WKPELA 2018.
Benchmark of Anchovy in Division 9a (ane.27.9a).

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And the valuable collaboration of:
Ruth Fernández and Jette Fredslund.

Background. Despite the long wait...Were we ready for the "fiesta"?

❑ **Ane.27.9a stock:**

- Categorized by ICES as a *DLS* belonging to the Category 3.2 (Stocks for which survey-based assessments indicate trends, but there is no survey-based proxy for MSY Btrigger and F values or proxies are not known)....but it is not so DLS!
- Assessed by WGHANSA in the past years by a Survey trend-based qualitative assessment (but without provision of any catch advice because the lack of information on the incoming recruitment).
- Different issues needed to be benchmarked, even following a non-analytical approach.
- The stock has not previously been benchmarked.
- Benchmark process for this stock foreseen in 2014 but postponed because the shortage of personnel.
- 2017: 2 important events/incentives to meet the Benchmark challenge in 2018 .
  - WGHANSA: First exploratory runs of a Gadget single-species model for anchovy in 9a South (developed by Margarita Rincón (ICMAN-CSIC) within the frame of the MAREFRAME project).
  - Incorporation to the "Anchovy 9a-team" of Margarita and Susana Garrido (IPMA).

Background. ***The fearsome schedule or "On the verge of a nervous breakdown".***

❑ The stock would be benchmarked together with 3 herring stocks in the WKPELA 2018 (initially WKHERRING 2018).

❑ ICES Chair: Pieter-Jan Schon (UK); External Chair: Katja Enberg (Norway); External Reviewers: Verena Trenkel (France), Ashleen Benson (Canada), Bjarki Elvarsson (Iceland, our proposal as Gadget expert).

❑ Too much work in too short time (July 2017- Feb 2018):

- Preparation, launching (27/10/2017) of- and giving appropriate reply to an ***ad-hoc*** **Data Call** (deadline 01/12/2017).

- Preparation of- and attendance to the **WKPELA 2018-Data Evaluation WK** (04-06/12/2017): 8 ppts.

- Preparation of- and attendance to the **WKPELA 2018-Benchmark Assessment WK** (12-16/02/2018): 5 WDs, 9 ppts.

Background. The long, long Issue List.

❑ The **Issue List** (IL) perhaps a too much ambitious one. Drawn up in 2012. It closely resembled the IL of pil.27.8c9a 1st Benchmark.

- Stock Identity: **The main issue. And the basis of our approach on the assessment and advice.**
- Surveys: length of the series, internal and between-surveys consistency, the catchability issue.
- Discards: the actual magnitude (in 2012) was unknown. Since 2014 on it is estimated. A not very relevant issue here.
- Biological parameters: Catches at age (in other subdivisions than 9a S). M. Maturity ojives, etc.
- Assessment method: age-structured or integrated, generalized, DLS methods.
- Forecast method: depending on the assessment method.
- Biological Reference Points: needed to be defined.
- Environmental drivers of the recruitment.

WKPELA 2018-Data Evaluation WK (04-06/12/2017, ICES HQ).

❑ **DEWK's Main Objective:** to evaluate the appropriateness of data and their quality. As a result of this evaluation, produce WDs to be reviewed during the Benchmark Assessment meeting.

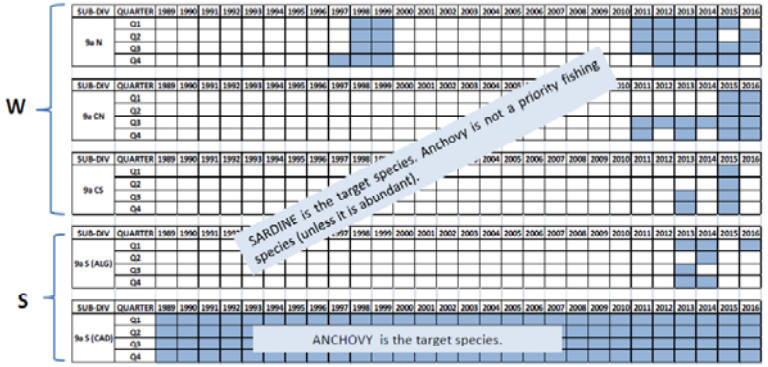
❑ *Ad hoc* **Data call** deadline just the week before.

❑ **The most relevant issues:**

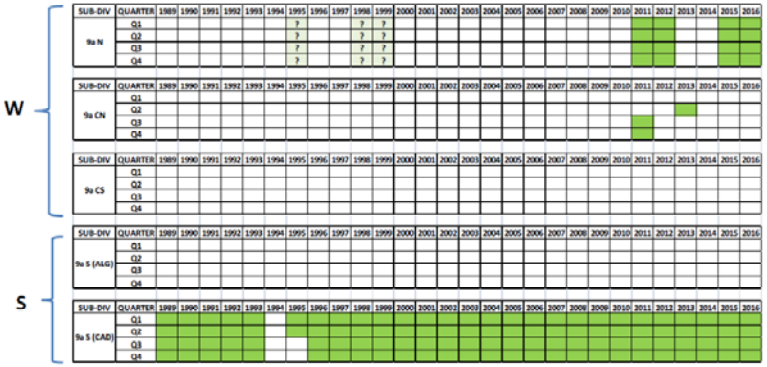
- **Stock Identity:** WGHANSA supported the existence of two different "stocks" or "management units". The evidences were the same ones than in 2015 (SIMWG 2015). They also were considered insufficient by the WKPELA Chairs to differentiate 2 different stocks.
- Quantity, quality and availability of the anchovy **fishery and biological data** show a great spatial and temporal variability along the Division:
  - Data Poor (DLS) *vs* Data Rich subdivisions.
  - Different sampling coverage and intensity depending on the resource's availability and commercial interest. Intensification of length-age-bio sampling in western areas needed.
- **Surveys:**
  - Shortness of some series (e.g. BOCADEVA DEPM, Autumn Surveys).
  - Absence of estimates of a measure of dispersion for the acoustic estimates.
  - Absence of age-structured estimates for the great part of the PELAGO series.
  - Consistence should be explored.
- **Assessment:** the Chairs required a WD, to be presented in the inter-workshops period, describing our work plan for the Benchmark Assessment WK and short- and mid-term pursued goals.

WKPELA 2018-Data Evaluation WK (04-06/12/2017, ICES HQ).

LFD sampling coverage



Catch at age sampling coverage



Surveys: LFD and Age structure coverage

SURVEY	SUB-DIVISION	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PELACUS	9a N																										
PELAGO	9a CN																										
	9a CS																										
	9a S (ALG)																										
	9a S (CAD)																										
ECOCADIZ	9a S (ALG)																										
	9a S (CAD)																										

SURVEY	SUB-DIVISION	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
BOCADEVA	9a S (ALG & CAD)																										

SURVEY	SUB-DIVISION	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
SAR (AUT)	9a CN																										
	9a CS																										
	9a S (ALG)																										
	9a S (CAD)																										
JUVESAR	9a CN																										
ECOCADIZ-RECLUTAS	9a S (ALG)																										
	9a S (CAD)																										

Aggregated estimates

Length-based estimates

Length- and age-structured estimates

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

❑ **WK's Main Objectives:**

- to evaluate the appropriateness and agree and document the preferred (analytical assessment) method for evaluating the stock status and (where applicable) short-term forecast. If no analytical assessment method can be agreed, then an alternative method (the former method, or following the ICES data-limited stock approach) should be put forward.

- to update the Stock Annex.

- to re-examine and update (if appropriate/necessary) MSY and PA reference points according to ICES guidelines.

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

Stock identity and structure. ICES SIMWG 2015.

- There were evidences to support a **resident population** of anchovy located in the Gulf of Cadiz (**ICES Subdivision 9a South**).

- There seems to be also a resident population of European anchovy **in 9a North, 9a Central-North and 9a Central-South**, although significantly more variable than in the South.

- These evidences were not sufficient for SIMWG to consider 2 different stocks.

- SIMWG recommended in 2015 that the current stock structure should stand and recommended the continued approach of employing spatially explicit management and monitoring of this subdivision.

ICES. 2015. Interim Report of the Stock Identification Methods Working Group (SIMWG), 10–12 June 2015, Portland, Maine, USA. ICES CM 2015/SSGEPI:13. 67 pp.
Ramos, F. 2015. On the population structure of the European anchovy (*Engraulis encrasicolus*) in ICES Division IXa: a short review of the state of art. Working document presented in the: ICES Stock Identification Methods Working Group (SIMWG). 10-12 June 2015. 22 pp.

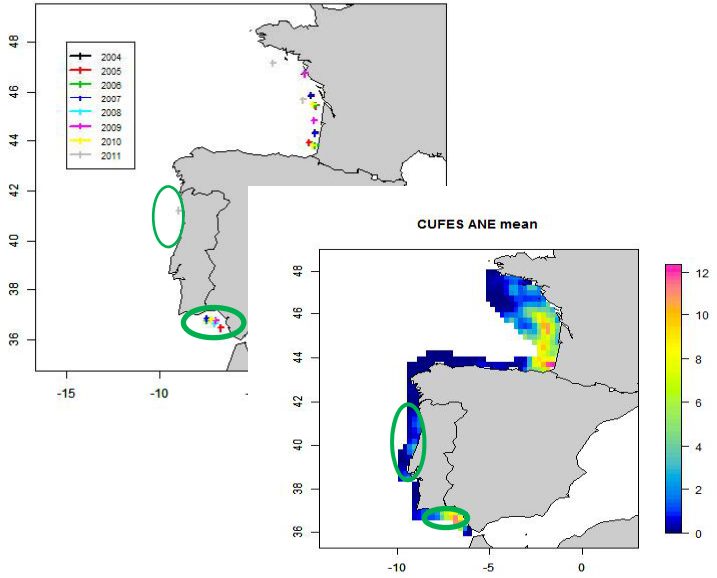
WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ). Stock identity and structure. Conclusions from pre-benchmark reviews & updating of available information.

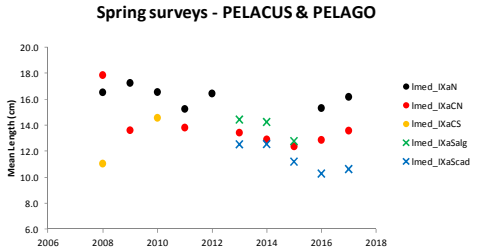
➢ Garrido *et al.* (2018a):

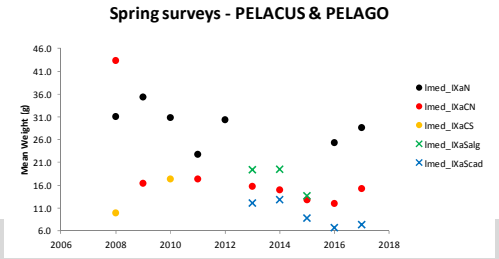
• New information on **spatial discontinuities**, **LHTs**, **genetic** and **morphometric** differences, and presence of **all life stages** indicate that the **western area also has a self-sustained anchovy population, independent of the southern component.**

• **No correlation** was found between anchovy **catches** between the two areas, suggesting independent dynamics. Anchovy landings in the western coast were significantly related to the abundance of the species in that area, corroborating the independent dynamics of anchovy fishery from the two components.

➢ **WGHANSA proposal**: to provide **separate advice** for the population in Subdivision 9a South and the populations from sub-divisions in the western coast (9a North, Central-North and Central-South).







Garrido *et al.* (2018a).

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

The two stock components approach. A proposal.

ICES WGHANSA members still supported the idea of two different “stocks” or “management units”:

- The anchovy fishery and their exploited populations are spatially separated and with independent dynamics (via their recruitment pulses).

- **Southern component** (stock unit 9a South): stable population, relatively independent of the remaining populations. Core habitat (for spawning and recruitment).

- **Western component** (stock unit 9a West): less abundant populations, with outbursts under suitable environmental conditions.

- Survey trends-based qualitative assessment is currently carried out considering this spatial explicit monitoring.

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

Stock identity and structure. WKPELA CONCLUSIONS AND PROPOSALS.

- Overall conclusion: further work is needed to address this issue in a satisfactory manner. The evidences were not consensually considered sufficient to modify the current stock structure.

- Consequences of changing the management scheme were not fully evaluated.

- Information on stock structure (available and new evidences from undergoing studies) should be evaluated by ICES SIMWG.

- A full management simulation should be conducted to investigate the appropriateness and robustness of the proposed structure in a future benchmark.

- In the interim, WKPELA 2018 proposes that a stepwise approach should be taken, where a separate advice will be given to the two stock components whilst the above issues are resolved.

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

Assessment methods to be benchmarked.

9a West

❑ DLS stock (category 3.2): Stocks for which survey-based assessments indicate trends, but there is no survey-based proxy for MSY Btrigger and F values or proxies are not known.

❑ **Two approaches of in-year advice for short-lived species DLS**, conditioned on having survey-based estimates (or other valid information) at the start of the year for which the advice is required (advice year), (applicable to both 9a West and 9a South stock units):

- Modification of DLS methods of (surveys) trends-based catch advice to better reflect the dynamics of short-lived species and to be applied as in-year advice.

(See Garrido *et al*. (2018b): WDWesternAssessment_benchmark_v5)

- Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield Per Recruit analysis).

(See Uriarte *et al*. (2018): WD_In year advice for anchovy 9a based on survey biomass estimates and sustainable harvest rates from Yield per recruit analysis)

❑ **Exploratory assessment with SPICT** (*Production model in Continuous Time*, Pedersen and Berg, 2017) to assess the 9a West anchovy and derive proxy MSY reference points.

(See Garrido *et al*. (2018b): WDWesternAssessment_benchmark_v5)

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

Assessment methods to be benchmarked.

9a South

❑ At present a DLS stock (category 3.2), but may be promoted to category 1 or 2.

(See Ramos *et al*. (2018): WD_Southern Data)

❑ Assessment with **Gadget (*Globally applicable Area Disaggregated General Ecosystem Toolbox*, Begley, 2004)** to assess the 9a South anchovy.

(See Rincón *et al*. (2018a): Gadgetbenchmark_run59)

Alternatively:

❑ Two approaches of in-year advice for short-lived species DLS, conditioned on having survey-based estimates (or other valid information) at the start of the year for which the advice is required (advice year), (applicable to both 9a West and 9a South stock units):

- Modification of DLS methods of (surveys) trends-based catch advice to better reflect the dynamics of short-lived species and to be applied as in-year advice.

(See Garrido *et al*. (2018b): WDWesternAssessment_benchmark_v5)

- Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

(See Uriarte *et al*. (2018): WD_In year advice for anchovy 9a based on survey biomass estimates and sustainable harvest rates from Yield per recruit analysis)

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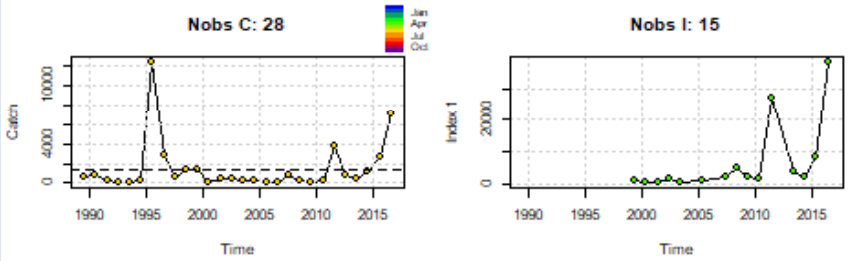
9a West. SPICT.

❑ **Input data**:

- ✓ Annual catches (1989-2016): assumed to be observed in mid-June (concentration of the fishery in 2º semester).
- ✓ PELACUS+PELAGO biomass indices (1999-2016): Indices of Exploitable Biomass (>11 cm).



❑ **Short data series**: select a model without signs of over-parameterization.

❑ **6 Runs** with different settings:

- ✓ 3 Shaeffer (n=2) runs (1, 2, 3) & 3 Fox (4, 5, 6) runs:
  - ▪ 2 options for priors on survey catchability (no prior vs prior with mean=1, SD=0.5).
    - ➢ α: 2 options for ratio of observation noise to process noise in biomass.
    - ➢ β: 1 option for ratio of observation noise to process noise in F.

Catch residuals violated Normality and correlated at lag 2.

Q<<<1: B and BMSY estimates one order of magnitude higher than observed values.

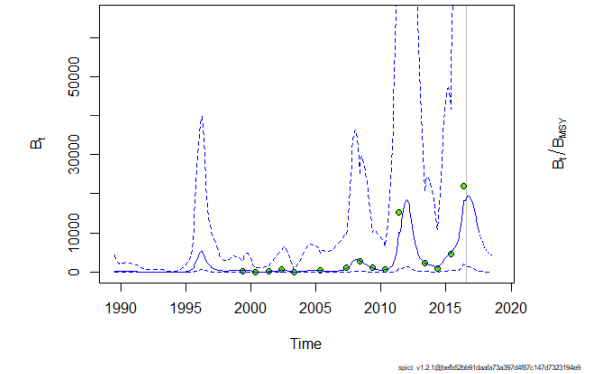
Summary of SPICT runs. n- curve shape parameter, alfa- the ratio of index observation error to biomass process error, beta- the ratio of catch observation error to fishing mortality process error. CV-coefficient of variation, sd-Standard deviation.

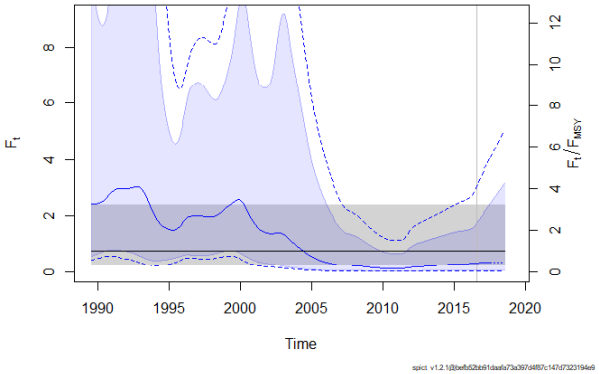
	RUN	FIXED PARAMETERS			RESULTS									
		n	alfa	beta	q	Residuals	Bmsy	cv_Bmsy	Fmsy	cv_Fmsy	MSY	cv_MSY	q	sd_q	Objective functio
Shaeffer	1	2		1	1 no prior	Catch residuals correlated at lag 2	423244	1.26	0.34	0.66	142268	1.28	0.03	2.66	63.37
	2	2		0.25	1 no prior	Catch residuals correlated at lag 2	277823	1.17	0.78	0.22	216437	1.17	0.07	1.84	62.6
	3	2		0.25	1 prior (1,0.5)	Catch residuals non-normal and correlated at lag 2	21290	1.09	0.99	0.00	21012	1.09	0.85	0.46	63.5
Fox	4	1		1	1 no prior	ALL checks OK	-	-	-	-	-	-	-	-	Model does not f
	5	1		0.25	1 no prior	ALL checks OK	9682	1.18	0.74	0.14	7159	1.13	1.75	1.03	60.6
	6	1		0.25	1 prior (1,0.5)	ALL checks OK	15764	1.16	0.61	0.36	9627	1.13	1.09	0.47	61.0

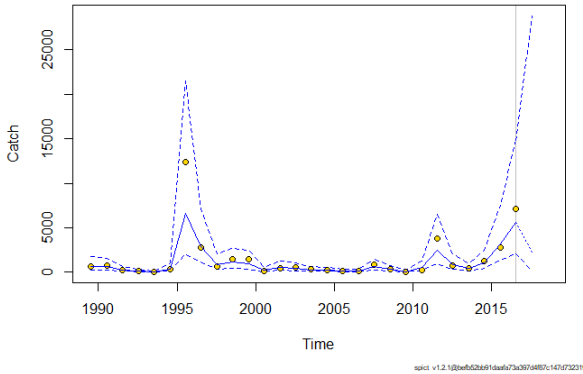
Very high CVs

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West. SPICT (RUN 5).







❑ **Outputs**:

- ✓ B_{MSY}= 9682 t (CV=1.18)
- ✓F_{MSY}= 0.74 (CV=0.14).
- ✓MSY= 7152 t (CV=1.13).
- ✓q= 1.75 (SD=1.03).
- ✓B_{2016}/B_{MSY}= 1.94
- ✓F_{2016}/F_{MSY}= 0.42
- ✓ **Suggest a stock in good status…but**

❑ **Conclusions**:

- ✓ Parameters with large confidence intervals. **None of the runs provided a reliable assessment of 9a-west anchovy**.
- ✓ Further exploration needed:
  - ❖Fixing additional parameters (e.g B/K, acoustic survey observation error) might improve confidence limits.
  - ❖ Use seasonal catch data.
  - ❖ Use of autumn surveys (demersal or acoustic).
- ✓WKLIFE7 (2017) discussed that SPICT might be appropriate to assess short-lived stocks using seasonal data and there are plans for a **workshop in 2018** (WKLIFE8) to work on seasonal SPICT versions using Sprat as a case study.

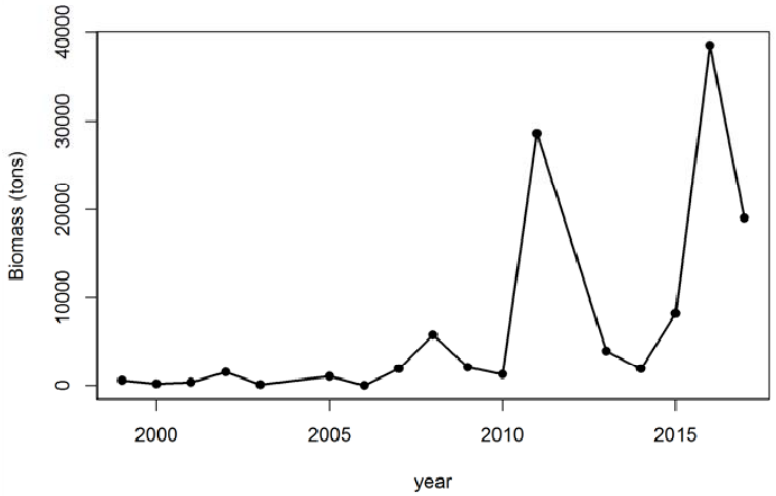
WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West. Modification of DLS methods of (surveys) trends-based catch advice to better reflect the dynamics of short-lived species and to be applied as in-year advice.

- Survey trends based on a **Stock size Biomass Indicator**: sum of spring PELACUS (in 9a N) & PELAGO (9a CN, 9a CS) acoustic estimates (WGACEGG 2017).

- **Harvest Rates**: 0.03 (2009) - 0.66 (2014). HR>1.00 (1999, 2001, 2003) probably as result of abnormal observation errors of the surveys (under-estimation errors).

- Analyzed series : 2007-2016.



		Western component		
		Subdiv. 9.a N + 9.a CN + 9.a CS		
Year	TAC 9a stock	Catches	Stock size	HR
1999		1466.3	596.0	2.46
2000		141.8		
2001		443.6	368.0	1.21
2002		543.4	1542.0	0.35
2003		301.0	112.0	2.69
2004		226.4		n.a
2005		92.2	1062.0	0.09
2006		109.9	0	
2007		843.9	1945.0	0.43
2008		303.3	5810.5	0.05
2009		58.6	2114.9	0.03
2010		281.1	1230.4	0.23
2011	7600	3781.5	28558.4	0.13
2012	8600	778.7		n.a
2013	8800	392.4	4284.2	0.09
2014	9700	1281.4	1947.0	0.66
2015	10600	2717.0	8237.0	0.33
2016	12500	7140.0	38507.4	0.19

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West. Modification of DLS methods of (surveys) trends-based catch advice to better reflect the dynamics of short-lived species and to be applied as in-year advice.

❑ Most of DLS with a monitoring system based on surveys. Advice on catches for year Y+1 based on a survey in year Y-1 (or over last 2 years):

- **Method 3.2:**

$$C_{y+1} = C_{y-1}\left(\frac{\sum_{i=y-x}^{y-1} I_i/x}{\sum_{i=y-z}^{y-x-1} I_i/(z-x)}\right)$$

With the **20% Uncertainty Cap** to the catch advice.

- But:
  - ✓ This implies inertia in the trends.
  - ✓Short lived species show large year to year fluctuations according to Recruits.
  - ✓Forecast is not possible in the absence of an early recruitment indicator.

❑ In such circumstances → **to provide <u>in-year advice</u> based on the latest survey at the beginning of the same year (Y)**.

- Example: Sprat in Division 3a (Skagerrak and Kattegat):

$$\boldsymbol{C_y = C_{y-1}\frac{I_y}{\sum_{y-4}^{y-1} I_i/4}}$$

- Anchovy in 9a may show variations of a 100% or more between years. For this anchovy in 9a it was proposed:

$$\boldsymbol{C_y = Mean(C_{y-3}^{y-1})\frac{I_y}{\sum_{y-3}^{y-1} I_i/3} = Mean(HR)\cdot I_y}$$

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West. Modification of DLS methods of (surveys) trends-based catch advice to better reflect the dynamics of short-lived species and to be applied as in-year advice.

❑ There is no standard method for in-year advice for Category 3 stocks.

❑ Methods tested are ad-hoc variants of the 3.2 method, modified to better suit a short-lived species with very high inter-annual variability. Variant (2) is similar to the one developed for in-year advice of sprat* in area 27.3a.

1) $$C_{y:=C(y-1)\left(\frac{\sum_{y-1}^{y} I_i/x+1}{\sum_{i=y-z}^{y-x-1} I_i/(z-x)}\right)}$$ X=1, Z=4 **(2/3)**

2) * $$C_y = C_{y-1}\frac{I_y}{\sum_{y-3}^{y-1} I_i/3}$$ **(1/3)**

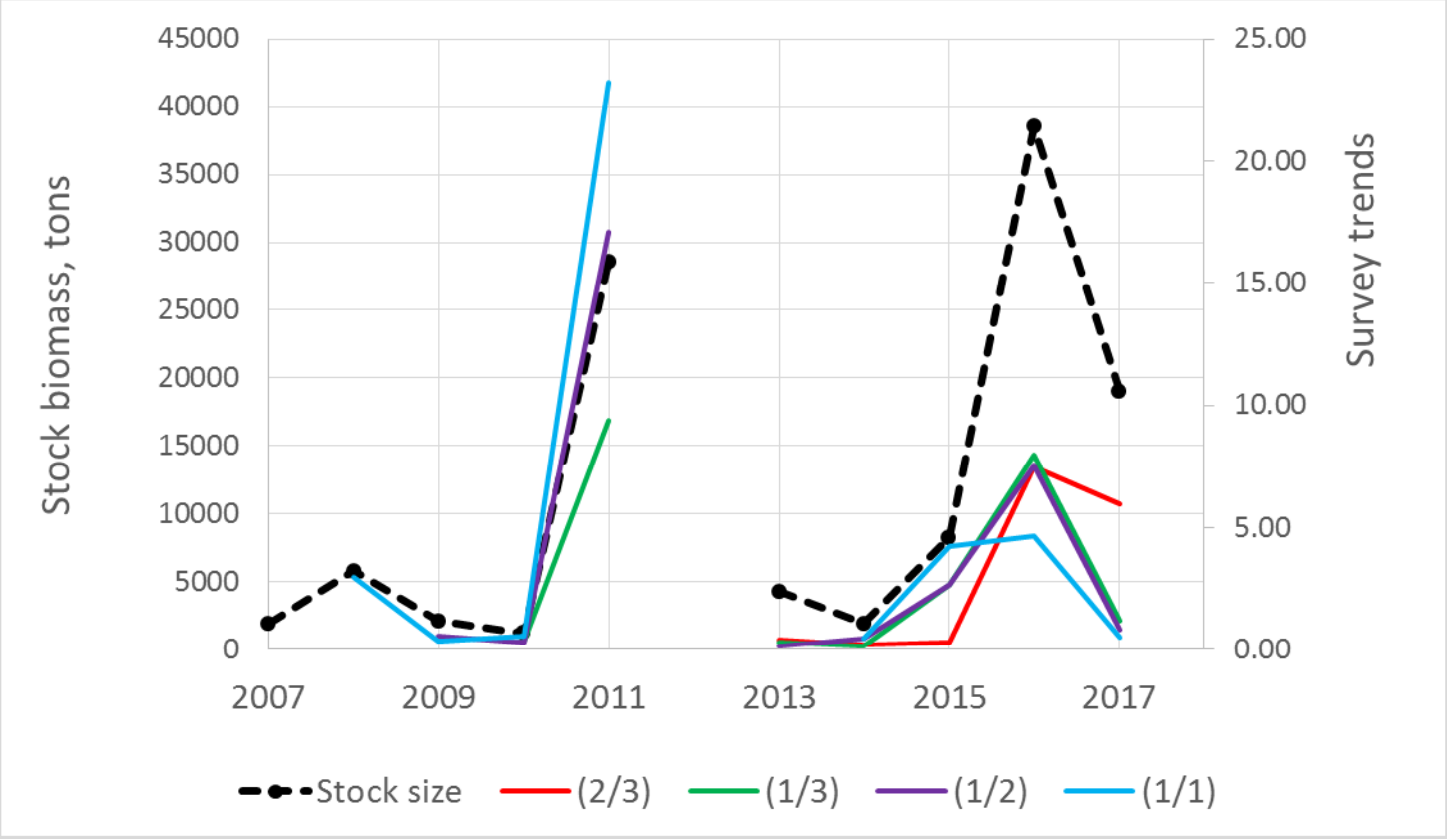
3) $$C_y = C_{y-1}\frac{I_y}{\sum_{y-2}^{y-1} I_i/2}$$ **(1/2)**

4) $$C_y = C_{y-1}\frac{I_y}{\sum_{y-1}^{y-1} I_i/1}$$ **(1/1)**

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West. Modification of DLS methods of (surveys) trends-based catch advice to better reflect the dynamics of short-lived species and to be applied as in-year advice.

❑ Alternative survey trends:



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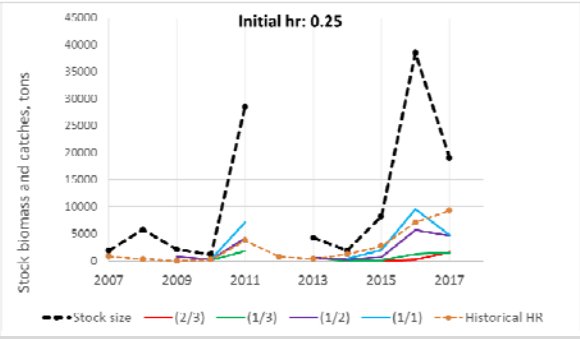
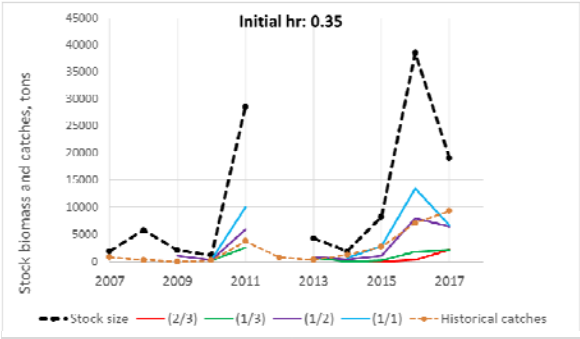
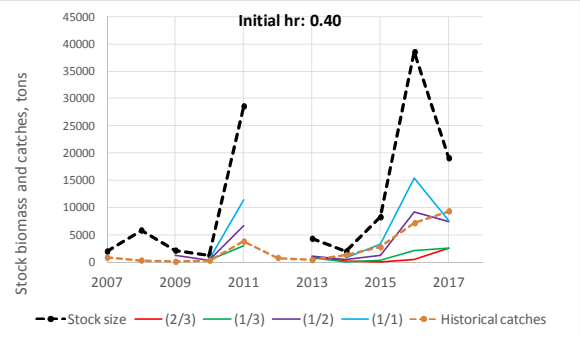
9a West. Modification of DLS methods of (surveys) trends-based catch advice to better reflect the dynamics of short-lived species and to be applied as in-year advice.

❑ Each variant was applied to the historical series assuming different HR in the beginning of the time series (2007):

HR=0.25 (historical mean).
HR= 0.35.
HR= 0.40 (below the maximum initial HR. The observed HR in 2007 = 0.43).







Mean HR's:
2/3 – 0.06
1/3 – 0.07
1/2 – 0.16
1/1 – 0.25

Mean HR's:
2/3 – 0.08
1/3 – 0.10
1/2 – 0.23
1/1 – 0.35

Mean HR's:
2/3 – 0.09
1/3 – 0.12
1/2 – 0.26
1/1 – 0.40

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West. Modification of DLS methods of (surveys) trends-based catch advice to better reflect the dynamics of short-lived species and to be applied as in-year advice.

❑ **Conclusions:**

• Due to the large variability of anchovy abundance in the west from year to year, **the trend that best corresponded to stock biomass was 1/1, then 1/2.**

•2/3 performed the worse, showing a lagged response and sometimes contradictory to changes in abundance.

•1/1 makes the HR to be constant along the series, implying the selection of a sustainable harvest rate to apply in the future (such as the YPR and precautionary approach).

•If choosing an in-year survey different than 1/1, the trend rule 1/2, starting with HR=0.40 (around the initial harvest rate of the series), results in a mean HR (=0.26) around the historical mean (=0.25).

• An in-year advice based on a precautionary fixed HR=0.29 (corresponding to a 1/1 trend) might be the best approach, at present.

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ). 9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

❑ **Deterministic approach for provision of in-year advice for a short-lived species based on survey biomass estimates**:

Deterministic advice: HR(Catch;BiomasIndex;Qmax)<= HR(Reference Point)

❑ **Estimation of sustainable HRs on the Survey's Biomass** obtained from a general **Yield per Recruit analysis** covering:

- A wide range of fishery patterns of **selectivity at age**:

Sel.	Selectivity	S_0	S_1	S_2	S_3	S_4+
Sel.1	Selectivity sharply increasing	0.05	1.00	1.00	1.00	1.00
Sel.2	Sel. gradually increasing	0.20	1.00	1.00	1.00	1.00
Sel.3	sel. sharply increasing & decreasing	0.05	1.00	0.50	0.50	0.50
Sel.4	gradually increasing & decreasing	0.20	1.00	0.50	0.50	0.50
Sel.5	sharp & gradually increasing untill age2	0.05	0.50	1.00	1.00	1.00
Sel.6	Gradually increasing untill age2	0.20	0.50	1.00	1.00	1.00

- A plausible range of **Natural mortality at age**:

	Natural Mortality Pattern at age					Mean
	M0	M1	M2	M3	M4+	M(1:2)
base	1.2	0.8	1.2	1.2	1.2	**1**
a	0.8	0.8	0.8	0.8	0.8	**0.8**
b	1.2	1.2	1.2	1.2	1.2	**1.2**
c	1.2	0.5	0.8	1	1	**0.65**
d	1.5	1	1.5	1.5	1.5	**1.25**

Base case) current M for BoB.

a) M Lower than in b.
b) Early M for BoB and assumed for 9a South.
c) Alboran Sea's M .
d) M Higher than BoB due to the very few Age2+ survivors.

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

- Given the **growth pattern** of the selected species (mean weight at age):

Western Comp. (from surveys)

	Wester Wages
Age 0	0.0053
Age 1	0.0164
Age 2	0.0238
Age 3	0.0271
Age 4	0.0313
Age 5	0.0349

Southern Comp. (in catches)

	Used (old) values	Updated Values
SWt	Mean 1999-2011	Mean 1999-2016
Age 0	0.0053	0.0060
Age 1	0.0111	0.0112
Age 2	0.0229	0.0222
Age 3	0.0234	0.0234
Age 4	0.0295	
Age 5	0.0346	

- W Age 5: by lineal interpolation.

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

❑ In-year Catch advice options according to Q_{survey}:

• The in-year catch advice (for unbiased survey estimates):

$$C_y = HR(S\%SBR) \cdot \hat{B}_y$$

• If the survey is suspected to produce biased estimates by a mean factor of catchability Q (Effective HR, EHR):

$$C_y = HR(S\%SBR) \cdot \frac{\hat{B}_y}{Q} = EHR(S\%SBR) \cdot \hat{B}_y$$

• If survey bias is unknown but its maximum value is presumed to be at or below Qmax, then a safe (Risk Averse HR, RAHR) advice on sustainable catches would be:

$$C_y = HR(S\%SBR) \cdot \frac{\hat{B}_y}{Q_{max}} = RAHR(S\%SBR) \cdot \hat{B}_y$$

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

❑ **Yield per recruit analysis for selection of Sustainable F values and Harvest rates:**

• Assess or guess the most likely fishing pattern of the fishery and population dynamics (growth and mortality).

• Computation of F-based RPs: F0.1 and F50%SBR, F40%SBR and F35%SBR of the maximum potential spawning biomass per recruit, in the absence of exploitation.

• Relate F to HRs defined according to the biomass estimates produced by the available survey at the particular surveying time (month) of the year, conditioned to unbiased estimates (catchability Q=1):

- ✓HRs on April Biomass: Survey of reference *PELAGO* in the South and *PELAGO+PELACUS* in the West. Reporting in April (PM=PF=0.25).
- ✓ HRs on SSB: Survey of reference *ECOCADIZ* (B1+) or Average of estimates in the South and *PELAGO+PELACUS* in the West. Reporting in Mid-year (PM=PF=0.50).

• Sustainable HRs (HR RPs): HR(50%SBR) or HR(40%SBR),(rather robust and conservative RPs sensu Horbowy and Luzencyk 2012), or HR(35%SPR; for a plausible worst scenario as agreed by experts).

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

❑ Yield per recruit analysis for selection of Sustainable F values and Harvest rates:
M base case & unknown selectivity-at-age for South and West.

Southern anchovy

M	M0	M1	M2	M3	M4+	F Reference Points				HR reference points				HR reference points			
	1.2	0.8	1.2	1.2	1.2	in terms of Fbar(ages 1-3)				relative to SSB (at mid year)				relative to Survey biomass estimates (1st April)			
Sel.	S_0	S_1	S_2	S_3	S_4+	F_SBR50%	F_SBR40%	F_SBR35%	F_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
S.1	0.0500	1.0000	1.0000	1.0000	1.0000	0.62	0.86	1.03	1.31	0.72	1.05	1.29	1.74	0.49	0.67	0.80	1.00
S.2	0.2000	1.0000	1.0000	1.0000	1.0000	0.53	0.74	0.87	1.29	0.71	1.05	1.29	2.20	0.49	0.70	0.83	1.28
S.3	0.0500	1.0000	0.5000	0.5000	0.5000	0.47	0.65	0.76	1.22	0.68	1.02	1.24	2.44	0.47	0.66	0.77	1.29
S.4	0.2000	1.0000	0.5000	0.5000	0.5000	0.41	0.55	0.64	1.17	0.69	1.02	1.24	3.19	0.48	0.68	0.81	1.72
S.5	0.0500	0.5000	1.0000	1.0000	1.0000	0.80	1.17	1.40	1.38	0.76	1.11	1.35	1.32	0.52	0.72	0.84	0.82
S.6	0.2000	0.5000	1.0000	1.0000	1.0000	0.64	0.90	1.06	1.38	0.76	1.11	1.34	1.85	0.53	0.74	0.87	1.16
					Mean	***0.58***	***0.81***	***0.96***	***1.29***	***0.72***	***1.06***	***1.29***	***2.12***	***0.50***	***0.69***	***0.82***	***1.21***
					CV	***24%***	***27%***	***28%***	***6%***	***5%***	***4%***	***4%***	***31%***	***5%***	***4%***	***4%***	***25%***
					Minimum	***0.41***	***0.55***	***0.64***	***1.17***	***0.68***	***1.02***	***1.24***	***1.32***	***0.47***	***0.66***	***0.77***	***0.82***

Western anchovy

M	M0	M1	M2	M3	M4+	F Reference Points				HR reference points				HR reference points			
	1.2	0.8	1.2	1.2	1.2	in terms of Fbar(ages 1-3)				relative to SSB (at mid year)				relative to Survey biomass estimates (1st April)			
Sel.	S_0	S_1	S_2	S_3	S_4+	F_SBR50%	F_SBR40%	F_SBR35%	F_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
S.1	0.0500	1.0000	1.0000	1.0000	1.0000	0.69	0.97	1.15	1.52	0.80	1.18	1.44	2.04	0.54	0.74	0.87	1.13
S.2	0.2000	1.0000	1.0000	1.0000	1.0000	0.59	0.81	0.96	1.30	0.76	1.11	1.36	2.03	0.52	0.72	0.86	1.19
S.3	0.0500	1.0000	0.5000	0.5000	0.5000	0.52	0.71	0.83	1.30	0.78	1.14	1.41	2.67	0.53	0.72	0.86	1.36
S.4	0.2000	1.0000	0.5000	0.5000	0.5000	0.43	0.59	0.69	1.08	0.73	1.08	1.33	2.57	0.50	0.71	0.85	1.42
S.5	0.0500	0.5000	1.0000	1.0000	1.0000	0.93	1.34	1.62	1.64	0.81	1.18	1.44	1.46	0.55	0.75	0.88	0.89
S.6	0.2000	0.5000	1.0000	1.0000	1.0000	0.72	1.00	1.18	1.39	0.76	1.10	1.33	1.62	0.53	0.73	0.87	1.02
					Mean	***0.65***	***0.90***	***1.07***	***1.37***	***0.78***	***1.13***	***1.39***	***2.07***	***0.53***	***0.73***	***0.86***	***1.17***
					CV	***27%***	***29%***	***30%***	***14%***	***4%***	***4%***	***4%***	***23%***	***3%***	***2%***	***1%***	***17%***
					Minimum	***0.43***	***0.59***	***0.69***	***1.08***	***0.73***	***1.08***	***1.33***	***1.46***	***0.50***	***0.71***	***0.85***	***0.89***

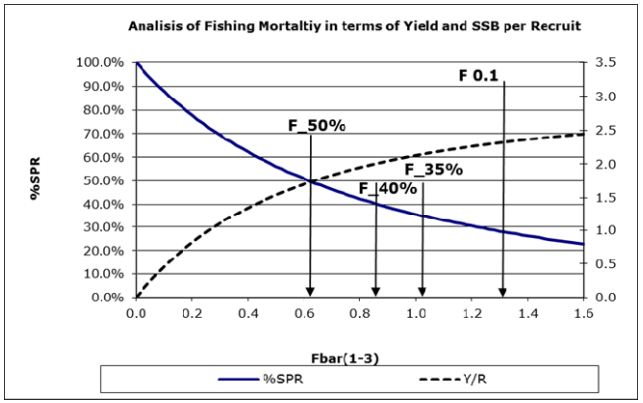
HRs not sensitive to actual fishing selectivity for a given M pattern.
HRs preferred for setting reference points for management in the absence of sufficient data to estimate selectivity.

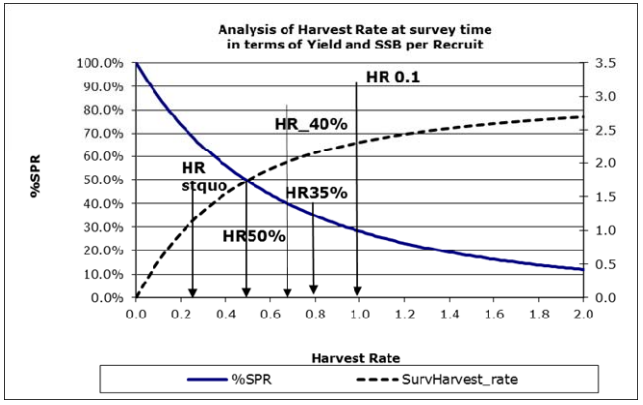
WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

❑ Yield per recruit analysis for selection of Sustainable F values and Harvest rates:
M base case & sel 1 (sharply increasing selectivity-at-age). At survey time.

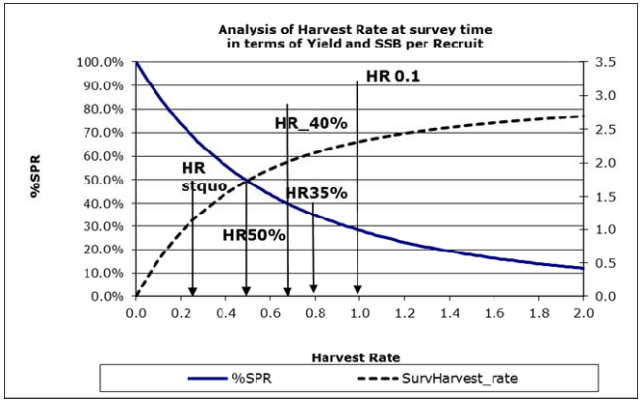
Southern anchovy

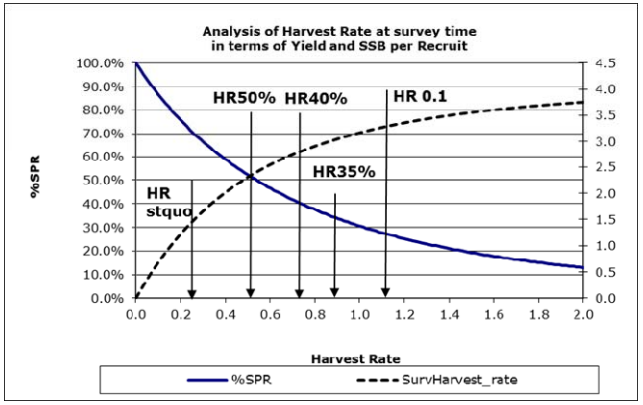




HR(50%SBR)=0.49

Western anchovy





HR(50%SBR)=0.54

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

❑ Yield per recruit analysis for selection of Sustainable F values and Harvest rates: **Dependency on M.**

Southern anchovy

							F Reference Points				HR reference points				HR reference points			
	Pattern of Natural Mortality					Mean	in terms of Fbar(ages 1-3)				relative to SSB (at mid year)				relative to Survey estimates (1st April)			
	M0	M1	M2	M3	M4+	M(1:2)	F_SBR50%	F_SBR40%	F_SBR35%	F_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Mean	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	**1**	*0.58*	*0.81*	*0.96*	*1.29*	*0.72*	*1.06*	*1.29*	*2.12*	*0.50*	*0.69*	*0.82*	*1.21*
Mean	0.8	0.8	0.8	0.8	0.8	0.8	*0.44*	*0.63*	*0.75*	*0.99*	*0.51*	*0.75*	*0.92*	*1.26*	*0.38*	*0.53*	*0.63*	*0.81*
Mean	1.2	1.2	1.2	1.2	1.2	1.2	*0.62*	*0.87*	*1.03*	*1.76*	*0.83*	*1.24*	*1.52*	*3.82*	*0.53*	*0.75*	*0.88*	*1.78*
Mean	1.2	0.5	0.8	1	1	0.65	*0.47*	*0.65*	*0.77*	*0.88*	*0.54*	*0.78*	*0.94*	*1.18*	*0.41*	*0.56*	*0.66*	*0.80*
Mean	1.5	1	1.5	1.5	1.5	1.25	*0.68*	*0.94*	*1.11*	*1.91*	*0.93*	*1.38*	*1.69*	*4.57*	*0.59*	*0.83*	*0.99*	*2.13*
							F Reference Points				HR reference points				HR reference points			
	Pattern of Natural Mortality					Mean	in terms of Fbar(ages 1-3)				relative to SSB (at mid year)				relative to Survey estimates (1st April)			
	M0	M1	M2	M3	M4+	M(1:2)	F_SBR50%	F_SBR40%	F_SBR35%	F_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Minimum	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	**1**	*0.41*	*0.55*	*0.64*	*1.17*	*0.68*	*1.02*	*1.24*	*1.32*	*0.47*	*0.66*	*0.77*	*0.82*
Minimum	0.8	0.8	0.8	0.8	0.8	0.8	*0.34*	*0.46*	*0.54*	*0.88*	*0.48*	*0.70*	*0.87*	*0.90*	*0.36*	*0.50*	*0.60*	*0.61*
Minimum	1.2	1.2	1.2	1.2	1.2	1.2	*0.42*	*0.58*	*0.67*	*1.52*	*0.80*	*1.19*	*1.48*	*1.95*	*0.50*	*0.70*	*0.84*	*1.05*
Minimum	1.2	0.5	0.8	1	1	0.65	*0.35*	*0.47*	*0.55*	*0.84*	*0.50*	*0.71*	*0.87*	*0.88*	*0.38*	*0.52*	*0.62*	*0.62*
Minimum	1.5	1	1.5	1.5	1.5	1.25	*0.45*	*0.61*	*0.71*	*1.59*	*0.88*	*1.30*	*1.61*	*2.12*	*0.56*	*0.77*	*0.92*	*1.16*

Western anchovy

							F Reference Points				HR reference points				HR reference points			
	Pattern of Natural Mortality					Mean	in terms of Fbar(ages 1-3)				relative to SSB (at mid year)				relative to Survey estimates (1st April)			
	M0	M1	M2	M3	M4+	M(1:2)	F_SBR50%	F_SBR40%	F_SBR35%	F_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Mean	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	**1**	*0.65*	*0.90*	*1.07*	*1.37*	*0.78*	*1.13*	*1.39*	*2.07*	*0.53*	*0.73*	*0.86*	*1.17*
Mean	0.8	0.8	0.8	0.8	0.8	0.8	*0.50*	*0.71*	*0.85*	*1.04*	*0.57*	*0.83*	*1.01*	*1.40*	*0.41*	*0.57*	*0.68*	*0.87*
Mean	1.2	1.2	1.2	1.2	1.2	1.2	*0.69*	*0.97*	*1.14*	*1.77*	*0.89*	*1.31*	*1.62*	*3.25*	*0.56*	*0.77*	*0.92*	*1.54*
																		0.84
																		1.68

The higher the mean M, the higher the sustainable HR.

The earlier the Survey within the year, the lower the sustainable HR.

	M0	M1	M2	M3	M4+	M(1:2)	F_SBR50%	F_SBR40%	F_SBR35%	F_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Minimum	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	**1**	*0.43*	*0.59*	*0.69*	*1.08*	*0.73*	*1.08*	*1.33*	*1.46*	*0.50*	*0.71*	*0.85*	*0.89*
Minimum	0.8	0.8	0.8	0.8	0.8	0.8	*0.37*	*0.50*	*0.59*	*0.87*	*0.53*	*0.78*	*0.96*	*1.00*	*0.39*	*0.55*	*0.65*	*0.67*
Minimum	1.2	1.2	1.2	1.2	1.2	1.2	*0.46*	*0.62*	*0.72*	*1.30*	*0.87*	*1.27*	*1.56*	*2.18*	*0.55*	*0.77*	*0.90*	*1.13*
Minimum	1.2	0.5	0.8	1	1	0.65	*0.38*	*0.51*	*0.60*	*0.84*	*0.55*	*0.79*	*0.97*	*0.94*	*0.41*	*0.58*	*0.69*	*0.66*
Minimum	1.5	1	1.5	1.5	1.5	1.25	*0.49*	*0.65*	*0.76*	*1.37*	*0.95*	*1.40*	*1.73*	*2.26*	*0.61*	*0.83*	*0.98*	*1.21*

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

❑ Yield per recruit analysis for selection of Sustainable F values and Harvest rates: **Dependency on Survey Q. South.**

							Survey Catchability Q =	1			Survey Catchability Q =	1.35			Survey Catchability Q =	1.7		
							HR reference points				HR reference points for survey catchability Q				HR reference points for survey catchability Q			
	Pattern of Natural Mortality					Mean	relative to Survey estimates (1st April)				relative to Survey estimates (1st April)				relative to Survey estimates (1st April)			
	M0	M1	M2	M3	M4+	M(1:2)	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Mean	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	**1**	***0.50***	***0.69***	***0.82***	***1.21***	***0.37***	***0.51***	***0.61***	***0.90***	***0.29***	***0.41***	***0.48***	***0.71***
Mean	0.8	0.8	0.8	0.8	0.8	0.8	***0.38***	***0.53***	***0.63***	***0.81***	***0.28***	***0.39***	***0.46***	***0.60***	***0.22***	***0.31***	***0.37***	***0.48***
Mean	1.2	1.2	1.2	1.2	1.2	1.2	***0.53***	***0.75***	***0.88***	***1.78***	***0.39***	***0.55***	***0.65***	***1.32***	***0.31***	***0.44***	***0.52***	***1.05***
Mean	1.2	0.5	0.8	1	1	0.65	***0.41***	***0.56***	***0.66***	***0.80***	***0.30***	***0.42***	***0.49***	***0.59***	***0.24***	***0.33***	***0.39***	***0.47***
Mean	1.5	1	1.5	1.5	1.5	1.25	***0.59***	***0.83***	***0.99***	***2.13***	***0.44***	***0.62***	***0.74***	***1.58***	***0.35***	***0.49***	***0.58***	***1.26***
							HR reference points				HR reference points for survey catchability Q				HR reference points for survey catchability Q			
	Pattern of Natural Mortality					Mean	relative to Survey estimates (1st April)				relative to Survey estimates (1st April)				relative to Survey estimates (1st April)			
	M0	M1	M2	M3	M4+	M(1:2)	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Minimum	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	**1**	***0.47***	***0.66***	***0.77***	***0.82***	***0.35***	***0.49***	***0.57***	***0.61***	***0.27***	***0.39***	***0.45***	***0.48***
Minimum	0.8	0.8	0.8	0.8	0.8	0.8	***0.36***	***0.50***	***0.60***	***0.61***	***0.27***	***0.37***	***0.45***	***0.45***	***0.21***	***0.30***	***0.35***	***0.36***
Minimum	1.2	1.2	1.2	1.2	1.2	1.2	***0.50***	***0.70***	***0.84***	***1.05***	***0.37***	***0.52***	***0.62***	***0.78***	***0.30***	***0.41***	***0.49***	***0.62***
Minimum	1.2	0.5	0.8	1	1	0.65	***0.38***	***0.52***	***0.62***	***0.62***	***0.28***	***0.39***	***0.46***	***0.46***	***0.22***	***0.31***	***0.36***	***0.37***
Minimum	1.5	1	1.5	1.5	1.5	1.25	***0.56***	***0.77***	***0.92***	***1.16***	***0.41***	***0.57***	***0.68***	***0.86***	***0.33***	***0.45***	***0.54***	***0.69***

Assuming catchability for anchovy equal to catchability for sardine in *PELAGO* survey Q=1.35

→ **Effective Harvest rate = HR /Q** → **Advice:**

$$C_y = HR(S\%SBR) \cdot \frac{\widehat{B}_y}{Q} = EHR(S\%SBR) \cdot \widehat{B}_y$$

Assuming maximum catchability for anchovy equal to the one estimated for *PELAGO* in SPICT Qmax=1.7 (aprox).

→ **Risk Averse Harvest rate = HR /Qmax** → **Advice:**

$$C_y = HR(S\%SBR) \cdot \frac{\widehat{B}_y}{Q_{max}} = RAHR(S\%SBR) \cdot \widehat{B}_y$$

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

❑ Yield per recruit analysis for selection of Sustainable F values and Harvest rates: **Dependency on Survey Q. West.**

							Survey Catchability Q = 1				Survey Catchability Q = 1.35				Survey Catchability Q = 1.7			
							HR reference points				HR reference points for survey catchability Q				HR reference points for survey catchability Q			
	Pattern of Natural Mortality					Mean	relative to Survey estimates (1st April)				relative to Survey estimates (1st April)				relative to Survey estimates (1st April)			
	M0	M1	M2	M3	M4+	M(1:2)	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Mean	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	**1**	***0.53***	***0.73***	***0.86***	***1.17***	***0.39***	***0.54***	***0.64***	***0.87***	***0.31***	***0.43***	***0.51***	***0.69***
Mean	0.8	0.8	0.8	0.8	0.8	0.8	***0.41***	***0.57***	***0.68***	***0.87***	***0.30***	***0.42***	***0.50***	***0.64***	***0.24***	***0.34***	***0.40***	***0.51***
Mean	1.2	1.2	1.2	1.2	1.2	1.2	***0.56***	***0.77***	***0.92***	***1.54***	***0.41***	***0.57***	***0.68***	***1.14***	***0.33***	***0.46***	***0.54***	***0.90***
Mean	1.2	0.5	0.8	1	1	0.65	***0.44***	***0.61***	***0.71***	***0.84***	***0.32***	***0.45***	***0.53***	***0.62***	***0.26***	***0.36***	***0.42***	***0.49***
Mean	1.5	1	1.5	1.5	1.5	1.25	***0.62***	***0.86***	***1.01***	***1.68***	***0.46***	***0.64***	***0.75***	***1.24***	***0.37***	***0.50***	***0.60***	***0.99***
							HR reference points				HR reference points for survey catchability Q				HR reference points for survey catchability Q			
	Pattern of Natural Mortality					Mean	relative to Survey estimates (1st April)				relative to Survey estimates (1st April)				relative to Survey estimates (1st April)			
	M0	M1	M2	M3	M4+	M(1:2)	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Minimum	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	**1**	***0.50***	***0.71***	***0.85***	***0.89***	***0.37***	***0.53***	***0.63***	***0.66***	***0.30***	***0.42***	***0.50***	***0.53***
Minimum	0.8	0.8	0.8	0.8	0.8	0.8	***0.39***	***0.55***	***0.65***	***0.67***	***0.29***	***0.41***	***0.49***	***0.49***	***0.23***	***0.32***	***0.39***	***0.39***
Minimum	1.2	1.2	1.2	1.2	1.2	1.2	***0.55***	***0.77***	***0.90***	***1.13***	***0.41***	***0.57***	***0.67***	***0.84***	***0.33***	***0.45***	***0.53***	***0.67***
Minimum	1.2	0.5	0.8	1	1	0.65	***0.41***	***0.58***	***0.69***	***0.66***	***0.31***	***0.43***	***0.51***	***0.49***	***0.24***	***0.34***	***0.40***	***0.39***
Minimum	1.5	1	1.5	1.5	1.5	1.25	***0.61***	***0.83***	***0.98***	***1.21***	***0.45***	***0.62***	***0.73***	***0.90***	***0.36***	***0.49***	***0.58***	***0.71***

Assuming catchability for anchovy equal to catchability for sardine in PELAGO survey Q=1.35

→ **Effective Harvest rate = HR /Q** → **Advice:** $$C_y = HR(S\%SBR) \cdot \frac{\widehat{B}_y}{Q} = EHR(S\%SBR) \cdot \widehat{B}_y$$

Assuming maximum catchability for anchovy equal to the one estimated for PELAGO in SPICT Qmax=1.7 (aprox).

→ **Risk Averse Harvest rate = HR /Qmax** → **Advice:** $$C_y = HR(S\%SBR) \cdot \frac{\widehat{B}_y}{Q_{max}} = RAHR(S\%SBR) \cdot \widehat{B}_y$$

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

❑ Yield per recruit analysis for selection of Sustainable F values and Harvest rates: **Proposal for Southern Component.**

							Survey Catchability Q =	1			Survey Catchability Q =	1.35			Survey Catchability Q =	1.7		
							HR reference points				HR reference points for survey catchability Q				HR reference points for survey catchability Q			
Selectiv.	Pattern of Natural Mortality					Mean	relative to Survey estimates (1st April)				relative to Survey estimates (1st April)				relative to Survey estimates (1st April)			
	M0	M1	M2	M3	M4+	M(1:2)	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	
Sel.1	1.2	0.8	1.2	1.2	1.2	1	*0.49*	*0.67*	*0.80*	*1.00*	*0.36*	*0.50*	*0.59*	*0.74*	*0.29*	*0.40*	*0.47*	
Mean	1.2	0.8	1.2	1.2	1.2	1	*0.50*	*0.69*	*0.82*	*1.21*	*0.37*	*0.51*	*0.61*	*0.90*	*0.29*	*0.41*	*0.48*	*0.71*
Mean	0.8	0.8	0.8	0.8	0.8	0.8	*0.38*	*0.53*	*0.63*	*0.81*	*0.28*	*0.39*	*0.46*	*0.60*	*0.22*	*0.31*	*0.37*	*0.48*
Mean	1.2	1.2	1.2	1.2	1.2	1.2	*0.53*	*0.75*	*0.88*	*1.78*	*0.39*	*0.55*	*0.65*	*1.32*	*0.31*	*0.44*	*0.52*	*1.05*
Mean	1.2	0.5	0.8	1	1	0.65	*0.41*	*0.56*	*0.66*	*0.80*	*0.30*	*0.42*	*0.49*	*0.59*	*0.24*	*0.33*	*0.39*	*0.47*
Mean	1.5	1	1.5	1.5	1.5	1.25	*0.59*	*0.83*	*0.99*	*2.13*	*0.44*	*0.62*	*0.74*	*1.58*	*0.35*	*0.49*	*0.58*	*1.26*
							HR reference points				HR reference points for survey catchability Q				HR reference points for survey catchability Q			
	Pattern of Natural Mortality					Mean	relative to Survey estimates (1st April)				relative to Survey estimates (1st April)				relative to Survey estimates (1st April)			
	M0	M1	M2	M3	M4+	M(1:2)	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Minimum	1.2	0.8	1.2	1.2	1.2	1	*0.47*	*0.66*	*0.77*	*0.82*	*0.35*	*0.49*	*0.57*	*0.61*	*0.27*	*0.39*	*0.45*	*0.48*
Minimum	0.8	0.8	0.8	0.8	0.8	0.8	*0.36*	*0.50*	*0.60*	*0.61*	*0.27*	*0.37*	*0.45*	*0.45*	*0.21*	*0.30*	*0.35*	*0.36*
Minimum	1.2	1.2	1.2	1.2	1.2	1.2	*0.50*	*0.70*	*0.84*	*1.05*	*0.37*	*0.52*	*0.62*	*0.78*	*0.30*	*0.41*	*0.49*	*0.62*
Minimum	1.2	0.5	0.8	1	1	0.65	*0.38*	*0.52*	*0.62*	*0.62*	*0.28*	*0.39*	*0.46*	*0.46*	*0.22*	*0.31*	*0.36*	*0.37*
Minimum	1.5	1	1.5	1.5	1.5	1.25	*0.56*	*0.77*	*0.92*	*1.16*	*0.41*	*0.57*	*0.68*	*0.86*	*0.33*	*0.45*	*0.54*	*0.69*

Assuming catchability for anchovy equal to catchability for sardine in *PELAGO* survey Q=1.35
And maximum catchability equal to the one estimated for *PELAGO* in SPICT Qmax=1.7 (aprox).

→ Effective Harvest Rate = HR /Q → Advice:

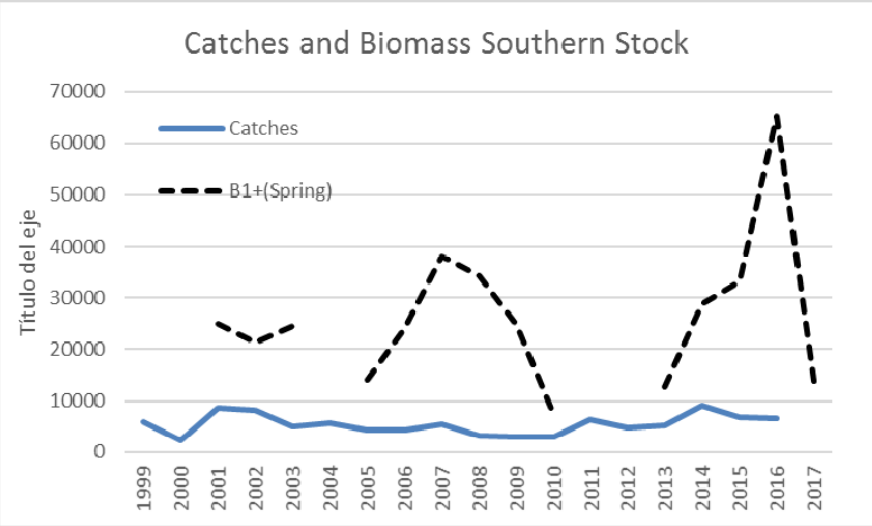
$$C_y = HR(S\%SBR) \cdot \frac{\widehat{B}_y}{Q} = EHR(S\%SBR) \cdot \widehat{B}_y$$

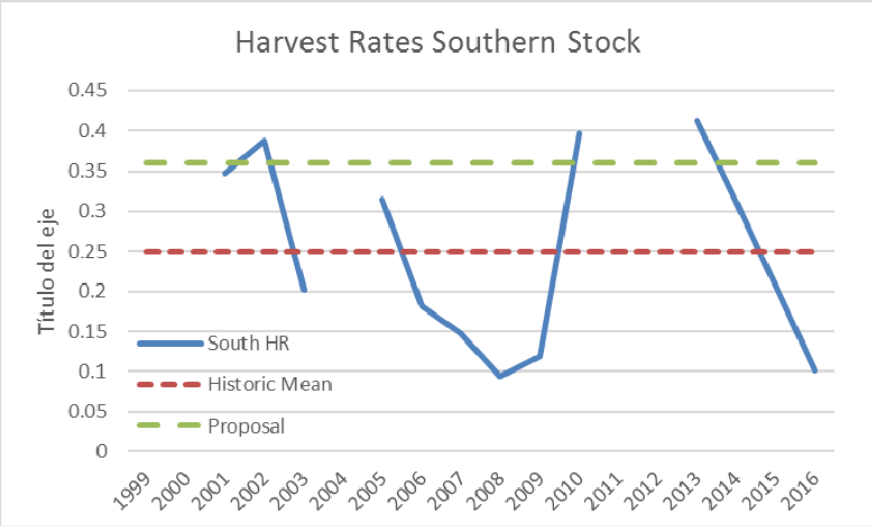
- **For Base case M and Sel.1: HR(50%SBR)= 0.49**
- **Effective HR(50%SBR) → EHR(50%SBR) = HR(50%SBR)/Q= 0.49/1.35 = 0.36**
- **If failing the assumption on fishing selectivity at age or about the Natural then Effective HR would assure to exploit the population about 40%SBR**
- **If failing on Q and it would be actually at 1.7 then selected HR would lead to about 35%SBR**

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

❑ Yield per recruit analysis for selection of Sustainable F values and Harvest rates: **Proposal for Southern Component.**





→ **Effective Harvest Rate →** **EHR(50%SBR)= 0.36**

→ **Mean (since 1999) HR = 0.25**

→ **It would assure (even at a catchability Qmax = 1.7) exploitation at slightly below 50%SBR (minimum value in Table=0.21 across M Patterns), but above 40%SBR (minimum values in Table=0.30).**

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

❑ Yield per recruit analysis for selection of Sustainable F values and Harvest rates: **Proposal for Western Component.**

							Survey Catchability Q = 1				Survey Catchability Q = 1.35				Survey Catchability Q = 1.7			
							HR reference points				HR reference points for survey catchability Q				HR reference points for survey catchability Q			
Selectiv.	Pattern of Natural Mortality					Mean	relative to Survey estimates (1st April)				relative to Survey estimates (1st April)				relative to Survey estimates (1st April)			
	M0	M1	M2	M3	M4+	M(1:2)	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Sel.1	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	**1**	*0.54*	*0.74*	*0.87*	*1.13*	*0.40*	*0.55*	*0.64*	*0.84*	*0.32*	*0.44*	*0.51*	*0.66*
Mean	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	**1**	*0.53*	*0.73*	*0.86*	*1.17*	*0.39*	*0.54*	*0.64*	*0.87*	*0.31*	*0.43*	*0.51*	*0.69*
Mean	0.8	0.8	0.8	0.8	0.8	0.8	*0.41*	*0.57*	*0.68*	*0.87*	*0.30*	*0.42*	*0.50*	*0.64*	*0.24*	*0.34*	*0.40*	*0.51*
Mean	1.2	1.2	1.2	1.2	1.2	1.2	*0.56*	*0.77*	*0.92*	*1.54*	*0.41*	*0.57*	*0.68*	*1.14*	*0.33*	*0.46*	*0.54*	*0.90*
Mean	1.2	0.5	0.8	1	1	0.65	*0.44*	*0.61*	*0.71*	*0.84*	*0.32*	*0.45*	*0.53*	*0.62*	*0.26*	*0.36*	*0.42*	*0.49*
Mean	1.5	1	1.5	1.5	1.5	1.25	*0.62*	*0.86*	*1.01*	*1.68*	*0.46*	*0.64*	*0.75*	*1.24*	*0.37*	*0.50*	*0.60*	*0.99*
							HR reference points				HR reference points for survey catchability Q				HR reference points for survey catchability Q			
	Pattern of Natural Mortality					Mean	relative to Survey estimates (1st April)				relative to Survey estimates (1st April)				relative to Survey estimates (1st April)			
	M0	M1	M2	M3	M4+	M(1:2)	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Minimum	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	**1**	*0.50*	*0.71*	*0.85*	*0.89*	*0.37*	*0.53*	*0.63*	*0.66*	*0.30*	*0.42*	*0.50*	*0.53*
Minimum	0.8	0.8	0.8	0.8	0.8	0.8	*0.39*	*0.55*	*0.65*	*0.67*	*0.29*	*0.41*	*0.49*	*0.49*	*0.23*	*0.32*	*0.39*	*0.39*
Minimum	1.2	1.2	1.2	1.2	1.2	1.2	*0.55*	*0.77*	*0.90*	*1.13*	*0.41*	*0.57*	*0.67*	*0.84*	*0.33*	*0.45*	*0.53*	*0.67*
Minimum	1.2	0.5	0.8	1	1	0.65	*0.41*	*0.58*	*0.69*	*0.66*	*0.31*	*0.43*	*0.51*	*0.49*	*0.24*	*0.34*	*0.40*	*0.39*
Minimum	1.5	1	1.5	1.5	1.5	1.25	*0.61*	*0.83*	*0.98*	*1.21*	*0.45*	*0.62*	*0.73*	*0.90*	*0.36*	*0.49*	*0.58*	*0.71*

Assuming catchability for anchovy equal to catchability for sardine in *PELAGO* survey Q=1.35
And maximum catchability equal to the one estimated for *PELAGO* in SPICT Qmax=1.7 (aprox).

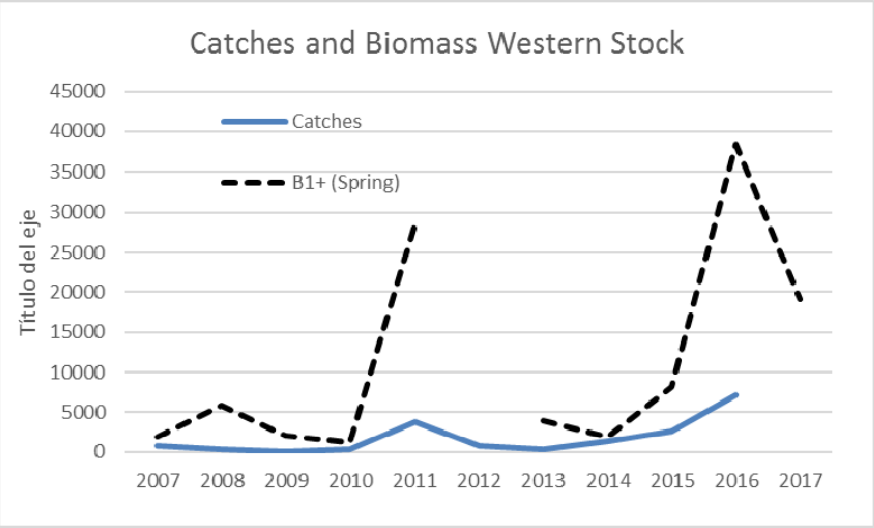
→ Effective Harvest Rate = HR /Q → Advice:

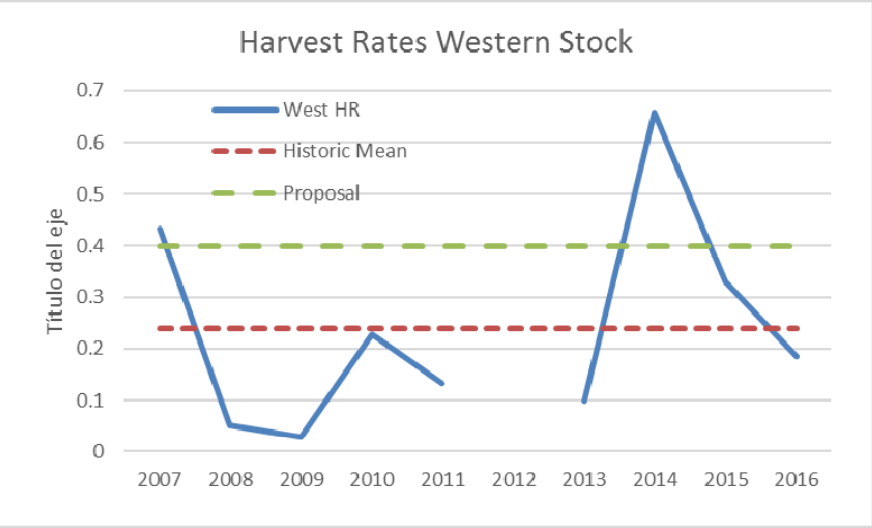
$$C_y = HR(S\%SBR) \cdot \frac{\hat{B}_y}{Q} = EHR(S\%SBR) \cdot \hat{B}_y$$

- **For Base case M and Sel.1: HR(50%SBR)= 0.54**
- **Effective HR(50%SBR) → EHR(50%SBR) = HR(50%SBR)/Q= 0.54/1.35 = 0.40**
- **If failing the assumption on fishing selectivity at age or about the Natural then Effective HR would assure to exploit the population at 40%SBR**
- **If failing on Q and it would be actually at 1.7 then selected HR would lead to about 35%SBR**

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ). 9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

❑ Yield per recruit analysis for selection of Sustainable F values and Harvest rates: **Proposal for Western Component.**





→ **Effective Harvest Rate → EHR(50%SBR)= 0.40**

→ **Mean (since 1999) HR = 0.24**

→ **It would assure (even at a catchability Qmax = 1.7) exploitation at 50%SBR (minimum value in Table=0.23 across M Patterns).**

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

❑ Yield per recruit analysis for selection of Sustainable F values and Harvest rates: **Seeking for a Precautionary Approach Advice for Western Component.**

							Survey Catchability Q =	1			Survey Catchability Q =	1.35			Survey Catchability Q =	1.7		
							HR reference points				HR reference points for survey catchability Q				HR reference points for survey catchability Q			
Selectiv.	Pattern of Natural Mortality					Mean	relative to Survey estimates (1st April)				relative to Survey estimates (1st April)				relative to Survey estimates (1st April)			
	M0	M1	M2	M3	M4+	M(1:2)	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Sel.1	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	1	*0.54*	*0.74*	*0.87*	*1.13*	*0.40*	*0.55*	*0.64*	*0.84*	*0.32*	*0.44*	*0.51*	*0.66*
Mean	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	1	*0.53*	*0.73*	*0.86*	*1.17*	*0.39*	*0.54*	*0.64*	*0.87*	*0.31*	*0.43*	*0.51*	*0.69*
Mean	0.8	0.8	0.8	0.8	0.8	0.8	*0.41*	*0.57*	*0.68*	*0.87*	*0.30*	*0.42*	*0.50*	*0.64*	*0.24*	*0.34*	*0.40*	*0.51*
Mean	1.2	1.2	1.2	1.2	1.2	1.2	*0.56*	*0.77*	*0.92*	*1.54*	*0.41*	*0.57*	*0.68*	*1.14*	*0.33*	*0.46*	*0.54*	*0.90*
Mean	1.2	0.5	0.8	1	1	0.65	*0.44*	*0.61*	*0.71*	*0.84*	*0.32*	*0.45*	*0.53*	*0.62*	*0.26*	*0.36*	*0.42*	*0.49*
Mean	1.5	1	1.5	1.5	1.5	1.25	*0.62*	*0.86*	*1.01*	*1.68*	*0.46*	*0.64*	*0.75*	*1.24*	*0.37*	*0.50*	*0.60*	*0.99*
							HR reference points				HR reference points for survey catchability Q				HR reference points for survey catchability Q			
	Pattern of Natural Mortality					Mean	relative to Survey estimates (1st April)				relative to Survey estimates (1st April)				relative to Survey estimates (1st April)			
	M0	M1	M2	M3	M4+	M(1:2)	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Minimum	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	1	*0.50*	*0.71*	*0.85*	*0.89*	*0.37*	*0.53*	*0.63*	*0.66*	*0.30*	*0.42*	*0.50*	*0.53*
Minimum	0.8	0.8	0.8	0.8	0.8	0.8	*0.39*	*0.55*	*0.65*	*0.67*	*0.29*	*0.41*	*0.49*	*0.49*	*0.23*	*0.32*	*0.39*	*0.39*
Minimum	1.2	1.2	1.2	1.2	1.2	1.2	*0.55*	*0.77*	*0.90*	*1.13*	*0.41*	*0.57*	*0.67*	*0.84*	*0.33*	*0.45*	*0.53*	*0.67*
Minimum	1.2	0.5	0.8	1	1	0.65	*0.41*	*0.58*	*0.69*	*0.66*	*0.31*	*0.43*	*0.51*	*0.49*	*0.24*	*0.34*	*0.40*	*0.39*
Minimum	1.5	1	1.5	1.5	1.5	1.25	*0.61*	*0.83*	*0.98*	*1.21*	*0.45*	*0.62*	*0.73*	*0.90*	*0.36*	*0.49*	*0.58*	*0.71*

Precautionary approach to avoid HR lim accounting for survey uncertainty:

Defining HR_lim as the HR_0.1 (which in some other long living species might be taken as target)

Assuming catchability for anchovy equal to catchability for sardine in *PELAGO* survey Q=1.35

For the lower range of Nat Mort. (0.8) and for the minimum across selectivity at age patterns (So using a Risk Averse approach) **The minimum of HR_0.1 values is = 0.49 = HR_lim**

By analogy with the relationship between Flim and Fpa (Fpa = Flim × exp(−1.645 × σ) (ICES suggest default σ =0.2)

→ **We can call HR(PA) = HR_lim * exp(-1.645*Sigma) =0.32 (at sigma=0.25) or 0.30 (at sigma=0.30)**

→ **Adopting HR(PA)=0.30 → Advice for every year as: Cy = HR(PA)*By = 0.30 * By**

Property: Managing with HR(PA)=0.30 leads to 50%SBR in the long term for a Q=1.35 or 40%SBR for a Q=1.7

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

❑ Yield per recruit analysis for selection of Sustainable F values and Harvest rates: **Seeking for a Precautionary Approach Advice for Western Component.**

							Survey Catchability Q = 1				Survey Catchability Q = 1.35				Survey Catchability Q = 1.7			
							HR reference points				HR reference points for survey catchability Q				HR reference points for survey catchability Q			
Selectiv.	Pattern of Natural Mortality					Mean	relative to Survey estimates (1st April)				relative to Survey estimates (1st April)				relative to Survey estimates (1st April)			
	M0	M1	M2	M3	M4+	M(1:2)	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Sel.1	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	1	*0.54*	*0.74*	*0.87*	*1.13*	*0.40*	*0.55*	*0.64*	*0.84*	*0.32*	*0.44*	*0.51*	*0.66*
Mean	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	1	*0.53*	*0.73*	*0.86*	*1.17*	*0.39*	*0.54*	*0.64*	*0.87*	*0.31*	*0.43*	*0.51*	*0.69*
Mean	0.8	0.8	0.8	0.8	0.8	0.8	*0.41*	*0.57*	*0.68*	*0.87*	*0.30*	*0.42*	*0.50*	*0.64*	*0.24*	*0.34*	*0.40*	*0.51*
Mean	1.2	1.2	1.2	1.2	1.2	1.2	*0.56*	*0.77*	*0.92*	*1.54*	*0.41*	*0.57*	*0.68*	*1.14*	*0.33*	*0.46*	*0.54*	*0.90*
Mean	1.2	0.5	0.8	1	1	0.65	*0.44*	*0.61*	*0.71*	*0.84*	*0.32*	*0.45*	*0.53*	*0.62*	*0.26*	*0.36*	*0.42*	*0.49*
Mean	1.5	1	1.5	1.5	1.5	1.25	*0.62*	*0.86*	*1.01*	*1.68*	*0.46*	*0.64*	*0.75*	*1.24*	*0.37*	*0.50*	*0.60*	*0.99*
							HR reference points				HR reference points for survey catchability Q				HR reference points for survey catchability Q			
	Pattern of Natural Mortality					Mean	relative to Survey estimates (1st April)				relative to Survey estimates (1st April)				relative to Survey estimates (1st April)			
	M0	M1	M2	M3	M4+	M(1:2)	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Minimum	**1.2**	**0.8**	**1.2**	**1.2**	**1.2**	1	*0.50*	*0.71*	*0.85*	*0.89*	*0.37*	*0.53*	*0.63*	*0.66*	*0.30*	*0.42*	*0.50*	*0.53*
Minimum	0.8	0.8	0.8	0.8	0.8	0.8	*0.39*	*0.55*	*0.65*	*0.67*	*0.29*	*0.41*	*0.49*	*0.49*	*0.23*	*0.32*	*0.39*	*0.39*
Minimum	1.2	1.2	1.2	1.2	1.2	1.2	*0.55*	*0.77*	*0.90*	*1.13*	*0.41*	*0.57*	*0.67*	*0.84*	*0.33*	*0.45*	*0.53*	*0.67*
Minimum	1.2	0.5	0.8	1	1	0.65	*0.41*	*0.58*	*0.69*	*0.66*	*0.31*	*0.43*	*0.51*	*0.49*	*0.24*	*0.34*	*0.40*	*0.39*
Minimum	1.5	1	1.5	1.5	1.5	1.25	*0.61*	*0.83*	*0.98*	*1.21*	*0.45*	*0.62*	*0.73*	*0.90*	*0.36*	*0.49*	*0.58*	*0.71*

Precautionary approach correcting the Target HR to account for survey uncertainty:

Assuming catchability for anchovy equal to catchability for sardine in *PELAGO* survey Q=1.35

For the proposed Effective EHR(50%SBR)=0.40 at Q=1.35 for the Base case M and Sel.1

In order to be sure that applied HR is not above the target for the uncertainty of the survey estimate (For its CV),

By analogy with the relationship between Flim and Fpa ($Fpa = Flim \times \exp(-1.645 \times \sigma)$)

→ **We can call HR(PATarget) = EHR50%SBR * exp(-1.645*Sigma) = 0.27 (at sigma=0.25) or 0.29 (at sigma=0.2)** (ICES allows $\sigma = 0.2$)

→ **Adopting HR(PA)=0.29 → Advice for every year as: Cy = HR(PA)*By = =0.29 * By**

Property: Managing with HR(PA)=0.29 assures 50%SBR in the long term for a Q=1.35 or 40%SBR for a Q=1.7

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

❑ Yield per recruit analysis for selection of Sustainable F values and Harvest rates: **Seeking for a Precautionary Approach Advice for Western Component.**

Precautionary Harvest Rate (to avoid HR_lim)

Precautionary approach to avoid HR lim accounting for survey uncertainty

↓

At Q=1.35
Robust to M and Selectivity uncertainty
HR(PA) = HR_lim * exp(-1.645*Sigma)
HR(PA) =0.30 (at sigma=0.30)

↓

Target but Precautionary Harvest Rate

Precautionary approach correcting the Target HR to account for survey uncertainty

↓

For the proposed Effective HER(50%SBR)=0.4
at Q=1.35 for the base case M and Sel.1
HR(PATarget) = EHR(50%SBR) * exp(-1.645*Sigma)
HR(PATarget) =0.29 (at sigma=0.20, as suggested by ICES)

↓

→ **Proposed Precautionary and risk averse sustainable HR = MIN [HR(PATarget) ; HR(PA)] = 0.29**

Property: Managing with HR(PATarget)= 0.29 leads to 50%SBR in the long term for a Q=1.35 or 40%SBR for a Q=1.7.

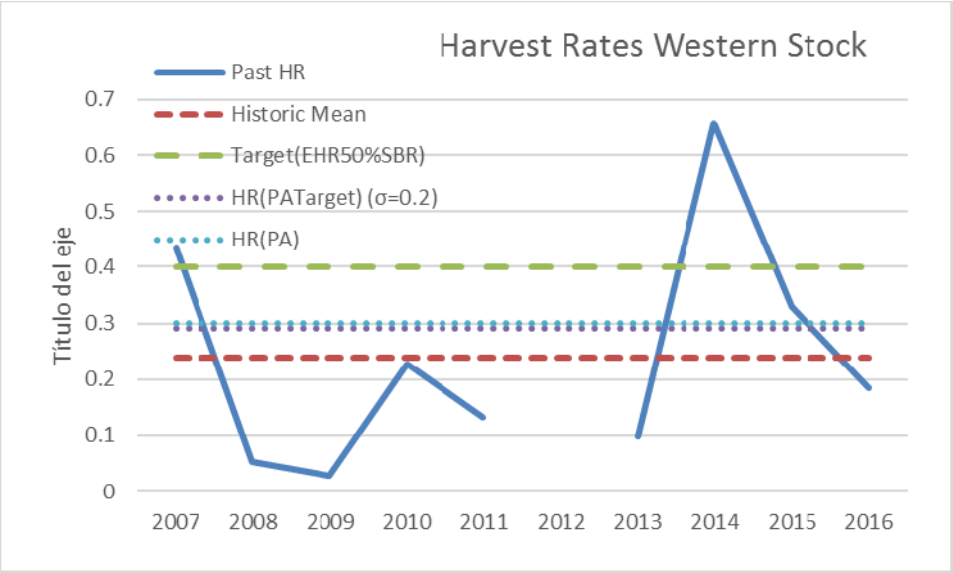
↓

Proposed In-year Advice for every year: Cy = HR(PATarget) * By = 0.29 * By

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).

9a West (and 9a South). Sustainability for different catch options based on a prior assessment of sustainable harvest rates for the survey monitoring the stock (based on a Yield per Recruit analysis).

❑ Yield per recruit analysis for selection of Sustainable F values and Harvest rates: **Seeking for a Precautionary Approach Advice for Western Component.**



→ **Mean Past HR = 0.24**

→ **for a Q=1.35 Target EHR(50%SBR) = 0.4 → HR(PATarget) =0.29 (σ = 0.2)**

→ **for a Q=1.35 Risk Averse Limit HR= HR_0.1 = 0.49 → HR(PA) =0.30 (σ = 0.3)**

→ **Proposed Precautionary and risk averse sustainable HR = MIN [HR(PATarget) : HR(PA)] = 0.29**

Property: Managing with HR(PATarget)= 0.29 leads to 50%SBR in the long term for a Q=1.35 or 40%SBR for a Q=1.7

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).
9a West. WKPELA CONCLUSIONS.

❑ SPICT:

- **Not accepted** to provide reliable assessment and proxies of MSY reference points of anchovy in 9a West.
- Further exploration to improve the model is needed (to reduce confidence limits of parameter estimates):
  - Seasonal data (to increase the data set).
  - Fixing additional parameters (B/K, acoustic survey observation error).
  - Include autumn surveys.
  - Include an environmental indicator (Chla).

❑ Deterministic approach for provision of in-year advice for anchovy 9a based on survey biomass estimates and sustainable harvest rates from Y/R analysis:

- **Approach not sufficiently tested or convincing as to adopt it**.
- Diverges from the standard ICES methods/advices for DLS (ICES, 2012) and from the ones being used for other short-lived stocks like sprat. Use of ICES standards is recommended.

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).
9a West. WKPELA PROPOSAL.

❑ PROPOSAL: An <u>interim</u> solution whilst a more appropriate form of the advice rule for DLS 3.2 for short-lived species is developed by WKLIFE (WKLIFE VIII?).

• Trends-based assessment, where the **(in-year) advice** is derived from changes in trends with **uncertainty caps (20%) applied** (the **1/2 rule**):

$$C_y = C_{y-1} \frac{I_y}{\sum_{y-2}^{y-1} I_i/2}$$

• Starting catch for C_{y-1} for the advice this year (July 2018):

  ✓ Catches in 2017, for a management calendar based on calendar years. Catch options for the period from January to June in the year *y* should be decided by ICES & managers.

  ✓ Catches from July 2017 to June 2018, <u>for a management year lasting from July in the year *y* to June in the year *y+1*</u>. <u>Best option since it does not require update advice.</u>

• C_{y-1} in the following years: catch advice of the former period.

• The 20% uncertainty cap might not be appropriate for short-lived species.

• The size (20%) of the precautionary buffer applied to changes in last year's TAC seems too small for a short-lived species like anchovy and should be evaluated through simulations.

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).
9a South. Single-species Gadget.

MARGARITA'S PREZI ON Gadget

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).
9a South. WKPELA CONCLUSIONS.

❑ Gadget:

• Appears to capture the main trends of the stock component and provides a satisfactory fit to the compositional data, particularly after 2001, when a minimum landing size was implemented for the anchovy fishery. Effect of omitting pre-2001 data is minimum.

• *BOCADEVA* (DEPM), *ECOCADIZ-RECLUTAS* and *SAR_NOV* (autumn-acoustic) too short series to evaluate the coherence with other data and to provide useful contrasts to the model. Inclusion should be examined at a new benchmark, when they are longer.

• M showed as a sensible setting.

• Some retrospective pattern but it was not a cause of huge concern.

• Underestimation of the size at Age 2+. But minimal effects as the number of Age 1 is dominant in catches. This issue should be monitored, particularly if the survival of Age 1 becomes higher between years.

• **Reviewers' view: supported the full analytical (Category 1) assessment** for the Southern Stock Component **as well as the choice of values of Reference Points and Advice Rules**, since they are in accordance with the ICES guidance (ICES fisheries management reference points for category 1 and 2 stocks).....**BUT**.....

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).
9a South. WKPELA CONCLUSIONS.

❑ Gadget (cont'd):

• The resulting **absolute levels of biomass and catchability** (**quite high** for the surveys series considered in the model: *PELAGO* and *ECOCADIZ*) **do not seem to be credible**.

• The current assessment was considered to produce a **too uncertain scaling of the population levels**.

• Further investigation and exploration of the catchability issue is needed before a future Benchmark.

• Local Experts proposed Category 2. ICES is trying to eliminate Category 2 from the list (misinterpretations by the managers when dealing with relative values). Category 2 is not an option for this stock.

WKPELA 2018-Benchmark Assessment WK (12-16/02/2018, ICES HQ).
9a South. WKPELA PROPOSAL.

❑ PROPOSAL:

• The agreed decision from WKPELA is to consider for the time being this stock component as a Category 3 stock (3.2).

• The assessment will be done in exactly the same manner as for western stock component (an in-year variation of the method 3.2).

• The Gadget assessment, while not reaching the full analytical stage , provides trends for Biomass, Recruitment and Fishing pressure.

• The "1/2 rule" formulation will make use of the Gadget-based Biomass estimates as indicative of trends only, instead of the direct survey estimates.

• The same considerations on timing of the advice and starting catch for C_{y-1} for the advice this year (July 2018) for the Western Component are also valid for the Southern one.