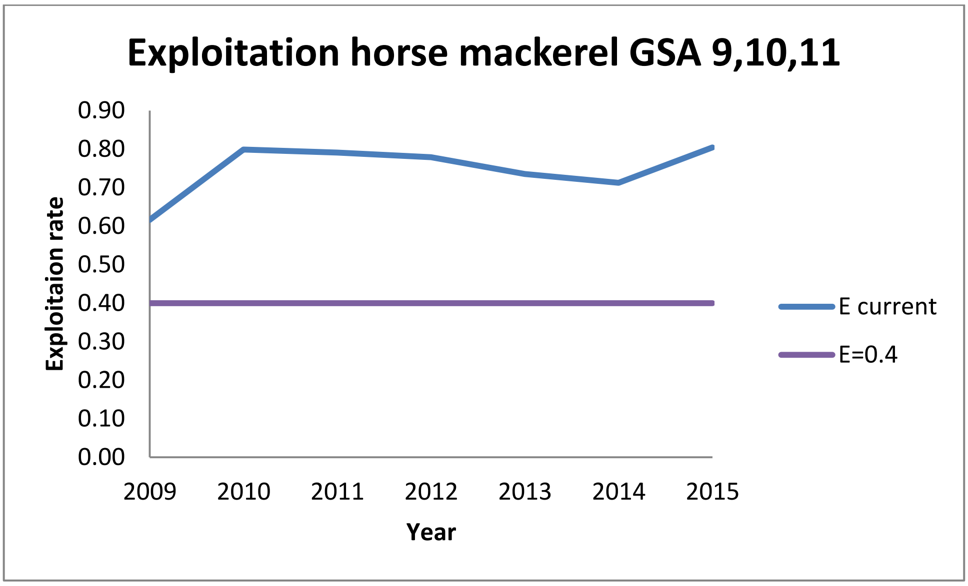


Figure 8.4.1.5. Horse mackerel in GSA 9, 10 and 11. Trend in the exploitation rate compare to E=0.4.

8.2.7 Short term forecasts

No short term forecasts have been conducted for EWG 16-13 for horse mackerel in GSA 9,10 and 11 due to instability in the assessment, mainly due to the very short time series, this makes short term forecasts particularly unreliable. In order to obtain a basis for catch advice recent harvest rates based on SSB and total biomass are compared to the exploitation rate E=F/(F+M). Based on this approach catch advice for E=0.4 (Patterson 1992) can be computed with respect to most recent SSB. The use of SSB is preferred over total biomass as it more closely reflects the fishery (ages 2-6) than total biomass. The relationship between E and F is not as strong and the intercept is not significant so the relationship is forced through zero, as E=0 when F =0 is expected. The resulting relationship is therefor a single factor of proportionality HR = 0.696 E. The resulting catch options based on different options for E and SSB in 2015 are given in Table 8.2.1.4, the option for E=0.4 gives a catch of 1959 t.

Table 8.2.7.1 Relationship between HR and E and resulting catch options based on SSB in 2015.

Exploitation Rate	Harvest Ratio on SSB	Catch options Related to E	Change in catch
0	0.000	0	-100%
0.2	0.139	980	-85%
0.4	0.278	1959	-71%
0.6	0.418	2939	-56%

0.8	0.557	3918	-41%
1	0.696	4898	-27%

8.2.8 **Quality and proposals for future assessments**

The quality of species separation in fisheries (between *T. trachurus* and *T. mediterraneus*) has been questioned, but no problems are evident in the available data, as a separation between the two species is clearly assumed within the DCF and data are provided separately for both species. The quality of landings data is therefore assumed to be sufficient for the most important gear targeting horse mackerel. If issues do exist, it is possible that they produce a different impact in the landings and discard data, possibly more impacting in the latter. We did not attempt to assess the *T. mediterraneus* stock.

Effort reporting seems to be improving in general in most recent years, with an increase in the number of gear for which days at sea are recorded and transmitted. For those gear for which longer time-series are available, effort is generally unchanged in the most recent years, and in many cases nominally decreased from the previous decade.

It is important to note that although small horse mackerel catches tend to occur with a number of different gear, significant volumes of landings and discards are concentrated in a more restricted group of gears, namely bottom trawling, purse-seining and gillnetting.

Days at sea may not always truly reflect effort in terms of fishing capacity. For the horse mackerel fishery, the most important gear are trawls (OTB), purse-seines and set gill nets (GNS) which are sufficiently different in terms of effort deployment that days at sea may not reflect effort similarly for all.

It would therefore be desirable that specific measures of effort are reported for each fishery, such that better measures of LPUE are available.

As data are presently reported, landings show a moderate decrease after a peak in the middle of the time-series, in the early to mid-2000s.

The frequency of assessment at the moment is perhaps difficult to judge, as this is the first time that an assessment is conducted for horse-mackerel in the Mediterranean. It would be useful to have a group of people who are familiar with the fishery that could strive to check data availability and quality prior to assessments.

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8.3 STOCK ASSESSMENT OF ATLANTIC HORSE MACKEREL IN REGION 3 (GSAs 17,18,19 and 20)

8.3.1 Method 1 (Stock assessment)

By using the FLR libraries (kell et al.2007) an Extended Survivors Analysis (XSA – Darby and Flatman, 1994) was carried out to assess trends in fishing mortality, stock biomass, spawning stock biomass, and recruitment in the region 3 (GSAs 17, 18, 19, 20).

8.3.2 Input data

The XSA was applied using as input data the DCF official data on the age structure and the landing of commercial catches. As a tuning fleet the data of MEDITS survey were used. For the analysis the timeframe (2005-2015) was the same for both catch and tuning data. The analysis was carried out for sex combined using the following growth parameters:

L_inf	k	t0	L-W: a	L-W: b
44	0.192	-1.31	0.0099	2.945

To derive catch numbers at age from the DCF annual size distributions a knife edge slicing technique was applied. For big individuals a 10+ group has been used. A SOP correction was applied to catch numbers at age.

The maturity at age has been derived from the DCF official data.

Natural mortality EWG16-13 taken from the ICES WGHANSA (2013) for the southern horse mackerel stock is reported up in this report (Table 6.9.1.3).

The input parameters (landings, catch number at age, weight at age, maturity at age, natural mortality at age and the tuning series at age) to the XSA were plotted (figure 8.3.2.1-5) and listed (table 8.3.2.1) below.

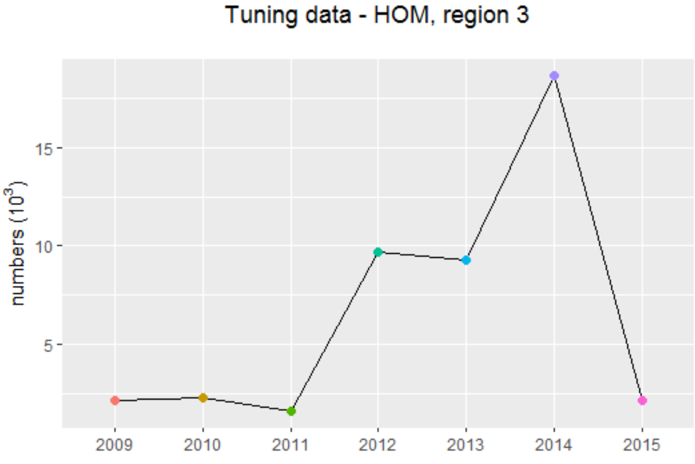

Figure 8.3.2.1. Atlantic Horse Mackerel in GSAs 17-20. Tuning input data to the XSA model.

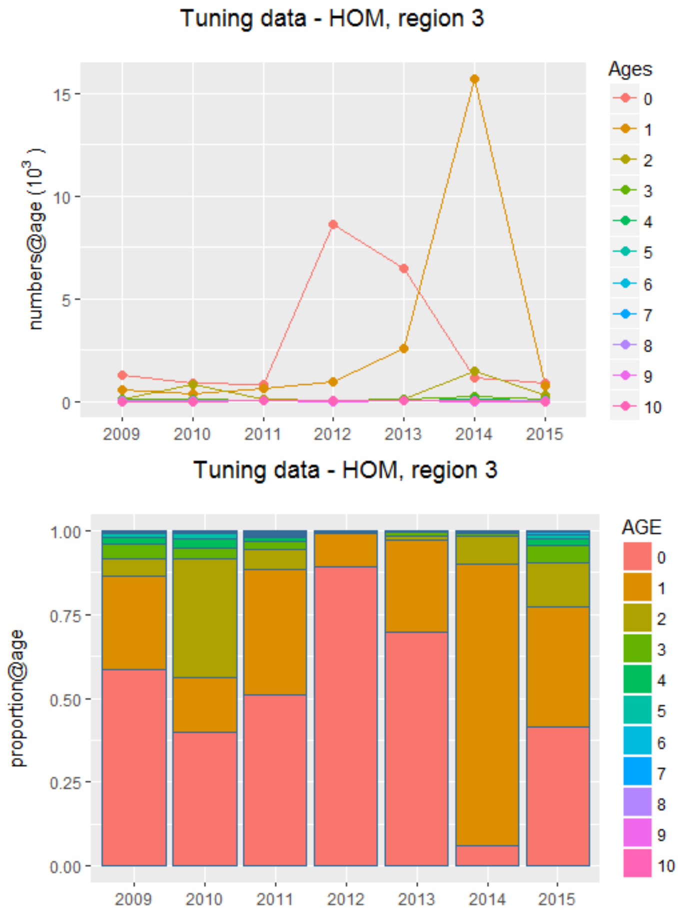

Figure 8.3.2.2. Atlantic Horse Mackerel in GSAs 17-20. Tuning at age (upper) and proportion by age (lower) as input data to the XSA model.

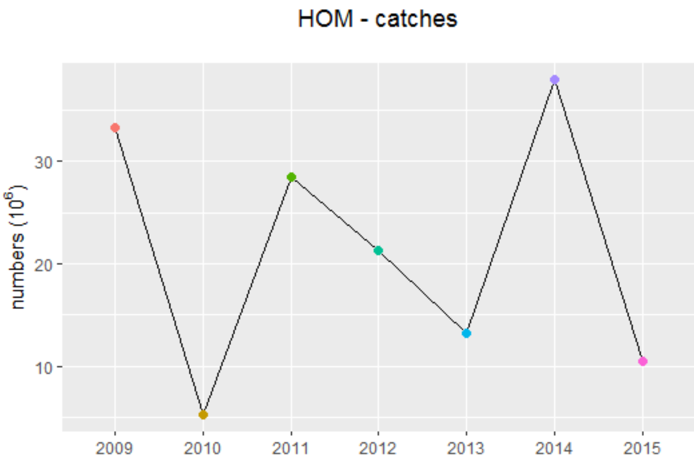

Figure 8.3.2.3. Atlantic Horse Mackerel in GSAs 17-20. Catch input data to the XSA model.

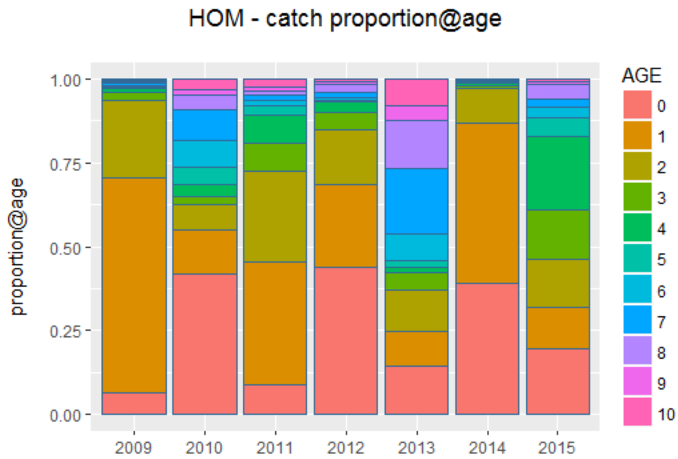

Figure 8.3.2.4. Atlantic Horse Mackerel in GSAs 17-20. Catch at age input data to the XSA model.

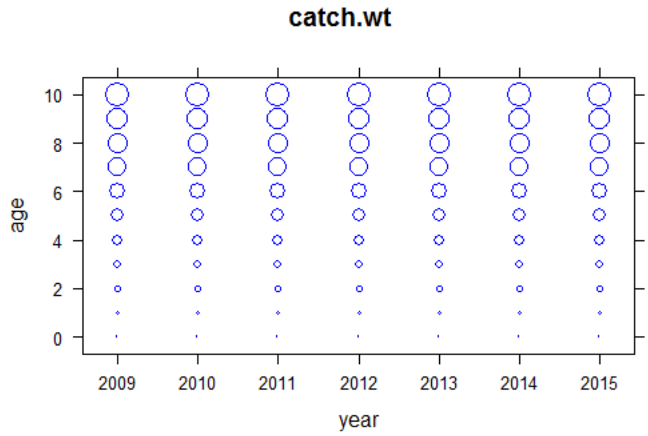

Figure 8.3.2.5. Atlantic Horse Mackerel in GSAs 17-20. Weight at age input data to the XSA model.

Table 8.3.1.2. Atlantic Horse Mackerel in GSAs GSAs 17-20. Input parameters to the XSA model.

```
### TUNING
age  2009 2010 2011 2012 2013  2014 2015
  0  1246  908  812 8641 6482  1128  901
  1   587  370  599  962 2575 15715  778
  2   114  799   93   21   99  1496  287
  3    93   78   41   18  104   203  113
  4    43   59   17   12   17    70   43
  5    20   38    9    5    4    25   27
  6     6    6    4    3    3     7   15
  7     6    5    5    2    3     4    4
  8     4    4    6    3    5     3    3
  9     1    1    5    1    4     2    2
  10    2    2    4    3    4     3    1

### initial settings
      min       max plusgroup   minyear   maxyear   minfbar   maxfbar
        0        10        10      2009      2015         2         6

### Mortality and Maturity vectors@age
             0    1   10    2    3   4    5    6    7    8    9
maturity  0.05 0.25 1.00 0.62 0.83 0.9 0.90 0.95 1.00 1.00 1.00
mortality 0.90 0.60 0.15 0.40 0.30 0.2 0.15 0.15 0.15 0.15 0.15

### Mean Weight@age (kg) in stock, catch, landings
age  2009  2010  2011  2012  2013  2014  2015
  0  0.019 0.019 0.019 0.019 0.019 0.019 0.019
  1  0.055 0.055 0.055 0.055 0.055 0.055 0.055
  2  0.108 0.108 0.108 0.108 0.108 0.108 0.108
  3  0.171 0.171 0.171 0.171 0.171 0.171 0.171
  4  0.239 0.239 0.239 0.239 0.239 0.239 0.239
  5  0.307 0.307 0.307 0.307 0.307 0.307 0.307
  6  0.371 0.371 0.371 0.371 0.371 0.371 0.371
  7  0.430 0.430 0.430 0.430 0.430 0.430 0.430
  8  0.484 0.484 0.484 0.484 0.484 0.484 0.484
  9  0.531 0.531 0.531 0.531 0.531 0.531 0.531
  10 0.573 0.573 0.573 0.573 0.573 0.573 0.573

### catch in weight (kg) by year
age    2009    2010    2011    2012    2013    2014    2015
  all 2684999  884000 3763000 1856000 3877001 2012000 1803000

### Catch at age matrix (numbers in thousands)
age  2009      2010      2011      2012      2013      2014      2015
  0    2177060  2183644  2525225  9377938  1881082 14811365  2062907
  1   21314129   689495 10443235  5249266  1376005 18275225  1273659
  2    7677862   397110  7607290  3516306  1684894  3915239  1521213
  3     793986   134575  2453171  1037052   651127   200692  1509784
  4     441620   182149  2371112   705322   223480   367677  2316040
  5     154574   266986   723362   101923   281268   124353   566879
  6     177516   420760   457446   117484  1054051    85770   355904
  7     227855   484899   498473   373171  2559471    81419   239086
  8     148403   223579   353862   522949  1904499    67468   432677
  9      57796    79859   301831   173422   572840    29941    96568
  10    151873   170967   689700   144687  1073170    46854    84089
```

8.3.3 Results

A sensitivity analysis was performed to select the most suitable best parameters to be used in the XSA. Several different runs (n=216) have been carried out, changing all the combination of rage (-1 to 1, step of 1), qage (0 to 3, step of 1), shk.ages (1 to 3, step of 1) and fse (0.5 to 3, step of 0.5). Among all setting runs, only 109 shows finite values with absolute means of residuals ranging from 0.6 to 12.9 (mean 3.6, 1st quartile 0.7). Only 48 runs are within the first quartile (0.7).of absolute means of residuals (table 8.3.3.1).

Table 8.3.3.1. Results of the sensitivity analysis in terms of min, max and absolute mean values of residuals

run_n	setsens	shkage	fse	rage	qage	minres	maxres	absmean
42	sh1se3r-1q2	sh1	se3	r-1	q2	-2.4730	2.5598	0.6067
48	sh2se3r-1q2	sh2	se3	r-1	q2	-2.4733	2.5598	0.6069
54	sh3se3r-1q2	sh3	se3	r-1	q2	-2.4733	2.5597	0.6071
41	sh1se2.5r-1q2	sh1	se2.5	r-1	q2	-2.4858	2.5494	0.6100
47	sh2se2.5r-1q2	sh2	se2.5	r-1	q2	-2.4862	2.5494	0.6102
53	sh3se2.5r-1q2	sh3	se2.5	r-1	q2	-2.4863	2.5493	0.6105
201	sh1se1.5r1q3	sh1	se1.5	r1	q3	-2.7879	2.0648	0.6106
207	sh2se1.5r1q3	sh2	se1.5	r1	q3	-2.7886	2.0649	0.6113
213	sh3se1.5r1q3	sh3	se1.5	r1	q3	-2.7883	2.0650	0.6117
212	sh3se1r1q3	sh3	se1	r1	q3	-2.7998	1.9949	0.6120
202	sh1se2r1q3	sh1	se2	r1	q3	-2.7884	2.0902	0.6166
208	sh2se2r1q3	sh2	se2	r1	q3	-2.7888	2.0903	0.6171
206	sh2se1r1q3	sh2	se1	r1	q3	-2.7995	1.9943	0.6174
214	sh3se2r1q3	sh3	se2	r1	q3	-2.7887	2.0903	0.6175
203	sh1se2.5r1q3	sh1	se2.5	r1	q3	-2.7892	2.1050	0.6209
209	sh2se2.5r1q3	sh2	se2.5	r1	q3	-2.7894	2.1051	0.6213
215	sh3se2.5r1q3	sh3	se2.5	r1	q3	-2.7894	2.1051	0.6216
200	sh1se1r1q3	sh1	se1	r1	q3	-2.7894	1.9932	0.6234
204	sh1se3r1q3	sh1	se3	r1	q3	-2.7900	2.1141	0.6240
210	sh2se3r1q3	sh2	se3	r1	q3	-2.7902	2.1142	0.6243
216	sh3se3r1q3	sh3	se3	r1	q3	-2.7902	2.1142	0.6245
114	sh1se3r0q2	sh1	se3	r0	q2	-2.4433	2.5832	0.6395
120	sh2se3r0q2	sh2	se3	r0	q2	-2.4436	2.5832	0.6396
126	sh3se3r0q2	sh3	se3	r0	q2	-2.4437	2.5831	0.6399
113	sh1se2.5r0q2	sh1	se2.5	r0	q2	-2.4577	2.5705	0.6424
119	sh2se2.5r0q2	sh2	se2.5	r0	q2	-2.4581	2.5704	0.6426
125	sh3se2.5r0q2	sh3	se2.5	r0	q2	-2.4582	2.5703	0.6429
40	sh1se2r-1q2	sh1	se2	r-1	q2	-2.6393	2.3867	0.6691
46	sh2se2r-1q2	sh2	se2	r-1	q2	-2.6399	2.3867	0.6695
52	sh3se2r-1q2	sh3	se2	r-1	q2	-2.6399	2.3866	0.6699
185	sh1se2.5r1q2	sh1	se2.5	r1	q2	-3.0914	1.9546	0.6886
191	sh2se2.5r1q2	sh2	se2.5	r1	q2	-3.0917	1.9546	0.6890
197	sh3se2.5r1q2	sh3	se2.5	r1	q2	-3.0917	1.9546	0.6891
186	sh1se3r1q2	sh1	se3	r1	q2	-3.0881	1.9624	0.6900
192	sh2se3r1q2	sh2	se3	r1	q2	-3.0884	1.9624	0.6903
198	sh3se3r1q2	sh3	se3	r1	q2	-3.0884	1.9624	0.6904
184	sh1se2r1q2	sh1	se2	r1	q2	-3.1000	1.9399	0.6907
190	sh2se2r1q2	sh2	se2	r1	q2	-3.1006	1.9399	0.6913
196	sh3se2r1q2	sh3	se2	r1	q2	-3.1005	1.9399	0.6915
60	sh1se3r-1q3	sh1	se3	r-1	q3	-2.7440	2.3872	0.6960
59	sh1se2.5r-1q3	sh1	se2.5	r-1	q3	-2.7462	2.3727	0.6963
66	sh2se3r-1q3	sh2	se3	r-1	q3	-2.7441	2.3872	0.6963
72	sh3se3r-1q3	sh3	se3	r-1	q3	-2.7441	2.3872	0.6965
65	sh2se2.5r-1q3	sh2	se2.5	r-1	q3	-2.7464	2.3728	0.6966
71	sh3se2.5r-1q3	sh3	se2.5	r-1	q3	-2.7464	2.3728	0.6969
58	sh1se2r-1q3	sh1	se2	r-1	q3	-2.7517	2.3417	0.6983
64	sh2se2r-1q3	sh2	se2	r-1	q3	-2.7520	2.3418	0.6988
70	sh3se2r-1q3	sh3	se2	r-1	q3	-2.7519	2.3418	0.6991

Sensitivity analyses were conducted to assess the effect of the main parameters in the top 48 runs in terms of minimizations of residuals (figure 8.3.1.3.2).

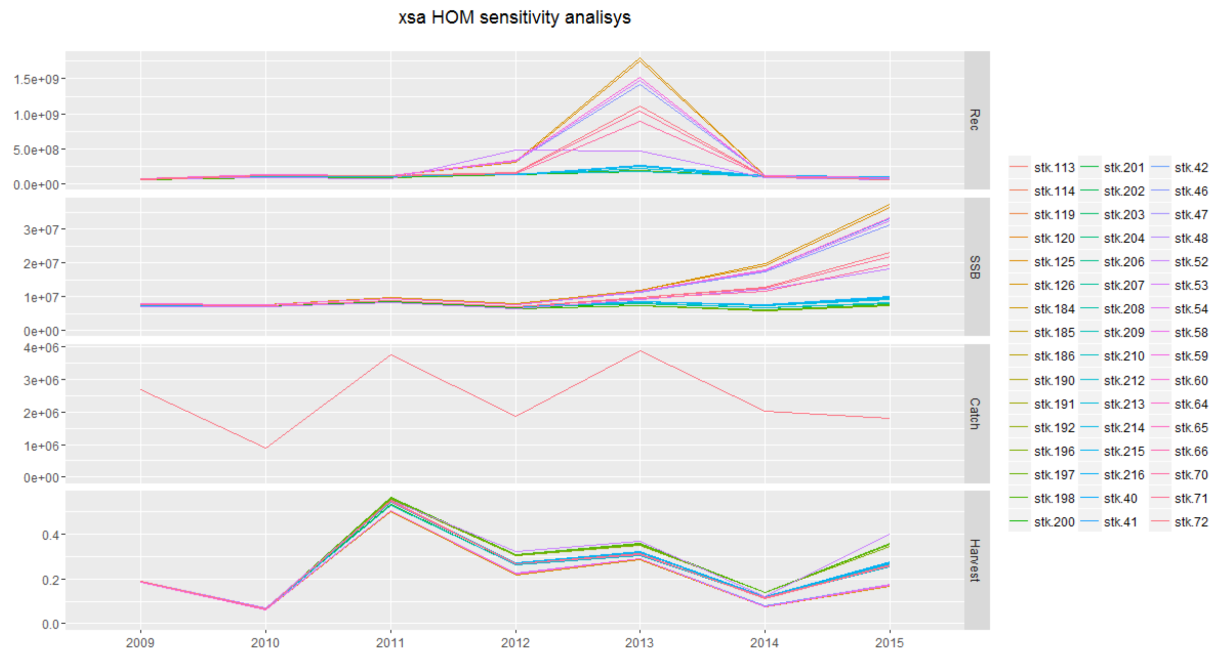

Figure 8.3.3.2. Atlantic Horse Mackerel in GSAs 17-20. Sensitivity analyses of the 48 top XSA runs.

To select the best setting parameters to be used in the final assessment a retrospective analysis was carried out for all the 48 runs for parameters combinations. All the retrospective analysis carried out shows high instability particularly for fishing mortality and recruitment as shown as an example in the figure below for the run 42 (Figure 8.3.1.3.3). The EWG 16-13 group concluded that these age structured models were not suitable to assess this stock with the current data availability and thus no more analysis were carried out.

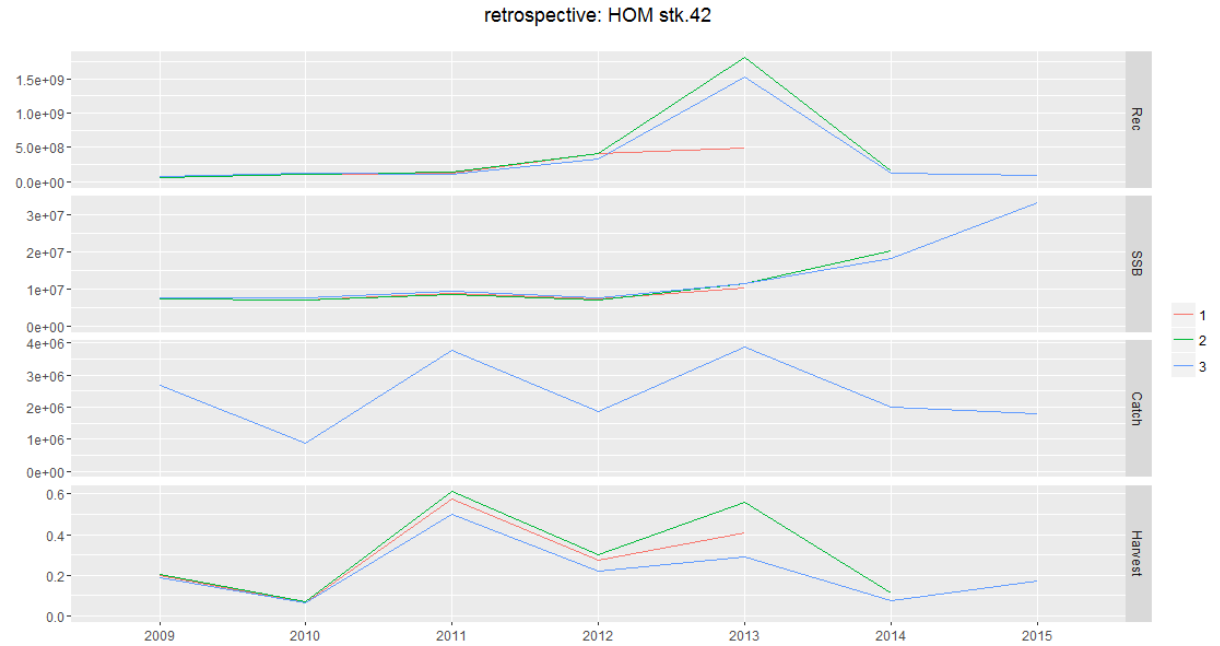

Figure 8.3.3.3. Atlantic Horse Mackerel in GSAs 17-20. Retrospective analyses of an XSA run (run 42).

8.3.4 Method 2: Data-limited approach

Following the ICES approach on data limited stocks, the last two years (1994-2015) of biomass index coming from MEDITS survey were compared with the previous three years (2011-2013) (Fig. 8.3.4.1.). The biomass estimated over the last five years was used to provide an index of change (1.12). As the increase in the index is less than 1.2 the value of the factor is used the catch to provide an initial catch advice. The exploitation rate is unknown and the state of the stock relative to B_{msy} is unknown therefore a precautionary buffer (0.8) is applied. The resulting catch advice taken from the average of the last three years (2564 t) is 2297 t.

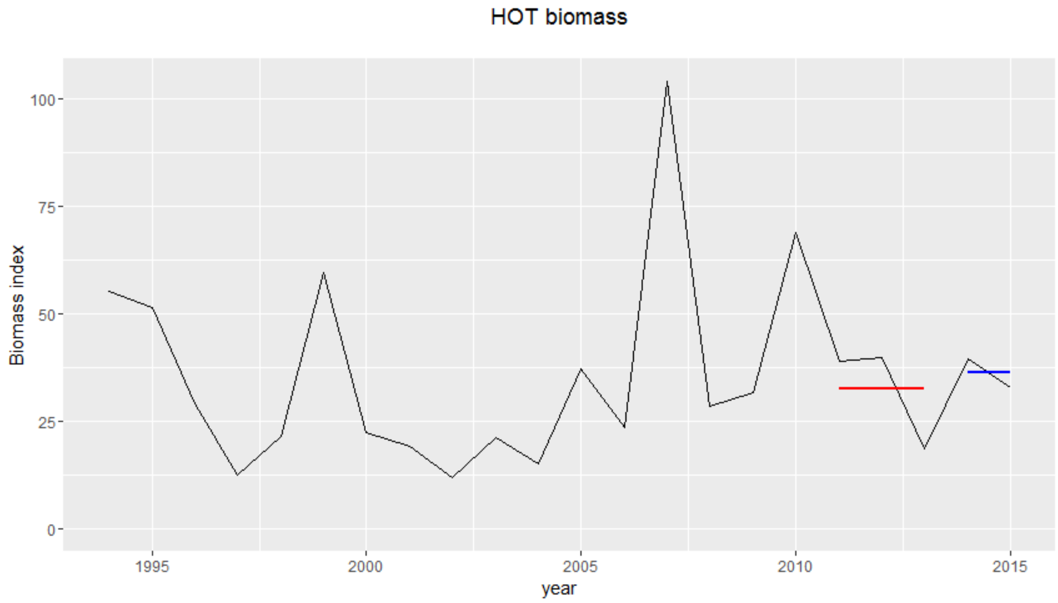

Fig. 8.3.4.1 Atlantic Horse Mackerel in region 3 (GSAs 17-20). Biomass index estimated from MEDITS survey. In blue the mean of the last two years compared with that of the previous three years (in red).

8.3.5 Quality and proposals for future assessments

The quality of species separation in fisheries (between *T. trachurus* and *T. mediterraneus*) has been questioned, but no problems are evident in the available data, as a separation between the two species is clearly assumed within the DCF and data are provided separately for both species.. The quality of landings data is therefore assumed to be sufficient for the most important gear targeting horse mackerel. If issues do exist, it is possible that they produce a different impact in the landings and discard data, possibly more impacting in the latter. We did not attempt to assess the *T. mediterraneus* stock.

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It is important to note that although small horse mackerel catches tend to occur with a number of different gear, significant volumes of landings and discards are concentrated in a more restricted group of gears, namely bottom trawling, purse-seining and gillnetting.

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8.3.6 Short term predictions 2015-2017

Due to instability in the assessment, particularly in F and R, no short term forecasts have been conducted for EWG 16-13.

8.4 STOCK ASSESSMENT OF EUROPEAN ANCHOVY IN GSA 9

8.4.1 Stock Trends and reference points

Methods: XSA (Extended Survival Analysis)

FLR libraries were employed in order to carry out an XSA based assessment. The European Anchovy stock in GSA 9 was assessed, by LCA approach using VIT software, the last time during STECF-EWG 11-12 (STECF report 11-14). XSA was carried out using as input data the period 2006-2015 for the catch data and two different series of surveys indexes as tuning file (acoustic MEDIAS survey carried out in late summer and otter trawl MEDITS survey carried out in late spring / early summer). Nevertheless, the acoustic surveys (MEDIAS) are likely the best source of fishery independent information for small pelagic species, only few years were available for the area (2009, 2011 and 2014-2015) and so, based on the main results obtained by Sbrana et al.,2010, also abundance indexes by age derived from MEDITS (otter trawl survey) from 2011 to 2015 were used as tuning data.

Input data

The VBGF parameters used to slice in age the standardized MEDITS length frequency and to compute the natural mortality vector based on Gislason method were L_{inf} = 17, k = 0.41, t_0 =-1.69.

Total catches and catch numbers at age collected through the DCF were used as input data. No SOP correction was applied to GSA 9 catch numbers at age. Anchovy in GSA9 was caught more than 96% by Purse Seine, only in 2013 was a 1000 tons caught by OTB however, an age structure was supplied for thgis gear and used. For this stock along the whole time series catch numbers and mean weight at age were consistent with total landings.

The following tables lists the input parameters to the XSA model used for assess the Anchovy in GSA9: namely landings, catch number at age, weight at age, maturity at age, natural mortality at age and the tuning series at age.

Catches (ton)									
2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
3724.5	2289.5	1349.8	2503.7	2999.1	4449.3	4912.4	5402.3	3440.2	3957.8

Catch numbers-at-age (thousands):	**Ages**			
	0	**1**	**2**	**3+**

2006	41990.3	201694.2	21890.4	153.5
2007	49078.7	101675.2	17050.9	625.1
2008	4902.0	55638.6	16627.0	326.1
2009	25247.6	140006.1	10122.7	53.2
2010	39780.8	185300.7	3395.5	13.0
2011	89389.7	255630.1	8873.1	26.1
2012	197487.8	240606.9	2564.6	13.0
2013	142214.8	297194.1	5645.6	13.0
2014	102998.6	182968.5	4086.4	13.0
2015	141028.8	209175.4	1827.0	13.0

Weights-at-age (kg)	**Ages**			
	0	**1**	**2**	**3+**
2006	0.008	0.014	0.022	0.030
2007	0.009	0.013	0.022	0.030
2008	0.009	0.015	0.022	0.030
2009	0.009	0.014	0.022	0.030
2010	0.009	0.013	0.021	0.030
2011	0.009	0.013	0.022	0.030
2012	0.008	0.013	0.021	0.030
2013	0.009	0.014	0.021	0.030
2014	0.009	0.013	0.021	0.030
2015	0.008	0.013	0.021	0.030

	Ages			
	0	**1**	**2**	**3+**
Maturity vector	0.5	1	1	1
Natural mortality vector	1.02	0.73	0.60	0.54

	Ages			
MEDITS numbers at age	**0**	**1**	**2**	**3**
2011	614.957	151.662	21.244	8.139
2012	10991.497	615.178	23.874	3.823
2013	7198.352	388.883	26.258	5.781
2014	6380.344	36.200	18.005	2.687
2015	6886.179	889.966	48.921	3.654

	Ages		
MEDIAS numbers at age	**0**	**1**	**2**
2009	2346924	1325179	203126
2010	NA	NA	NA
2011	5470	142513	17995
2012	NA	NA	NA
2013	NA	NA	NA
2014	70263	4264069	157408
2015	1771925	9044264	470958.1

Results

Sensitivity analyses were conducted to assess the effect of the main parameters. Setting rage value=-1, qage=1, shk.years=2 and shk.ages=2, values ranging from 0.5 to 3 (0.5 increasing) have been tested.

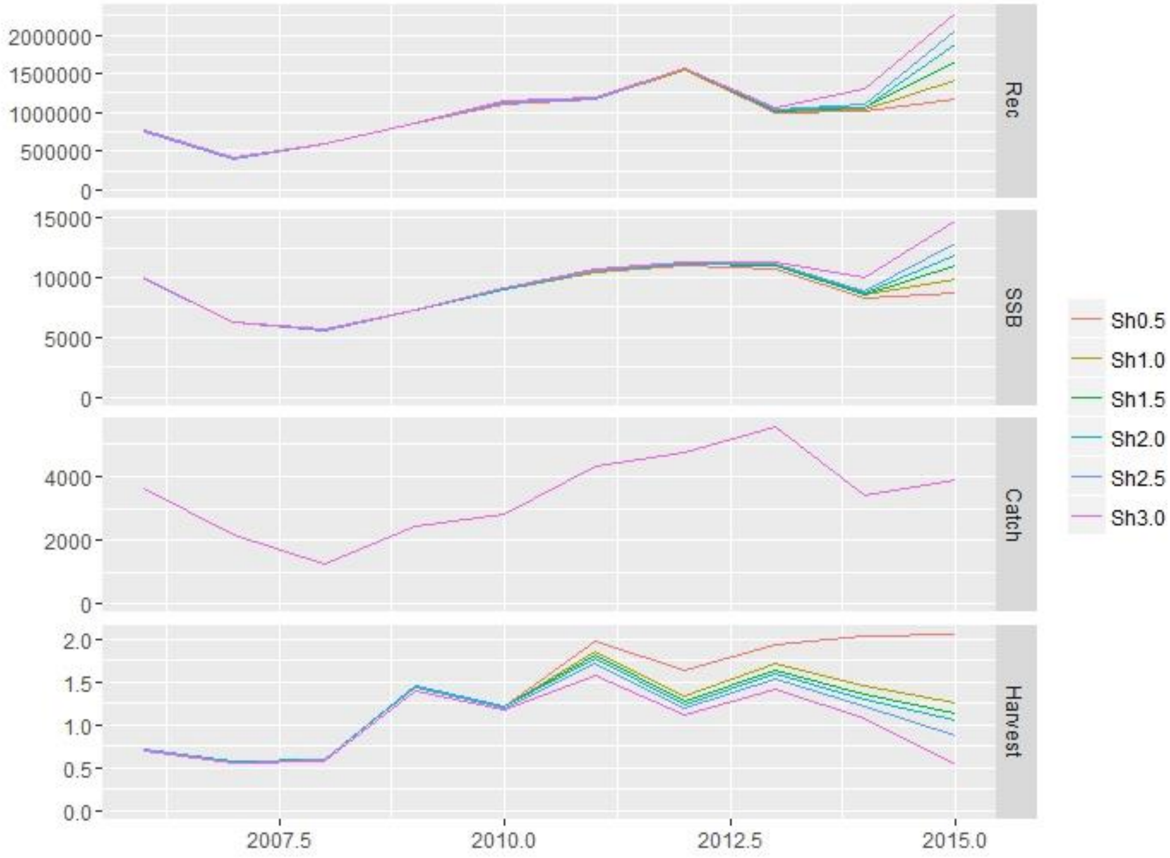


Figure 8.4.1.1. European Anchovy in GSA 9. Sensitivity on shrinkage weight.

In Table 8.4.1.1. the residuals of the models with different shrinkage values are presented.

Table 8.4.1.1. European Anchovy in GSA 9. Minimum, maximum, and average residual values of the XSA models with different shrinkage weight values for the two tuning fleets.

Shrinkage	**Minimum MEDITS**	**Maximum MEDITS**	**Average MEDITS**	**Minimum MEDIAS**	**Maximum MEDIAS**	**Average MEDIAS**
Sh0.5	-2.072	2.156	0.811	-3.680	2.626	1.787
Sh1.0	-2.021	1.387	0.640	-3.624	2.687	1.471
Sh1.5	-2.001	1.332	0.612	-3.577	2.737	1.410
Sh2.0	-2.006	1.243	0.599	-3.542	2.774	1.381

Sh2.5	-1.978	1.025	0.589	-3.509	2.808	1.355
Sh3.0	-1.883	0.988	0.555	-3.434	2.885	1.339

As a result, all the settings minimized the residuals and the mean diagnostics output also in term of retrospective analysis were used for the final assessment:

Fbar	**fse**	**rage**	**qage**	**shk.yrs**	**shk.age**
0-2	1.5	-1	1	2	2

The residuals pattern of the MEDITS trawl survey and MEDIAS acoustic survey is shown in Figure 8.4.1.2.

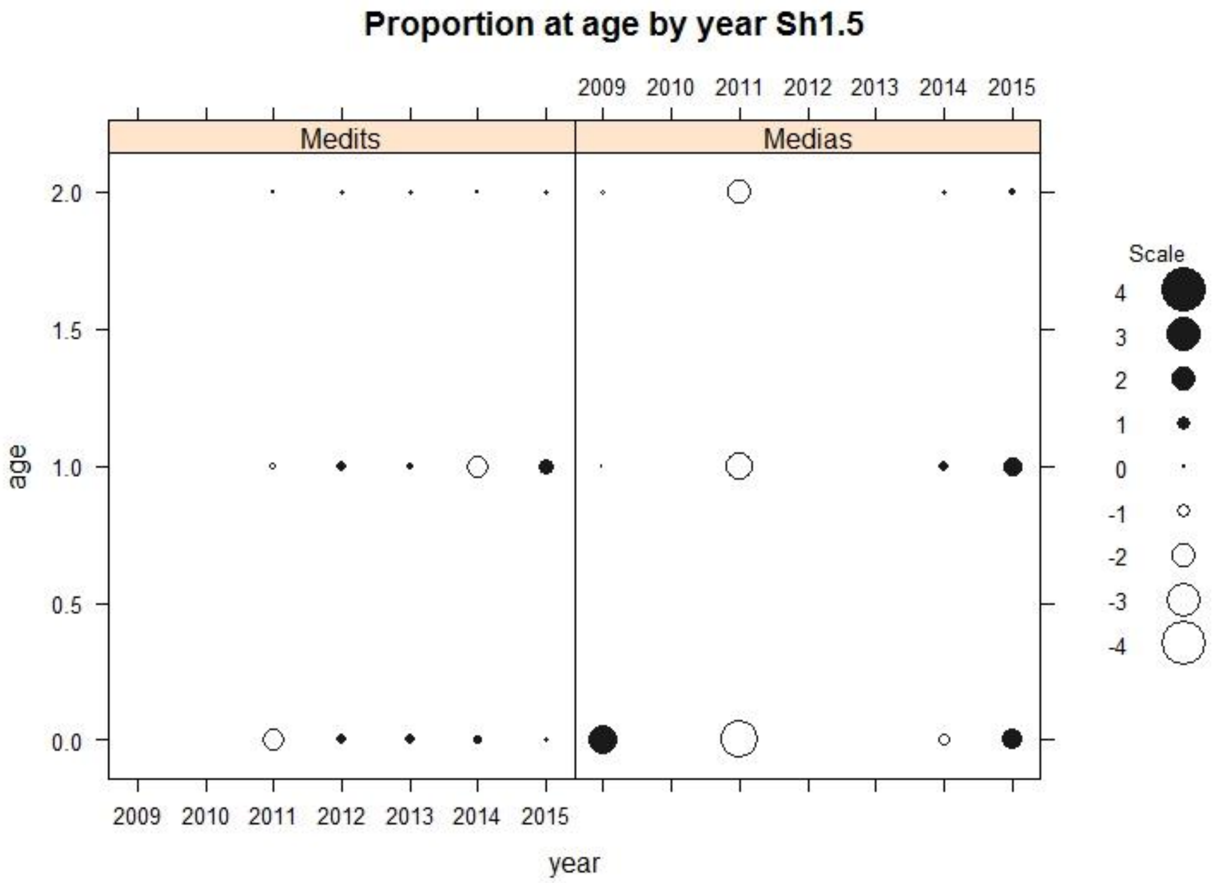


Figure 8.4.1.2. European Anchovy in GSA 9. XSA residuals for the MEDITS (from 2011 to 2015) and MEDIAS surveys (from 2009 to 2015).

The results of the retrospective analysis are shown in Figure 8.4.1.3.

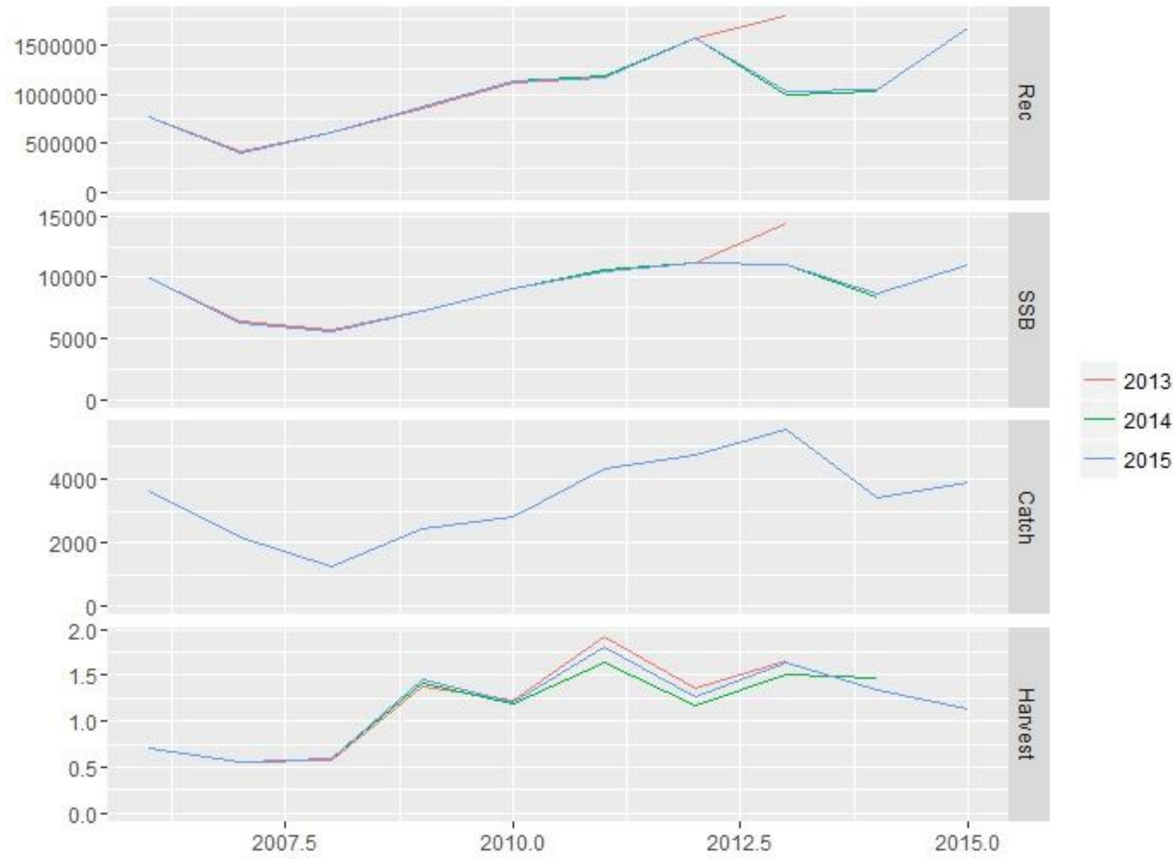


Figure 8.4.1.3. European Anchovy in GSA 9. XSA retrospective analysis.

Fishing mortality retrospective analysis was quite good, while both SSB and recruitment were overestimated in 2013.

The results of the XSA are shown in the following figure and tables.

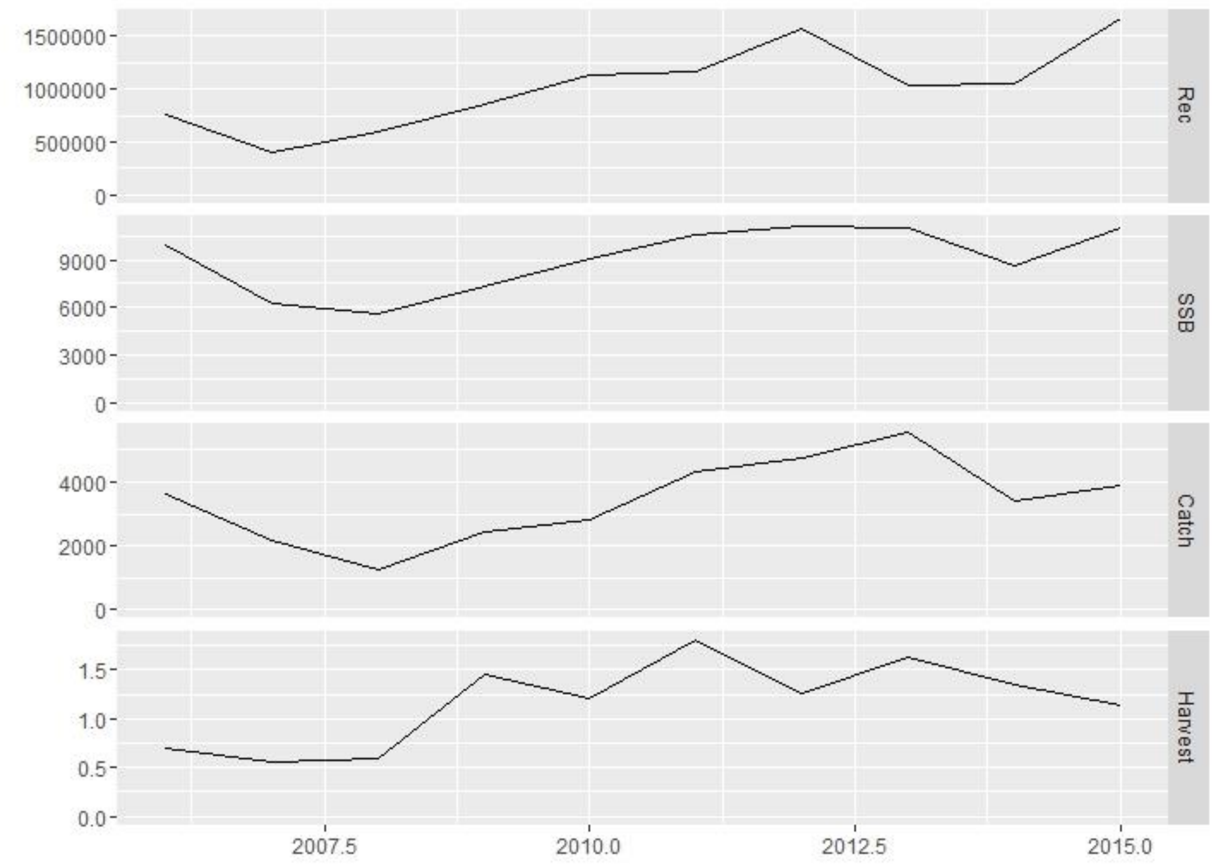


Figure 8.4.1.4. European Anchovy in GSA 9. XSA summary results. SSB and catch are in tons, recruitment in 1000s individuals.

Table 8.4.1.2. European Anchovy in GSA 9. Stock numbers at age (thousands) as estimated by XSA

	Stock numbers at age			
	0	**1**	**2**	**3**
2006	759270	399630	57442	383
2007	404770	248570	52571	1846
2008	604510	116490	49207	923
2009	862260	215040	17511	84
2010	1125900	295770	6437	23

2011	1170200	382100	13897	37
2012	1560300	368310	6682	32
2013	1026700	444040	10462	22
2014	1051400	284820	7674	23
2015	1664900	317290	10239	71

Table 8.4.1.3. European Anchovy in GSA 9. XSA summary results.

	Fbar (0-2)	**Ebar (0-2)**	**Recruitment (thousands)**	**SSB (t)**	**Catch (t)**	**Total Biomass (t)**
2006	0.706	0.474	759269	9907	3724.5	12944
2007	0.564	0.418	404766	6265	2289.5	8086
2008	0.596	0.432	604505	5578	1349.8	8298
2009	1.448	0.649	862260	7278	2503.7	11159
2010	1.211	0.607	1125898	9047	2999.1	14114
2011	1.811	0.698	1170248	10540	4449.3	15806
2012	1.266	0.618	1560274	11170	4912.4	17411
2013	1.631	0.676	1026680	11057	5402.3	15677
2014	1.347	0.632	1051436	8596	3440.2	13327
2015	1.139	0.592	1664877	11001	3957.8	17661

	F at age			
	0	**1**	**2**	**3+**
2006	0.097	1.298	0.722	0.722
2007	0.226	0.890	0.576	0.576
2008	0.014	1.165	0.609	0.609
2009	0.050	2.779	1.516	1.516
2010	0.061	2.328	1.245	1.245
2011	0.136	3.316	1.980	1.980

2012	0.237	2.831	0.730	0.730
2013	0.262	3.328	1.303	1.303
2014	0.178	2.596	1.269	1.269
2015	0.152	2.989	0.276	0.276

The XSA results show an increasing trend in the recruitment and decreasing trend in the last three years in fishing mortality with an estimated F_{curr} of about 1.14.

Conclusions to assessment.

Retrospective analysis although limited indicates a relatively stable model with some sensitivity to the first estimate of recruiting year classes. As age 0 is partially mature this influences SSB in the final year. Such a short assessment and with uncertainty on recruitment results may be expected to fluctuate.

Short term forecasts depend on information on recruitment and F and stability in the assessment. Confidence in this assessment is still low for provision of advice, nevertheless biomass based catch advice related to exploitation rate E (see below) should provide some guidance for catch advice.

Reference points

The mainly exploited ages were from 0 to 2 and for this age range were estimated the corresponding mean F values. These values were used to computed a corresponding value of exploitation rate (E) to compare with exploitation rate reference point (E=0.4) proposed by Patterson (1992) (Fig. 8.4.1.5)

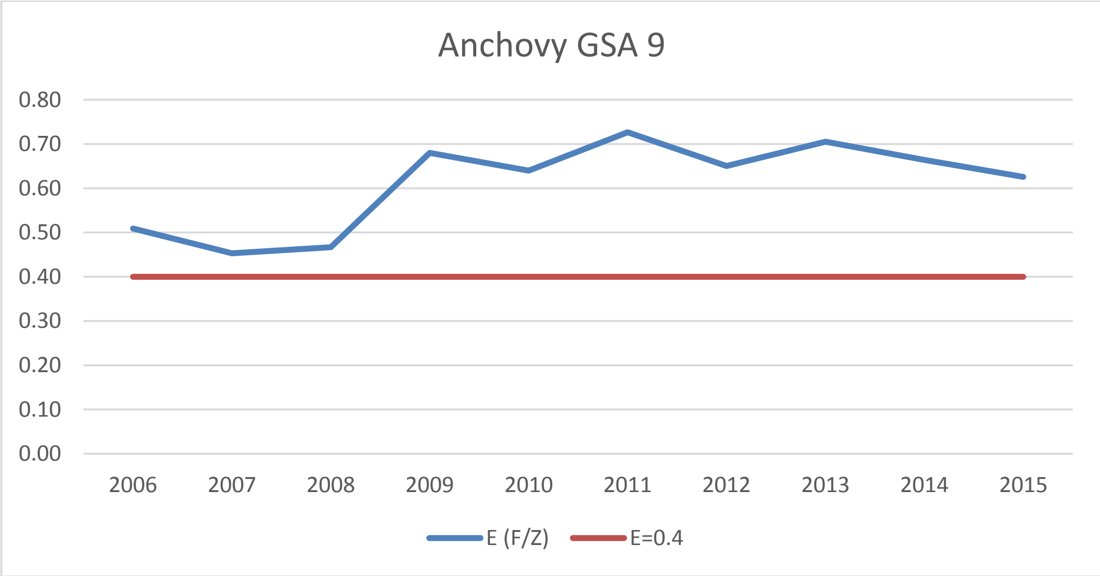


Figure 8.4.1.5. European Anchovy in GSA 9. Trend in the exploitation rate compare to E=0.4.

Short term forecasts

No short term forecasts have been conducted for EWG 16-13 for Anchovy in GSA 9, due to instability in the assessment, mainly due to the very short time series, this makes short term forecasts particularly unreliable. In order to obtain a basis for catch advice recent harvest rates based on SSB and total biomass are compared to the exploitation rate E=F/(F+M). Based on this approach catch advice for E=0.4 (Patterson 1992) can be computed with respect to most recent Total Biomass. Figure 8.4.1.6 shows the relationship between HR and E based on the most recent 8 years. The use of total biomass is preferred over SSB as it includes recruitment and thus more information about the future. The predictions at E=0.4 are only just outside the range of observations and although the relationship is not as strong as for anchovy in GSA 17-18, but the resulting factor is very close to observations at E=0.4 and is likely to be substantially more reliable than the use of the assessment based on trends alone, as this approach does take account of more recent biomass and also utilizes E to set the catch advice. The resulting catch options based on different options for E and SSB in 2015 are given in Table 8.4.1.4, the option for E=0.4 gives a catch of 2740 t.

Table 8.4.1.4 Relationship between HR and E and resulting catch options based on Total Biomass in 2015.

Exploitation rate	Harvest Ratio on total biomass	Catch options based on E
0.0	0.000	0
0.2	0.078	1370
0.4	0.155	**2740**
0.6	0.233	4109
0.8	0.310	5479

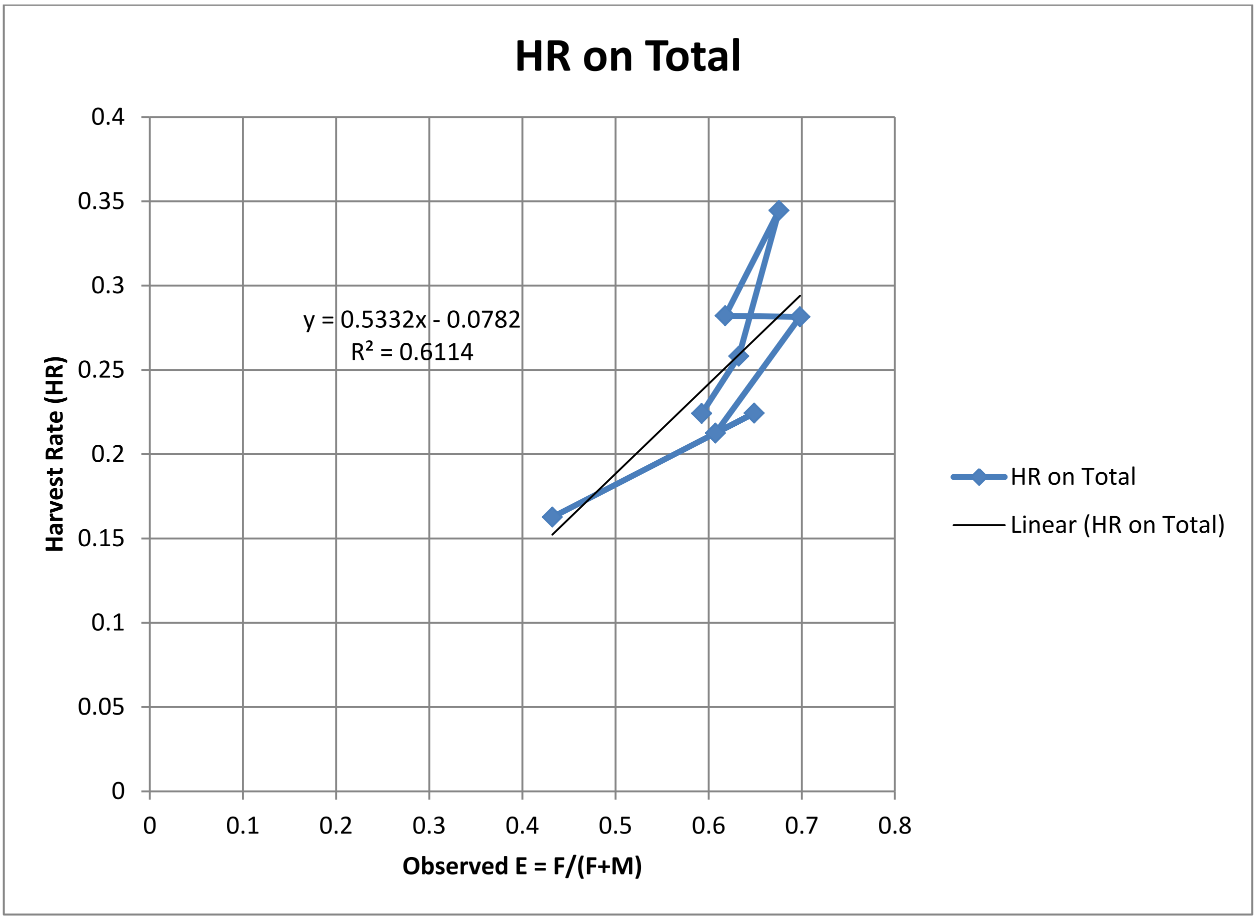


Figure 8.4.3.1. Anchovy in GSA 9**.** Relationship between HR based on SSB and on total biomass based on most recent 6 years of observations. The fit is forced through the origin as the intercept is not significantly different from zero, and conceptually zero HR should be equivalent to zero E. The fit to SSB is very slightly better than the fit to total biomass but the total biomass contains more information on the future. The results at E=0.4 are close to the linear relationship. Neither relationship is strong, see text.

8.4.2 Quality and proposals for future assessments

Data provided from DCF at the EWG 16-13 contained useful information on total landings and catch at age of anchovy in GSA9 for the years 2006-2015. Having also a series of fishery independent information to use as tuning indexes, data available were enough to perform an Extended Survivor Analysis (XSA). Usually for small pelagic species a suitable series of tuning indexes should be obtained through the acoustic surveys. Data provided from DCF at the EWG 16-13 contained abundance data by age estimated by acoustic survey MEDIAS only for 2015.

Anyway in the period 2009–2014, four acoustic surveys were carried out in the Tyrrhenian and Ligurian seas to evaluate biomass and the spatial distribution of anchovy and sardine populations in the summer period.

The four acoustic surveys were carried out in the summer of 2009 and in late spring– early summer during 2011, 2013 and 2014. Because of available time and bad weather conditions, the survey in summer 2013 in the GSA 9 was not carried out. The results of these echo surveys were made available for anchovy in the GSA 9. It would be wise to maintain acoustic campaigns along the lines of those currently made to increase the time series available and permit a better evaluation of the state of exploitation of this resource in the future.

8.5 STOCK ASSESSMENT OF EUROPEAN ANCHOVY IN GSA 10

8.5.1 Stock Trends and reference points

Methods: XSA (Extended Survival Analysis)

DCF data provided to EWG 16-13 included biological parameters, landings, catches and catch at age during 2002-2015. Fishery independent abundance indexes (MEDIAS acoustic surveys) were available for the period 2015. Anyway in the period 2009–2014, four acoustic surveys were carried out in the Tyrrhenian and Ligurian seas to evaluate biomass and the spatial distribution of anchovy and sardine populations in the summer period. The four acoustic surveys were carried out in the summer of 2009 and in late spring– early summer during 2011, 2013 and 2014. The results of these echo surveys were made available for anchovy in the GSA 10. These data series were long enough to perform an Extended Survivor Analysis (XSA). The analyses were made using R software and the FLR libraries with scripts provided by JRC.

Inconsistencies were found between the numbers at age in the landings and in the surveys (see 8.5.2 chapter) driven to unreliable results.

In conclusion until data inconsistencies are resolved stock status cannot be assessed.

8.5.2 Quality and proposals for future assessments

Data on catches at age were extracted from the repository of the Data Collection Framework for anchovy (*Engraulis encrasicolus*) to create data files for subsequent stock assessment modelling. Data ranged from 2002 to 2015. Age structure from landings and from MEDIAS surveys available data (2014 and 2015) were compared in order to evaluate the opportunity to use both datasets with the XSA approach. Results showed a quite scarce degree of consistency in age class proportion between Catch at age data and MEDIAS samples. Namely, the number of age classes were quite higher than in survey data: from survey were observed 3 year classes (0-2) while from Catch at age there were 5 classes in 2014 and 9 classes in 2015 (Figure 8.5.2.1). While differences in catches at young ages might be explained by different selection patterns in survey and fishery, the difference at old ages is not seen in other areas to the same extreme degree. These differences suggest rather different exploitation rates and need to be further explored before conclusions on stock status can be drawn.

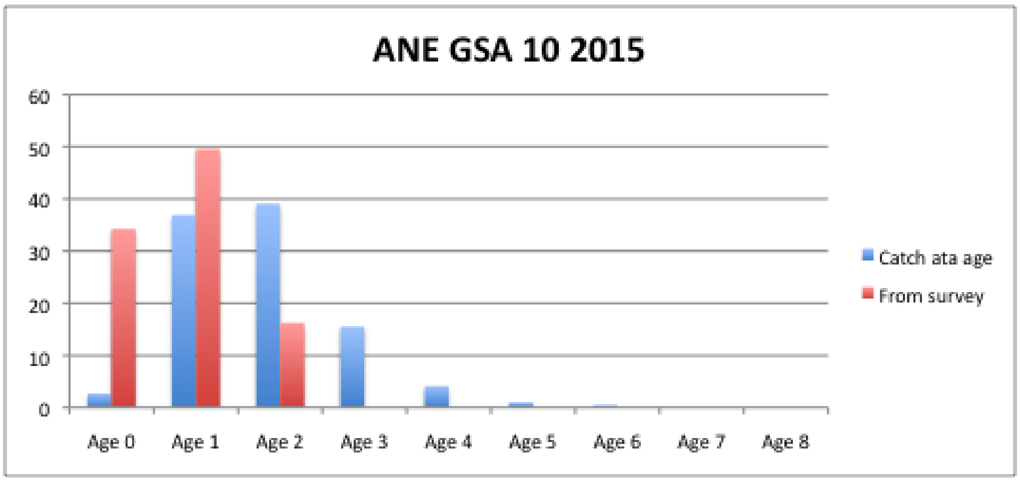


Figure 8.5.2.1. European Anchovy in GSA 10. Consistency in age classes between catch data and survey in 2015

8.6 STOCK ASSESSMENT OF EUROPEAN SARDINE IN GSA 10

8.6.1 Stock Trends and reference points

Methods

DCF data provided to EWG 16-13 included biological parameters, landings, catches and catch at age during 2002-2015. Fishery independent abundance indexes (MEDIAS acoustic surveys) were available for the period 2015. In the period 2009–2014, four acoustic surveys were carried out in the Tyrrhenian and Ligurian seas to evaluate biomass and the spatial distribution of anchovy and sardine populations in the summer period. The results of these echo surveys were made available for sardine in the GSA 10. Since catch at age data reported has observations in too many age classes, in this case ranging from 4 to 21 age classes because this is quite unusual for short living species like sardine, any stock assessment was attempt.

8.6.2 Quality and proposals for future assessments

Data on catches at age were extracted from the repository of the Data Collection Framework of Sardine (Sardina pilchardus) to create data files for subsequent stock assessment modelling. Data ranged from 2002 to 2015.

Catch at age data provided cover too many age classes, ranging from 4 to 21 age classes. This is quite unusual for short living species like sardine. Moreover, age data from the neighbouring GSA 9 are composed by quite lower number of age classes, suggesting that these data have to be revisited.

8.7. STOCK ASSESSMENT OF SARDINE IN GSA 5

8.7.1. Stock Trends and reference points

Not enough data was available to STECF EWG 16-13 to preform neither stock assessment nor length-based analysis for sardine in GSA 5, so only catch per unit of effort trends are presented (Fig 8.7.1.1).

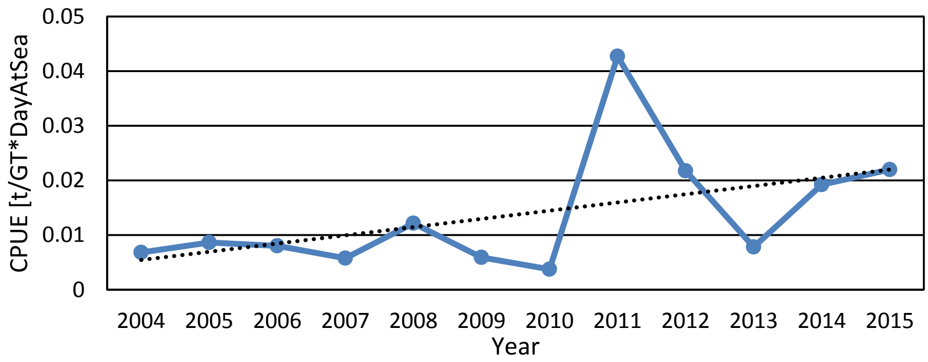


Figure 8.7.1.1 . Sardine in GSA 5.CPUE by year for purse seine fishery with trend line.

8.7.2. Quality and proposals for future assessments

Due to lack of data no assessment could be attempted for sardine in GSA 5. According to the StockMed project the population of sardine in GSA 5 belongs to a stock unit encompassing GSAs 1, 5, 6 and a part of GSA 7. Furthermore, due to low purse seine fishing activity in the area it seems this population is not in an immediate danger of overexploitation. However, considering the overexploited status of sardine in GSAs 1 and 5, its unknown status in GSA 7 and the StockMed results indicating a single stock unit for the whole area, a merged stock assessment for sardine in these GSAs would be advisable in the future.

8.8. STOCK ASSESSMENT OF EUROPEAN ANCHOVY IN GSA 5

8.8.1. Stock Trends and reference points

Not enough data was available to STECF EWG 16-13 to preform neither stock assessment nor length-based analysis for anchovy in GSA 5, so only catch per unit of effort trends are presented (Fig. 8.8.1.1)).

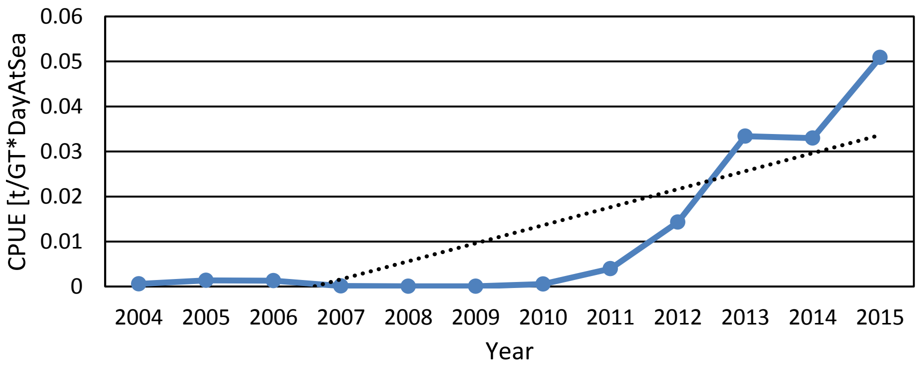


Figure 8.8.1.1. European Anchovy in GSA5. CPUE by year for purse seine fishery with trend line.

Despite the lowering of purse seine fishing activity in the area, the CPUE shows a rising trend for anchovy catch in GSA 5 and this observation is also reflected in the high abundance and biomass MEDITS survey indices in the last year.

8.7.2. Quality and proposals for future assessments

Due to lack of data no assessment could be attempted for anchovy in GSA 5. According to the StockMed project the population of anchovy in GSA 5 belongs to a stock unit encompassing GSAs 1, 5, 6, 7, 9 and even a part of GSA 10 (Figure 6.14.1.2.). Furthermore, due to low purse seine fishing activity in the area, the rising CPUE trend and very high MEDITS indices in 2015 it seems this population is not in an immediate danger of overexploitation.

However, considering the overexploited status of anchovy in GSA 6, its unknown status in GSAs 1, 7 and 9 and the StockMed results indicating a single stock unit for the whole area, a merged stock assessment for anchovy in these GSAs would be advisable as a priority.

9. Length-based analysis

ToR 5: For the stocks given in Annex I-B, the STECF-EWG 16-13 is requested to assess trends in catch length composition, survey indices and catch-per-unit effort, depending on the data availability. In addition, provide size-based indicators (*e.g.* proportion of mature fish in the catch) to be used as reference points of the population status.

9.1 Length-based analysis of Sardine in GSA 11

There was no data on catch length composition available in the DCF data base for sardine in GSA 11, so neither trend in catch length composition nor size-based indicators could be provided for this stock. In addition, there was no acoustic data available, so only a short time series of MEDITS indices and the relevant trends were presented (Figure 18, Figure 19, and Figure 20). Furthermore, data on landings and discards were only available for years 2011 and 2012 for OTB. Since sardine is a by-catch species for this fishery, calculating CPUE based on the effort from OTB was not considered suitable for indicating trends of sardine stock status.

Based on the StockMed results on sardine stock unit encompassing GSAs 8 - 11, 15, 16, majority of GSA 19 and a part of GSA 7, given the considerable lack of data in this area and considering the high vulnerability of small pelagic species, data collection effort should be considered to make at least Level 4 assessment possible in the future. On the other hand, if available data from GSA 11 are reliable, it can be concluded that catch and landings of sardine are negligible and stock assessment is not needed for this stock.

9.2 Length-based analysis of Anchovy in GSA 11

Only MEDITS data was available for anchovy in GSA 11, so a short time series of MEDITS indices and the relevant trends were presented (Figure 6.16.4.1 European Anchovy in GSA 11. , Figure 6.16.4.2. European Anchovy in GSA 11. MEDITS biomass index by year.

, Figure 6.16.4.3. European Anchovy in GSA 11), however, they should not be considered indicative of stock status.

Based on the StockMed results on sardine stock unit encompassing GSAs 11 and a part of GSA 9, given the considerable lack of data in this area and considering the high vulnerability of small pelagic species, data collection effort should be considered to make at least Level 4 assessment possible in the future. On the other hand, if available data from GSA 11 are reliable, it can be concluded that catch and landings of anchovy are negligible and stock assessment is not needed for this stock.

9.3 Length-based analysis of *Scomber* spp. in GSAs 1, 5, 6, 7

No length-based analysis was carried out for *Scomber* spp. in GSAs 1, 5, 6 and 7 due to the unknown relative contribution of *S. scombrus* and *S. japonicus* in the total catch, and the lack of consistent landings data from all GSAs and gears. CPUE trends from PS catches were examined, indicating an overall decreasing trend in 2004-2015 (Fig. 9.3.1) which could be indicative of some degree of overexploitation. Also, the fact that the landings are dominated by fish aged 0-1 y (Fig. 6.17.2.5), which are juveniles, indicates the possible occurrence of growth overfishing.

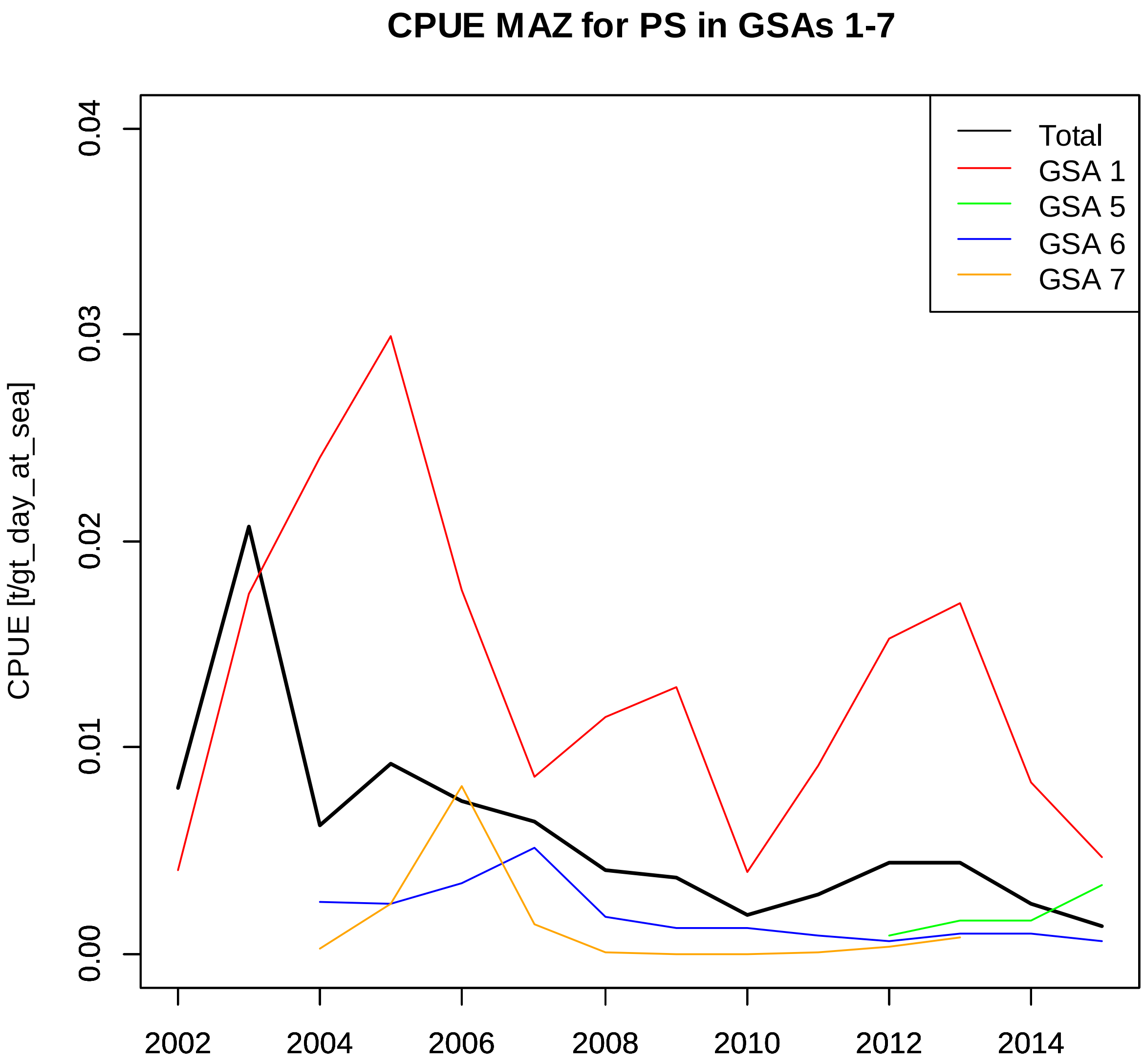


Figure 9.3.1. Scomber spp. in GSAs 1,5,6,7. CPUE trends of *Scomber* spp. caught by purse seines (PS) in GSAs 1, 5, 6 and 7 in 2002-2015. Effort data for 2002-2003 were available only from GSA 1.

9.4 Length-based analysis of *Scomber* spp. in GSAs 9, 10,11

No length-based analysis was carried out for *Scomber* spp. in GSAs 9-11 due to the unknown relative contribution of *S. scombrus* and *S. japonicus* in the total catch, and the lack of consistent landings data from all GSAs and gears. *Scomber* spp. CPUE of PS in GSA 10 in 2009-2015 exhibited a peak in 2009 followed by lower values in the following years (Fig. 9.4.1). This trend was not in line with the MEDITS-derived biomass trend which exhibited high values in 2013 and 2014 (Fig. 9.4.1).

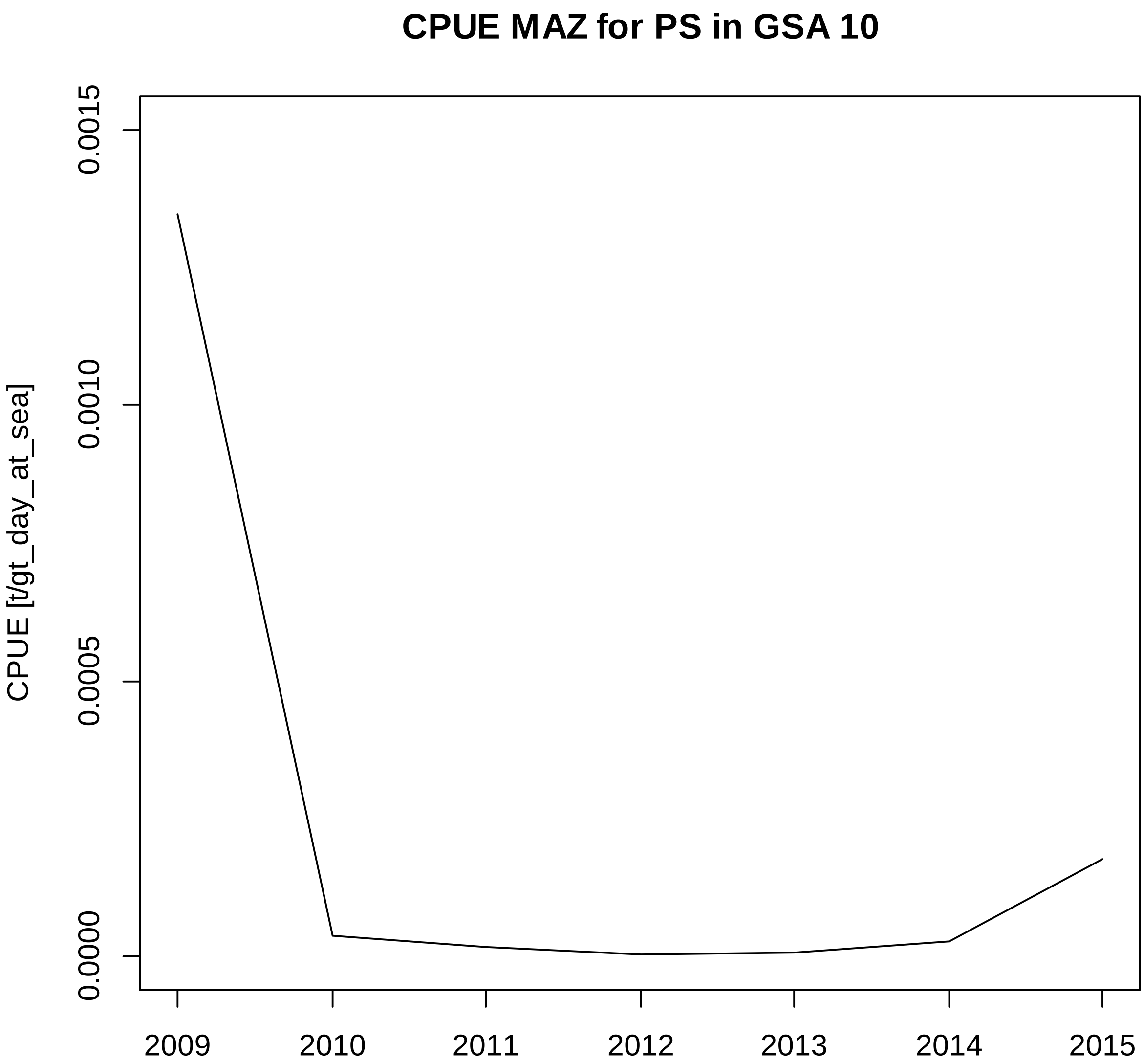


Figure 9.4.1. Scomber spp. in GSAs 9,10,11. CPUE trends of *Scomber* spp. caught by purse seines (PS) in GSA 10 in 2009-2015.

9.5 Length-based analysis of *Scomber* spp. in GSAs 17,18,19,20

No length-based analysis was carried out for *Scomber* spp. in GSAs 17-20 due to the unknown relative contribution of *S. scombrus* and *S. japonicus* in the total catch, and the lack of consistent landings data from all GSAs and gears. CPUE trends were examined in GSAs 18-19, where there were consistent catch and effort data available. The CPUE of *Scomber* spp. in Italian OTBs exhibited a somewhat decreasing trend in 2006-2015 in GSA 18, but no trend was observed in GSA 19 (Fig. 9.5.1). There was no particular agreement between the CPUEs and the MEDITS-derived indices. Based on the data available there can be no assessment of the exploitation status of *Scomber* spp. in GSAs 17-20.

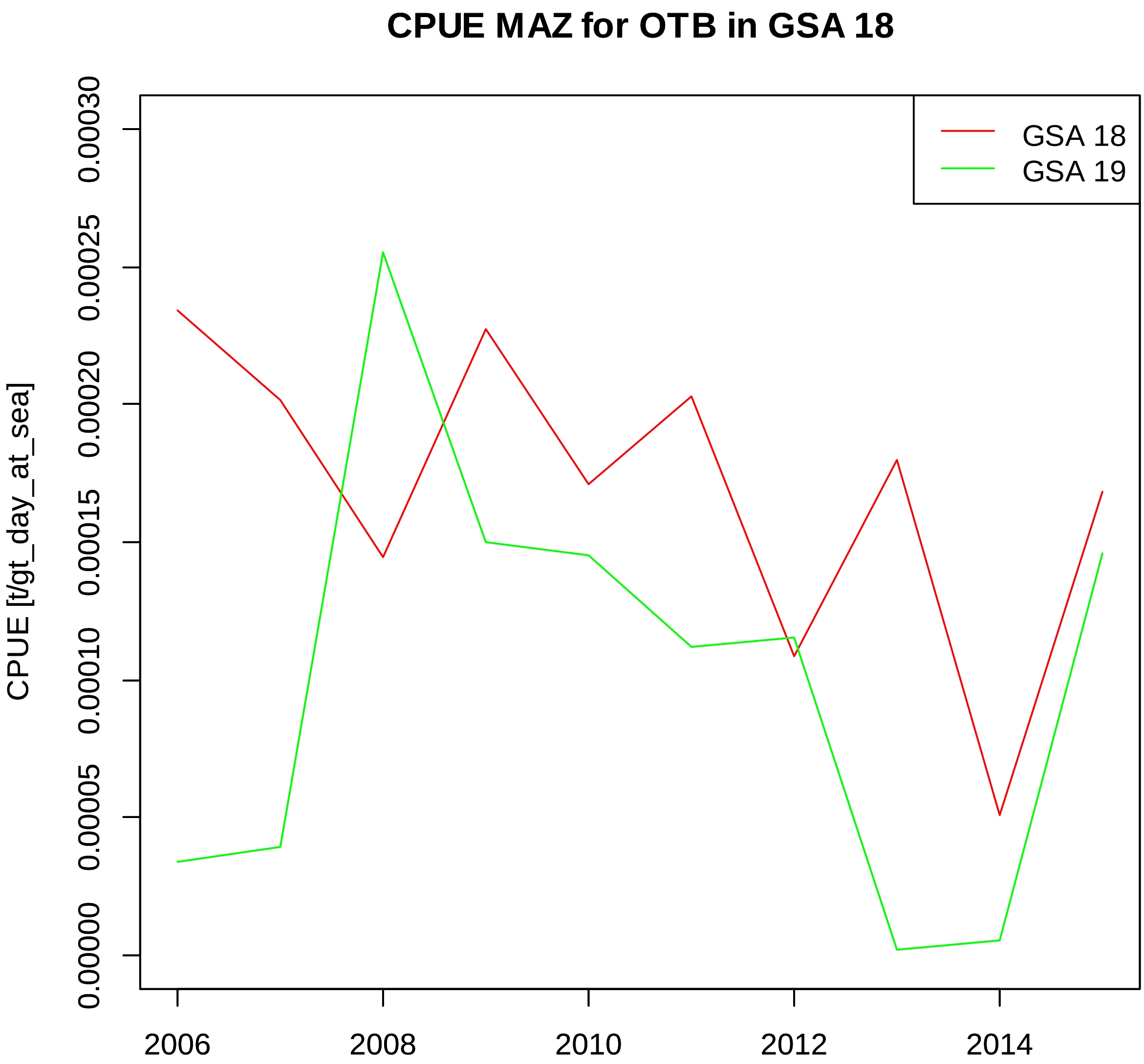


Figure 9.5.1. Scomber spp. in GSAs 17,18,19,20. CPUE trends of *Scomber* spp. caught by Italian bottom otter trawls (OTB) in GSAs 18 and 19 in 2006-2015.

10. Data quality check

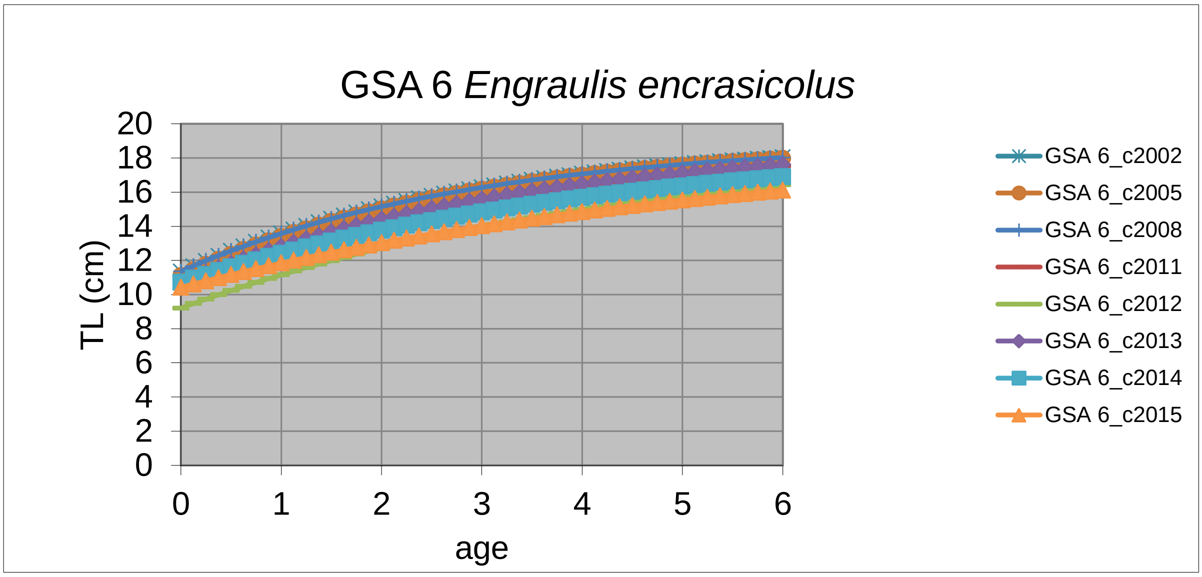
ToR 6: Summarize and concisely describe all data quality deficiencies, including possible limitations with the surveys of relevance for stock assessments and fisheries. Such review and description are to be based on the data format of the official DCF data call for the Mediterranean Sea launched on the 28 April 2016. Identify further research studies and data collections which would be required for improved fish stock assessments.

10.1 Data quality check of European Anchovy in GSA 6

Growth parameters estimation should be revised. Over the period 2002-2015 L_{inf} was set to 19 cm TL (the largest sampled size), k gradually decreased and t_0 became more and more negative. Sizes at age 0 appear to be too large. It should be taken into account that the recruitment size to the gear is 10 cm TL, that is, only the oldest age 0 individuals are being fished. This is important because, according to the DCF an important fraction of age 0 individuals would be mature, when in fact, could be age 0 individuals that will shift to age 1 during the spawning season in summer.

If available, the monthly size distributions would allow knowing the time of the year when 10 cm TL individuals are caught, which might useful information for the analysis of anchovy growth.

	2002	2005	2008	2011	2012	2013	2014	2015
L_INF	19	19	19	19	19	19	19	19
K	0,3454	0,3413	0,3443	0,2947	0,2223	0,2985	0,2293	0,1818
T0	-2,6283	-2,5763	-2,6428	-2,7028	-2,9799	-2,7562	-3,6214	-4,3751



10.2 Data quality check of Sardine in GSA 6

EWG 16-13 has conducted assessment of sardine in GSA 6, with catch at age data provided by DCF and XSA analytical model. Due to instability of F vector on the last three years, it cannot be done short term predictions and propose and MSY value. It could be useful revise length-age keys used in GSA 6 for sardine to construct catch at age matrix in DCF. It seems unlike that age class 0 begins in 10 cm. On the next assessment experts could use another methodology like production models to explore more reliable results and advice

10.3 Data quality check of European Anchovy in GSA 7

Data from DCF 2015 as submitted through the Official data call in 2016 were used. There were a numbers of data deficiencies and errors in the data submitted through DCF. Detailed information can be found in section 6.3.The most critical issues appear to be the missing age structure data in 2004 in both landings and survey data.

10.4 Data quality check of Sardine in GSA 7

Concerning sardine in GSA 07, some errors and deficiencies have been detected in the DCF official database coming from the Data Call performed in 2016.

The lack of some important data did not allow carrying out the assessment. In particular, no length structure data of French pelagic trawling (OTM_SPF) are available for 2011, taking into account that this metier represents more than 90% of the landing of the species in that year.

Length structure data of Spanish bottom otter trawl (OTB_DES) are missing for many years; however, this metier gives a low contribution to the total landing of sardine in GSA 07.

Length structure data of Spanish purse seine (PS_SPF) are missing. This metier represents from 0.8 to 10.9% of the total landing of sardine according to the different years.

Age structure data are not available for French pelagic trawling (OTM_SPF) in the years 2004, 2005 and 2011.

Age structure data are missing for the Spanish fleets fishing sardine in GSA 07 (PS_SPF and OTB_DES).

Biomass index form PELMED acoustic survey is not available for the period 2002-2005. This means that stock assessment applying PELMED data as tuning can be performed starting from 2006.

Fishing effort data for the French fleets fishing for sardine in GSA 07 are available only for 2015.

The size structure data of the landing of French purse seine (PS_SPF) in 2013 shows a factor of thousand times higher than the other years. Probably the data are in kgs and not in tons.

Length structure data of discard include specimens larger than 70 cm TL for French pelagic trawling (OTM_SPF) in 2007 and 2008 and for French bottom otter trawling (OTB_DES) in 2007.

10.5 Data quality check of Atlantic Horse Mackerel in Region1,2 and 3

The quality of species separation in fisheries (between *T. trachurus* and *T. mediterraneus*) has been questioned, but no problems are evident in the available data, as a separation between the two is clearly assumed. The quality of landings data is therefore assumed to be sufficient for the most important gear targeting horse mackerel. If issues do exist, it is possible that they produce a different impact in the landings and discard data, possibly more impacting in the latter. We did not attempt to assess the *T. mediterraneus* stock.

Effort reporting seems to be improving in general in most recent years, with an increase in the number of gear for which days at sea are recorded and transmitted. For those gear for which longer time-series are available, effort is generally unchanged in the most recent years, and in many cases nominally decreased from the previous decade.

It is important to note that although small horse mackerel catches tend to occur with a number of different gears, significant volumes of landings and discards are concentrated in a more restricted group of gears, namely bottom trawling, purse-seining and gillnetting.

Days at sea may not always truly reflect effort in terms of fishing capacity. For the horse mackerel fishery, the most important gear are trawls (OTB), purse-seines and set gill nets (GNS) which are sufficiently different in terms of effort deployment that days at sea may not reflect effort similarly for all.

It would therefore be desirable that specific measures of effort are reported for each fishery, such that better measures of LPUE are available.

As data are presently reported, landings show a moderate decrease after a peak in the middle of the time-series, in the early to mid-2000s.

The frequency of assessment at the moment is perhaps difficult to judge, as this is the first time that an assessment is conducted for horse-mackerel in the Mediterranean. It would be useful to have a group of people who are familiar with the fishery that could strive to check data availability and quality prior to assessments.

10.6 Data quality check of European Anchovy in GSA 9

Data on catches at age were extracted from the repository of the *Data Collection Framework* for anchovy (*Engraulis encrasicolus*) to create *ad hoc* data files for subsequent stock assessment modelling. Data ranged from 2006 to 2015. Age structure from landings and from MEDIAS survey data available (2014 and 2015) were compared in order to evaluate the opportunity to use both datasets with the XSA approach. Results showed a high degree of consistency in age class proportion between landings and MEDIAS samples (Figures 2 and 3). Only age O Class in 2014 from survey was different mainly because of the sampling duration and timing of the MEDIAS survey.

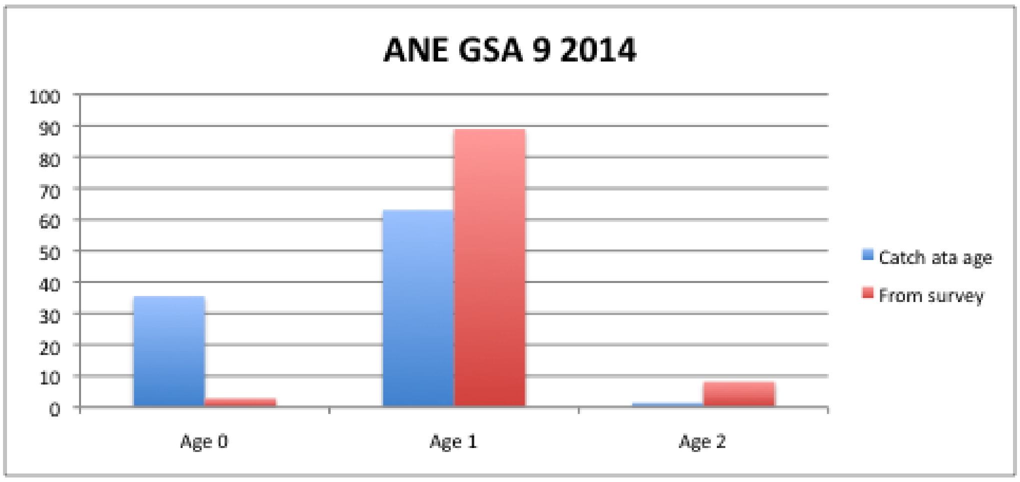


Figure 10.6.1 European Anchovy in GSA 9. Consistency in age classes between catch data and survey 2014

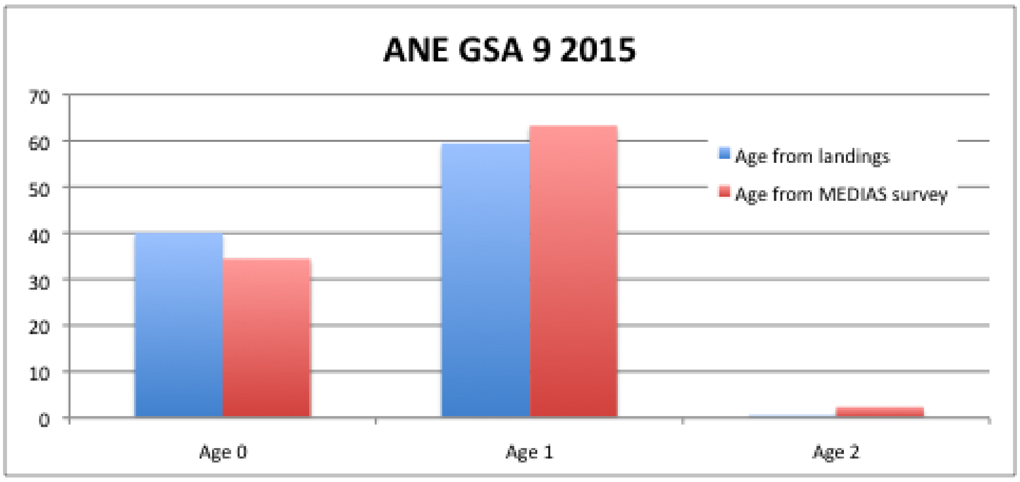


Figure 10.6.2 European Anchovy in GSA 9. Consistency in age classes between catch data and survey 2015

10.7 Data quality check of European Anchovy in GSA 10

Data on catches at age were extracted from the repository of the *Data Collection Framework* for anchovy (*Engraulis encrasicolus*) to create data files for subsequent stock assessment modelling. Data ranged from 2002 to 2015. Furthermore, age structure from landings and from MEDIAS surveys available data (2014 and 2015) were compared in order to evaluate the opportunity to use both datasets with the XSA approach. Results showed a quite scarce degree of consistency in age class proportion between Catch at age data and MEDIAS samples (Figure 4). Namely, the numbers of age classes were more numerous than in survey data: from survey were observed 3 year classes (0-2) while from Catch at age there were 5 classes in 2014 and 9 classes in 2015.

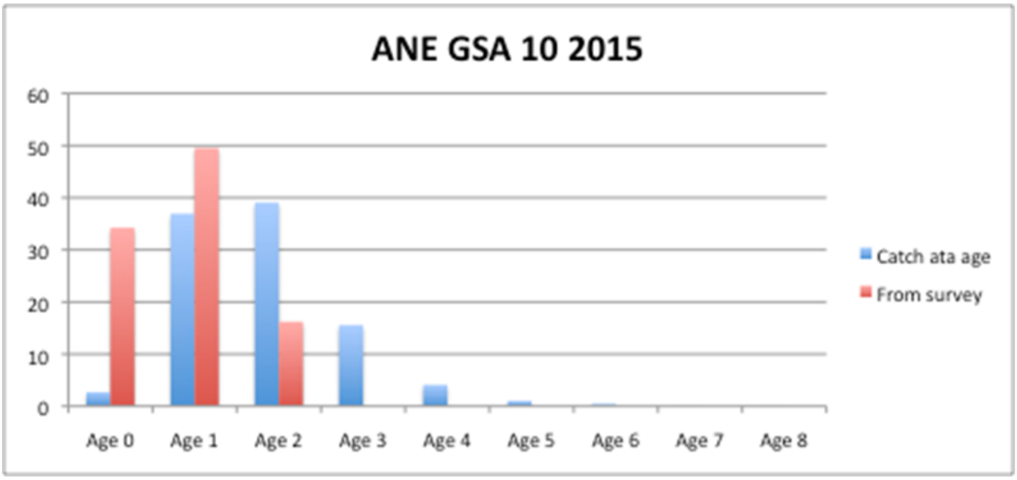


Figure 10.7.1 European Anchovy in GSA 10. Consistency in age classes between catch data and survey 2015

10.8 Data quality check of Sardine in GSA 10

Data on catches at age were extracted from the repository of the Data Collection Framework of Sardine (Sardina pilchardus) to create data files for subsequent stock assessment modelling. Data ranged from 2002 to 2015. Catch at age data covered too many age classes were in the dataset, ranging from 4 to 21 age classes. This is quite unusual for short living species like sardine. Moreover, age data from the neighbouring GSA 9 are composed by quite lower number of age classes, suggesting that these data have to be revisited.

10.9 Data quality check of Sardine in GSA 5

Based on the StockMed results establishing that a single sardine stock unit in the NW Mediterranean encompasses populations in GSAs 1, 5, 6 and a part of GSA 7, it would be advisable to put more effort in collecting reliable fisheries data, at least length frequencies, as well as to extend the already existing acoustic surveys to cover the whole area in question. In the long run this would enable a joint stock assessment for sardine and a better small pelagic fisheries management in the NW Mediterranean.

10.10 Data quality check of European Anchovy in GSA 5

Based on the fairly reliable StockMed results establishing that anchovy in GSAs 1, 5, 6, 7 and 9 compose a single stock unit it would be advisable to put more effort in collecting reliable fisheries data, at least length frequencies, as well as to extend the already existing acoustic surveys to cover the whole area in question. In the long run this would enable a joint stock assessment for anchovy and a better small pelagic fisheries management in the NW Mediterranean10.11 Data quality check of Sardine in GSA 11

There was no data on catch length composition available in the DCF data base for sardine in GSA 11, so neither trend in catch length composition nor size-based indicators could be provided for this stock. In addition, there was no acoustic data available, so only a short time series of MEDITS indices and the relevant trends were presented (**Error! Reference source not found.**, Figure 6.15.4.2. Sardine in GSA 11. MEDITS biomass index by year.

, Fig. 6.15.4.3 **Sardine in GSA 11.**). Furthermore, data on landings and discards were only available for years 2011 and 2012 for OTB. Since sardine is a by-catch species for this fishery, calculating CPUE based on the effort from OTB was not considered suitable for indicating trends of sardine stock status.

Based on the StockMed results on sardine stock unit encompassing GSAs 8 - 11, 15, 16, majority of GSA 19 and a part of GSA 7, given the considerable lack of data in this area and considering the high vulnerability of small pelagic species, data collection effort should be considered to make at least Level 4 assessment possible in the future.

10.11 Data quality check of Sardine in GSA 11

There was no data on catch length composition available in the DCF data base for sardine in GSA 11, so neither trend in catch length composition nor size-based indicators could be provided for this stock. In addition, there was no acoustic data available, so only a short time series of MEDITS indices and the relevant trends were presented (Figure 18, Figure 19, and Figure 20). Furthermore, data on landings and discards were only available for years 2011 and 2012 for OTB. Since sardine is a by-catch species for this fishery, calculating CPUE based on the effort from OTB was not considered suitable for indicating trends of sardine stock status.
Based on the StockMed results on sardine stock unit encompassing GSAs 8 - 11, 15, 16, majority of GSA 19 and a part of GSA 7, given the considerable lack of data in this area and considering the high vulnerability of small pelagic species, data collection effort should be considered to make

at least Level 4 assessment possible in the future. On the other hand, if available data from GSA 11 are reliable, it can be concluded that catch and landings of sardine are negligible and stock assessment is not needed for this stock.

10.12 Data quality check of European Anchovy in GSA 11

Only MEDITS data was available for anchovy in GSA 11, so a short time series of MEDITS indices and the relevant trends were presented (Figure 6.16.4.1 European Anchovy in GSA 11. , Figure 6.16.4.2. European Anchovy in GSA 11. MEDITS biomass index by year.

, Figure 6.16.4.3. European Anchovy in GSA 11), however, they should not be considered indicative of stock status.

Based on the StockMed results on sardine stock unit encompassing GSAs 11 and a part of GSA 9, given the considerable lack of data in this area and considering the high vulnerability of small pelagic species, data collection effort should be considered to make at least Level 4 assessment possible in the future.

10.13 Data quality check of mackerel in GSAs 1-20

The majority of mackerel data in the DCF referred to *Scomber* spp., with the relative contribution of *S. scombrus* and *S. japonicus* being unknown. This makes species-specific stock assessments and length-based analysis unfeasible. Also, examination of the population genetic structure of *Scomber* spp. has indicated that while Mediterranean *S. japonicus* populations are organised into a single panmictic unit, Mediterranean *S. scombrus* populations are divided into a western and an eastern unit (Zardoya et al., 2004). This implies that species-specific stock assessments should probably be carried out at different scales for these two species.

Catch-at-length and catch-at-age data for Mediterranean mackerels are sporadic, covering a limited number of areas and gears. GSAs 1 and 6 exhibited a somewhat better data availability and quality compared to the other GSAs, albeit data were given at the *Scomber* spp. level. GSAs 9, 11 and 20 exhibited the greatest data deficiencies; total *Scomber* spp. catches in these areas were unknown or available only for 1-3 non-consecutive years. Biological data were also scarce, with growth parameters being available only from GSA 6 and maturity ogives based on substantial samples being available only from GSAs 6 and 17.

In these GSAs where CPUE trends could be estimated, little agreement was found with the respective trends of MEDITS biomass indices. This indicates that MEDITS data quality for *Scomber* spp. is probably low; therefore, enhanced surveys would be needed to provide more objective fisheries independent data.

11 General Data submission Issues

The data call was issued in April 2016. The 'legal' deadline for submissions was the 2nd of July 2015. Upon communication with the member states some data tables were corrected and re-uploaded in relation to the 'operational' deadline of the 17th August 2015.

Data was uploaded by each country according to the following table:

Table 8.1.1. Timeline of data upload from Mediterranean Member States, data call '**legal' deadline of the 2h of July 2015; 'operational' deadline 17 August 2015**.

COUNTRY	First Upload	Last Upload
ITA	29 June 2015	12 August 2015
ESP	01 July 2015	05 August 2015
FRA	19 June 2015	02 July 2015
SVN	05 June 2015	23 July 2015
MLT	02 July 2015	02 July 2015
CYP	01 July 2015	06 August 2015
GRC	02 July 2015	31 Aug 2015
HRV	27 June 2015	31 July 2015*

*: *additional submissions on 4 Sep 2015 upon a request by the EWG*

The overall 2015 Data Call performance of data coverage, timeliness and progress of submissions by member state and main table/variable will be made available by the end of the year and after the completion of the EWG 15-16 Mediterranean stock assessments part 2, on the dedicated weblink: http://datacollection.jrc.ec.europa.eu/coverage

MEDITS Specific data problems

It should be noted that the MEDITS data that were made available to STECF 15-11 contained some obvious errors regarding the majority of hauls coordinates in GSA 6 in years 2010 and 2013 and the entire years can't be used in the context of any spatial analysis. The error clearly is related with the incorrect specification of the Hauling Quadrant and should be fixed.

12 Stock Specific Data Issues

Section 8.21..	GSA 6	Anchovy
Section 8.22..	GSA 6	Sardine
Section 8.23..	GSA 7	Anchovy
Section 8.24..	GSA 7	Sardine
Section 8.25..	GSAs 17-18	Anchovy
Section 8.28.2.	GSAs 17-18	Sardine
Section 8.27..	GSA 1-5-6-7	Atlantic horse mackerel
Section 8.28..	GSA 9-10-11	Atlantic horse mackerel
Section 8.29..	GSA 17-18-19-20	Atlantic horse mackerel
Section 8.210..	GSA 9	Anchovy
Section 8.211..	GSA 10	Anchovy
Section 8.212..	GSA 10	Sardine
Section 8.213..	GSA 5	Sardine
Section 8.214..	GSA 5	Anchovy
Section 8.215..	GSA 11	Sardine
Section 8.218.2.	GSA 11	Anchovy
Section 8.217..	GSA 1-5-6-7	Atlantic mackerel
Section 8.218..	GSA 9-10-11	Atlantic mackerel
Section 8.219..	GSA 17-18-19-20	Atlantic mackerel

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14 CONTACT DETAILS OF EWG-16-13 Participants

[1] - Information on EWG participant's affiliations is displayed for information only. In any case, Members of the STECF, invited experts, and JRC experts shall act independently. In the context of the STECF work, the committee members and other experts do not represent the

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15 List of Background Documents

Background documents are published on the meeting's web site on: http://stecf.jrc.ec.europa.eu/web/stecf/ewg1613

List of background documents:

1. EWG-16-13 – ToRs_STECF_EWG16-13.pdf
2. AGENDA EWG 16-13.docx
3. 2015-12_Template for the data transmission feedback.xlsx
4. EWG-16-13 – Declarations of invited and JRC experts (see also section 14 of this report – List of participants)

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