Benchmark process for ane.27.9a stock (Anchovy in Division 9a). Short- and mid-term goals pursued in the assessment of the stock.

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SHORT-TERM GOALS (IN THE BENCHMARK WK).

The following WDs will be presented to the Benchmark assessment WK:

- A WD summarizing all the available information regarding the anchovy stock ID in the Division 9a (hereinafter referred to as *WD Stock ID*).
- A WD describing all of the progresses achieved in those remaining benchmark issues not related with the stock assessment (i.e. fishery data, surveys, biological parameters, etc.) and the results from the different approaches followed for the assessment of the Western stock component (subdivisions 9a North, 9a Central-North and 9a Central-South, see below and Figure 1; hereinafter referred to as *WD Western Assessment*).
- A WD describing all of the progresses achieved in those remaining benchmark issues not related with the Southern stock component assessment (i.e. fishery data, surveys, biological parameters; hereinafter referred to as *WD Southern Data*).
- A WD describing the results from a Gadget model developed for the Southern stock component (subdivision 9a South, see below and Figure 1; hereinafter referred to as *WD Southern Assessment*).

ISSUE: STOCK IDENTITY:

- The *WD Stock ID* will summarize all the available information regarding the stock ID, particularly new information available since the comprehensive review on sub-stock structure of European anchovy in the Bay of Biscay and Iberian-Atlantic waters provided by Ramos (2015) to the ICES Stock Identification Methods Working Group (SIMWG) 2015.
- At that time, the ICES SIMWG (ICES, 2015a) considered that there was evidence to support a resident population of anchovy located in the Gulf of Cadiz (ICES Subdivision 9a South), but there as a lack of information regarding the origin of European anchovy in ICES Subdivisions 9a North, 9a Central-North and 9a Central-South (Figure 1).
- New evidences based on the distribution of anchovy in the western Iberian coast, including the early life stages (eggs and larvae) will be presented in that WD, showing the absence of this species in most of the Sub-division 9a Central-South, both in years

of high and low abundance, and a probable disconnection between the western and southern anchovy populations.

- According to this updated information, ICES WGHANSA considers that providing one management advice for the anchovy in the whole of Division 9a may be inadequate, since survey results and the fishery demonstrate independent dynamics of the anchovy in the north-western part of Division 9a from the dynamics of the population in Sub-division 9a South. For this reason, the short, medium and long term plans described in this document are constructed separately for the southern (subdivision 9a South) and western (subdivisions 9a North, 9a Central-North and 9a Central-South) stock units.

- The proposal put forward is that of considering the anchovy populations inhabiting the southern and western Iberian-Atlantic regions <u>as separate stock units</u> for management purposes.
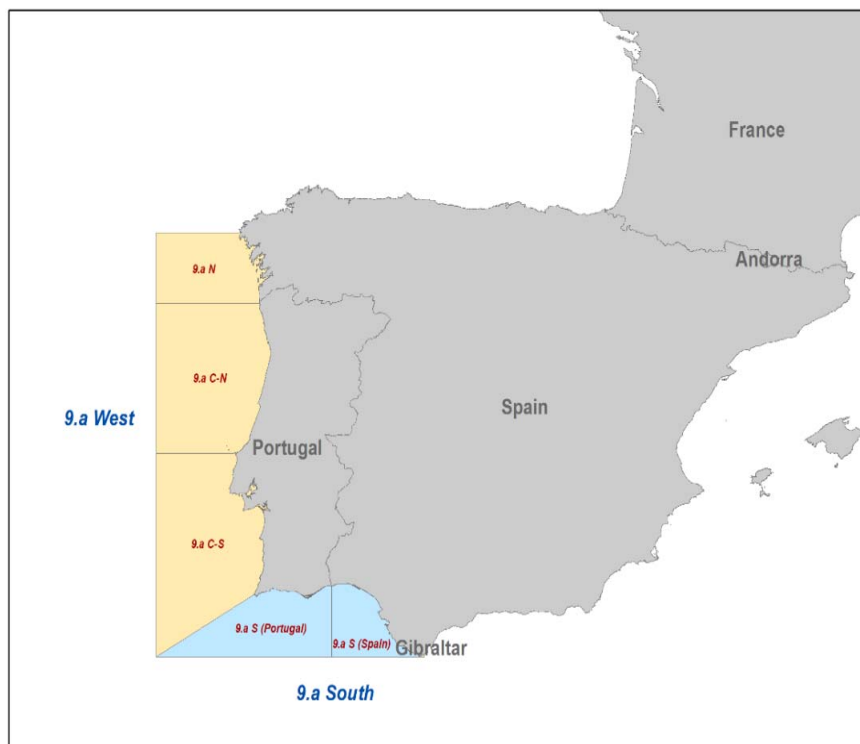
Figure 1. Anchovy in Division 9.a**.** The map shows the split of Division 9.a into the stock units 9.a South and 9.a West. Note that, in turn, the stock unit 9.a South is divided into Portuguese and Spanish waters, whereas stock unit 9.a West is divided into the sub-divisions 9.a North, 9.a Central–North, and 9.a Central–South.

SOUTHERN STOCK UNIT

ISSUE: ASSESSMENT METHOD.

- A Gadget model has been developed for the Southern stock unit (subdivision 9a South). Model settings, data inputs and estimated parameters from the model will be described in the *WD Southern Assessment*. Sensitivity to different assumptions will be tested in terms of output variability and goodness of fit (likelihood scores) and a retrospective analysis will be provided.

- Forecast will be performed under three different scenarios to test the effect of including the recruitment information provided by the autumn acoustic survey *ECOCADIZ-RECLUTAS* (usually performed in November of the year 'y'), assuming that the advice is provided:
    o In February of year 'y+1' for year 'y+1' including all the available surveys indices (*i.e.* for recruitment informed on estimates from *ECOCADIZ-RECLUTAS*).
    o In June of year 'y' for year 'y+1' without consider the estimates provided by that survey (*i.e.* for an assumed scenario of recruitment-uninformed by surveys).
    o In June of year 'y' for year 'y+1' without consider the estimates provided by that survey and updated in April/May of year 'y+1' by including the *PELAGO* survey performed in March/April.

    ISSUE: SURVEYS SERIES:

- The internal consistency of the *PELAGO* survey and the *ECOCADIZ* survey conducted during spring and summer respectively will be evaluated and reported to the Benchmark WK in the *WD Southern Data*. This will be done by comparing graphically the progression of size-age data and also perform correlation analysis to track the cohorts.
- The *ECOCADIZ-RECLUTAS* survey conducted in Sub-division 9a South is an acoustic survey series aimed at the acoustic estimation of the abundance of anchovy and sardine juveniles (Age 0 fish). The series is still short (2012, 2014-2016, 4 data points). The internal consistency of the *ECOCADIZ-RECLUTAS* survey series will also be reported to the Benchmark WK in the *WD Southern Data*. This will be done by comparing graphically the progression of size-age data and also perform correlation analysis of the recruits identified in this survey with age-1 anchovies quantified in the *ECOCADIZ* and *PELAGO* surveys of the following year for the 9a South component.
- *BOCADEVA* DEPM survey provides estimates of Spawning Biomass in July every three years: the consistency for this index with *ECOCADIZ* and *PELAGO* will be checked in terms of relative trends of adult abundances provided for these surveys for the same years.
- *ARSA* autumn survey series (ground-fish surveys) belongs to the IBTS program and dates back to 1997. The survey provides estimates of anchovy from the Spanish waters of the Gulf of Cadiz (9a South). Length-based estimates are already available and they will be incorporated to the model. The internal consistency of *ARSA* survey series will be reported to the Benchmark WK, as well as a correlation analysis of this series with those of the autumn and spring acoustic surveys of the present and following year, respectively.

Table 1 Anchovy in Division 9.a. Biomass estimates (in tonnes) from each survey series on a regional basis.

Year	Acoustic survey biomass estimates								DEPM
	Spring				Summer	Autumn			Summer
	Sp. survey 9.a N	Port. survey 9.a C-N to 9.a C-S	Sp.+Port. Surveys 9.a N to 9.a C-S	Port. survey 9.a S	Sp. survey 9.a S	Port. survey 9.a C-N to 9.a C-S *	Port. survey 9.a S	Sp. survey 9.a S	Sp. survey 9.a S
	PELACUS	PELAGO	PELACUS+PELAGO	PELAGO	ECOCADIZ	JUVESAR	SAR-NOV	ECOCADIZ RECLUTAS	BOCADEVA
Months	March–April	March–April	March–April	March–April	July		Oct–Nov	Oct–Nov	June–July
1998							30695		
1999		596		24763					
2000							33909		
2001		368		24913			25578		
2002		1542		21335					
2003		112		24565					
2004					18177				
2005		1062		14041					14637
2006		0		24082	36521				
2007	0	1945	1945	38020	28882		23723		
2008	306	5505	5811	34162					31527
2009	26	2089	2115	24745	21580				
2010	42	1188	1230	7395	12339				
2011	1508	27050	28558	0					32757
2012	45							13680	
2013	0	3955	3955	12700	8487				
2014	0	1947	1947	28917	29219			8113	31569
2015	0	8237	8237	33100	21305	29556		30827	
2016	205	38302	38507	65345	34184	14397		19861	
2017	3566	15481	19047	13797	12229				12422

*The survey covers only partially 9.a C-S.

ISSUE: DISCARDS:

- This issue is not a relevant problem. Although the actual magnitude of discarding practices for the past anchovy fishery in the Division is unknown, the respective DCF national sampling programs have revealed for the recent fishery (since the early 2000s) that, in general terms, anchovy discards may be considered as negligible or even null. Anchovy discards in the Portuguese fishery are considered null. Discards in the Spanish fishery are estimated since 2014, when the sampling coverage was sufficient to provide reliable estimates: in the 9a South Spanish discards are quite low, almost negligible (discard ratios have oscillated for the period 2014-2016 between 0.01 (1%)–0.026 (2.6%)). Discards estimates started to be summed to landings to provide catch estimates since 2014 for the Spanish fishery. In the Portuguese fishery landings = catches.

ISSUE: BIOLOGICAL PARAMETERS:

AGE STRUCTURE AND LENGTH COMPOSITION OF CATCHES:
- Catches by length and at age are regularly available from the Spanish fishery in the Sub-division 9a South on a quarterly basis. Catches by length and at age of the

Portuguese fishery from the 9a South is practically inexistent (as shown in presentation to the Data Evaluation WK). Nevertheless, the length distribution of the few data from landings will be compared to those from surveys to inspect for a potential selectivity of the catches for given sizes or a consistency between the two.

MATURITY AT LENGTH AND AT AGE:
- Maturity ogives from anchovy in 9a South are regularly available from the Spanish fishery. They are estimated from commercial samples. The Data Call has shown that biological data from the Portuguese waters in subdivision 9a South are only available from the surveys and therefore length at first maturity was derived from this data. Nevertheless, the available data series show several gaps.

NATURAL MORTALITY:
- The natural mortality estimates adopted in the Gadget model for the Southern stock will be those estimates of natural mortality by ages 0 and 1 used in the assessment of the Alboran Sea anchovy (M age 0 = 1.17 y^{-1}; M age 1= 0.43 y^{-1}; Giráldez *et al*., 2009). For ages 2 and 3 were considered higher values (M age 2= 0.80 y^{-1}; M age 3= 1.00 y^{-1}) than those estimates proposed for the Alboran Sea anchovy to force to die the oldest fish. Mortality at age as a parameter will also be considered for the Gadget implementation.

WESTERN STOCK UNIT

ISSUE: ASSESSMENT METHOD

- Several data-limited methods will be applied to the available data and outputs compared: 1) Stock indicator from *PELACUS + PELAGO* surveys, harvest rate indicator based on landings and survey biomass 2) biomass dynamics model (explore SpicT), 3) Yield per Recruit analysis. Settings, input parameters and outputs from the methods explored will be described in the *WD Western Assessment*.

ISSUE: ADVICE

- The advice options correspond to the assessment methods proposed above.
  1) Based on survey trends, in-year advice provided after the surveys from the current year.
  2) Based on reference points derived from the biomass dynamics model.
  3) Based on SPR analysis.

ISSUE: SURVEYS SERIES:

- The inter-series comparability between Spanish (*PELACUS*, surveying the subarea 8c and subdivision 9a North) and Portuguese (*PELAGO*, surveying the subdivisions 9a Central-North, 9a Central-South and 9a South) spring acoustic surveys is still unknown because the results from inter-calibration exercises between research vessels (in 2008 and 2009) were not conclusive (ICES 2008, 2009, 2011). An inter-calibration exercise in 2014 between the old and new vessel used in the *PELACUS* surveys demonstrated that

this survey series was not affected by the change of vessels (Carrera, 2015; ICES, 2015b). *PELACUS* and *PELAGO* surveys estimates are combined in a single index of abundance and biomass for the analytical assessment of the Iberian-Atlantic sardine stock (stock pil.27.8c9a). Based on the same assumption and on the complementary coverage of the subdivisions along the western regions of Division 9a, the same approach will be applied for anchovy in the Division 9a for the computation of indices for the Western stock unit. Such an approach may be adopted both in a qualitative trend-based assessment, as it is at present, and in any alternative quantitative assessment model (for the Western stock unit).

-   The internal consistency of the *PELACUS* and *PELAGO* surveys series conducted in the Western component will be evaluated and reported to the Benchmark WK in the *WD Western Assessment*. This will be done by comparing graphically the progression of size-age data and also perform correlation analysis to track the cohorts.

-   The *JUVESAR* survey conducted in Sub-division 9a Central-North is an acoustic survey series aimed at the acoustic estimation of the abundance of anchovy and sardine juveniles (Age 0 fish). The series is still short (2013-2016, but providing anchovy estimates in 2015 and 2016, 2 data points). The internal consistency of the *JUVESAR* survey series will be reported to the Benchmark WK in the abovementioned WD. This will be done by comparing graphically the progression of size-age data and also perform correlation analysis of the recruits identified in the *JUVESAR* survey with age-1 anchovies quantified in the *PELACUS* and *PELAGO* surveys of the following year.

ISSUE: DISCARDS:

-   This issue is not a relevant problem. Although the actual magnitude of discarding practices for the past anchovy fishery in the Division is unknown, the respective DCF national sampling programs have revealed for the recent fishery (since the early 2000s) that, in general terms, anchovy discards may be considered as negligible or even null. Anchovy discards in the Portuguese fishery are considered null. Discards in the Spanish fishery are estimated since 2014, when the sampling coverage was sufficient to provide reliable estimates: in 9a North discards are almost zero (discards ratios have oscillated for the period 2014-2016 between 0 (0%) − 0.001 (<0.1%)). Discards estimates started to be summed to landings to provide catch estimates since 2014 for the Spanish fishery. In the Portuguese fishery landings = catches.

ISSUE: BIOLOGICAL PARAMETERS:

AGE STRUCTURE AND LENGTH COMPOSITION OF CATCHES:
-   Catches by length and at age from the Spanish (9a North) and from the Portuguese fishery (9a Central North and Central South) are available since 2011 but not on a regular basis. The length distribution and age structure available from landings will be compared to those from surveys in the same areas, to explore a potential selectivity of the catches for given sizes or a consistency between the two types of data.

MATURITY AT LENGTH AND AT AGE:

- Maturity data for the western area are available from the surveys and therefore lengths at first maturity were derived from these data. Nevertheless, the available data series show several gaps.

NATURAL MORTALITY:
- For the time being, this issue will not be addressed for the Western stock unit within the short-term goals.

MID-TERM GOALS (IN THE ICES WGHANSA 2018, June 2018).

ISSUE STOCK IDENTITY:

- New genetic and otolith microchemistry studies currently underway will be evaluated to confirm the separation of the two stocks units of the Division 9a.

ISSUE: ASSESSMENT METHOD:

- If Gadget model and data-limited approach are accepted for the assessment of Southern and Western stock units, respectively, these models will be updated with the new information available.
- In case Gadget and data-limited approach won't be accepted for the assessment:
  o We should consider implementing all the suggestions given in WKPELA 2018 for an improved Gadget for the South and an improved method for the West that could be evaluated further.
  o We will continue to use the qualitative assessment method that has been applied in the last years for the whole Subdivision.

ISSUE: MANAGEMENT ADVICE:

- A two-stage approach to advice management based on *PELAGO* spring survey will be explored. The approach will consist in to carry out an assessment in year *y* in June (or later in the year) and provide advice to start with a minimum TAC in *y+1* (TAC$y+1_{ini}$, according to the geometric mean recruitment). Then, to carry out a new assessment and advice for TAC$y+1$ after *PELAGO* survey estimate for the entire Division 9a become available in year *y+1* (in April/May), TAC$y+1_{def}$., according to sustainable harvest rates, provided TAC$y+1_{def}$ > TAC$y+1_{ini}$.
- For the western stock explore also the possibility of in-year advice based on spring surveys

LONG-TERM GOALS (IN THE NEXT BENCHMARK, WITHIN APPROX. 3 YEARS).

ISSUE: ENVIRONMENT AND RECRUITMENT PROCESS:

- Gadget (for the Southern stock unit) has been calculating the recruitment without a stock-recruitment relationship, a stock recruitment relationship tailored to incorporate the effect of the environment on recruitment can be included (Ruiz *et al*., 2006). A recruitment index can be included in the Western stock model.

ISSUE: ASSESSMENT

- Improve the biomass dynamic model and explore the development of a Gadget model for the western stock.

ISSUE: DATA FROM LANDINGS AND SURVEYS:

- Improvement of age-length information of Western stoc uint and for the Portuguese waters of the Southern stock (landings and surveys).
- Testing the validity of the recruitment surveys to predict recruitment.

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