Reference points and short-term forecast for WKBANSP 2024: Anchovy in ICES Subdivision 9a South (ane.27.9a Southern component)

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Biological Reference points

The methodology applied was the same decided in WKPELA 2018 (page 286 of WKPELA 2018 report (ICES, 2018)) following ICES guidelines for calculation of reference points for category 1 and 2 stocks and the report of the workshop to review the ICES advisory framework for short lived species ICES WKMSYREF5 2017 (ICES, 2017).

According to the above ICES guidelines and the $S-R$ plot characteristics (Figure 1), this stock component can be classified as a “stock type 5” (i.e. stocks showing no evidence of impaired recruitment or with no clear relation between stock and recruitment (no apparent $S-R$ signal)).

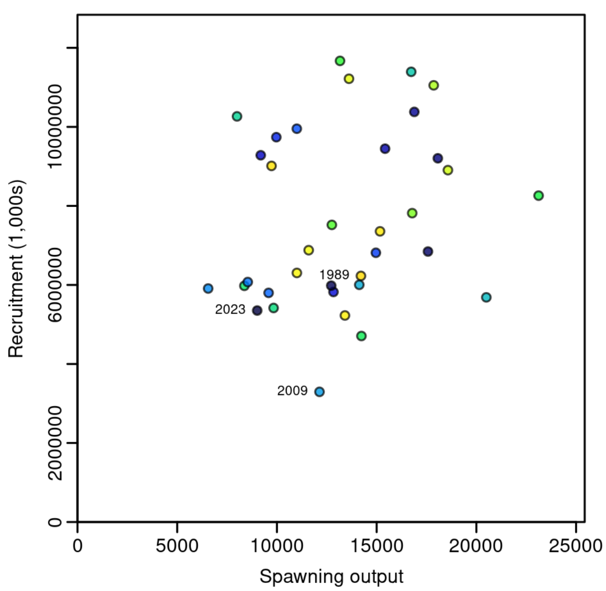

Figure 1: ane.27.9a Southern stock. Stock-recruit curve. Point colors indicate year, with warmer colors indicating earlier years and cooler colors in showing later years.

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The estimation of B_{lim} was carried out assuming $B_{lim} = B_{loss}$. For the 9a South anchovy, B_{loss} was calculated based on the estimated SSB in 2010, with a value of 6552.06 t, representing 39% of the unfished biomass ($B_0 = 16865$ t). This value falls below the range suggested by WKREF1 and WKREF2 (ICES, 2022), which recommend setting B_{lim} between 10% and 25% of B_0, depending on the species' life-history characteristics.

Three alternative methods were evaluated to calculate B_{lim}: a) $B_{lim} = 0.2 \times B_0$, b) $B_{lim} = B_{loss}$, and c) $B_{lim} = B_{pa} \times e^{-1.645 \times \sigma_B}$, where $B_{pa} = B_{loss}$ and σ_B is the standard deviation of $ln(SSB)$ in the terminal year of the assessment, accounting for uncertainty in the SSB. If σ_B is unknown, ICES guidelines recommend using a default value of $\sigma = 0.20$, or $\sigma = 0.30$ for small pelagic species.

The results of these alternatives are presented in Table 1 and Figure 2. Using $\sigma = 0.2$ provides an intermediate solution between the assessment's estimated value and the recommended value for small pelagic species, ensuring that B_{lim} is calculated in accordance with the stock's biological characteristics and ICES guidelines. Therefore, the recommended value is $B_{lim} = B_{pa} \times e^{-1.645 \times \sigma_B} = 4715$ tonnes, with $B_{pa} = B_{loss}$ and $\sigma_B = 0.2$, as applied in other fisheries.

The adopted approach aligns with guidelines for Type 6 stocks, characterized by a narrow SSB dynamic range and no evidence of impaired recruitment. Notably, using B_{loss} as B_{pa} rather than B_{lim} avoids an excessively high B_{lim}, which would represent approximately 0.4 B_0—indicating a relatively narrow range of biomass values covered in the assessment. This method offers a more suitable baseline for the stock's management.

Table 1: Alternative options for Technical basis for Blim calculation.

Technical basis Blim	SigmaB	Blim (tonnes)	Fraction B0
0.2*B0		3373	0.20
Bloss		6552	0.39
Bpa*exp(-1.654*sigmaB)	0.3	4000	0.24
Bpa*exp(-1.654*sigmaB)	**0.2**	**4715**	**0.28**
Bpa*exp(-1.654*sigmaB)	0.1	5542	0.33

Note: The bold row indicates the recommended method for calculating Blim.

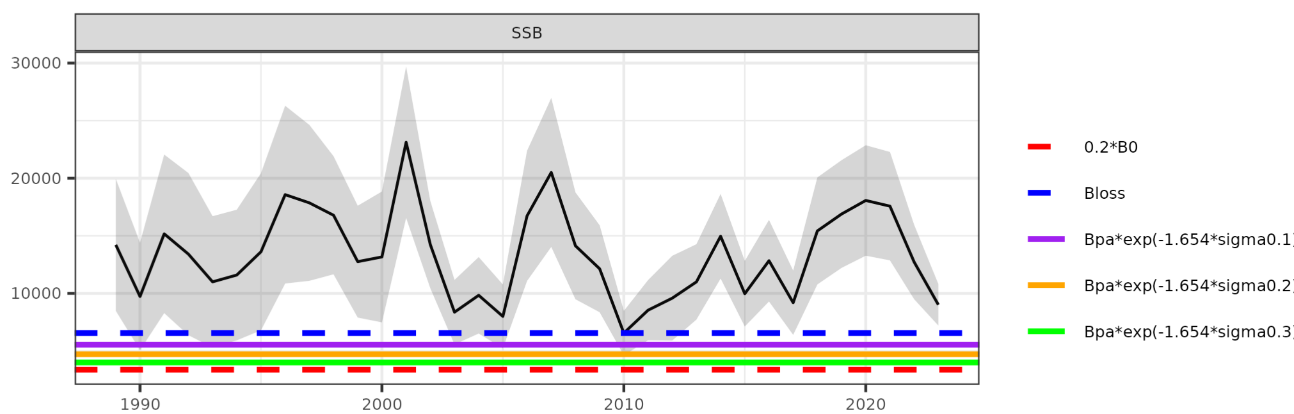

Figure 2: ane.27.9a Southern stock. Time series of estimated spawning biomass (tons) for 9a South anchovy, compared with three methods for calculating B_{lim}: a) $B_{lim} = 0.2 \times B_0$, b) $B_{lim} = B_{loss}$, and c) $B_{lim} = B_{pa} \times e^{-1.645 \times \sigma_B}$, with $\sigma_B = 0.1$, 0.2, and 0.3.

Short-term predictions

The SS3 forecast module was used to perform short-term projections, considering the model's final year conditions, associated uncertainties, and varying fishing intensities. The initial stock size was derived from the abundance at ages 0-3 on January 1 of the final assessment year, while the spawning stock biomass (SSB) was estimated for April 1. Natural mortality and maturity rates were held constant, with selectivity and weight-at-age averaged over the last three years. Recruitment for the forecast year was projected using the Stock Synthesis Beverton-Holt stock-recruitment relationship and the geometric mean of the last three years recruitment.

Status quo fishing mortality (Fsq) was calculated as the average across the last three years, by fleet and season (FfleetQ1=0.29, FfleetQ2=1.65, FfleetQ3=2.93, FfleetQ4=1.7). The Figures 3 and 4 show the short-term predictions of catch and SSB evaluated at different fishing mortality levels, under the recruitment projection scenario based the stock-recruitment relationship used in the model to forecast (Table 2) and the geometric mean of the last three years recruitment (Table 3).

Multipliers of the status quo fishing mortality (Fsq*Mult) of 0, 1, 1.2, 1.6, and 2,0 were evaluated. Additionally, an iterative process was used to identify the multiplier that would achieve a 2024 and 2025 catch with probabilities of 5% and 50% that SSB in 2024 and 2025 would fall below $Blim$ ($p(SSB < Blim) = 0.05$ and 0.5, respectively). These multipliers were adjusted according to the projected recruitment scenarios, providing management options based on different levels of fishing mortality. Tables 4 y 5 presents the management options derived from the short-term forecasts, evaluated at different fishing mortality levels, corresponding to the catch scenarios described previously.

The management options derived from these short-term projections entail shifting the timing of the advice to year-end, with assessments in November and management recommendations for the following calendar year (January to December).

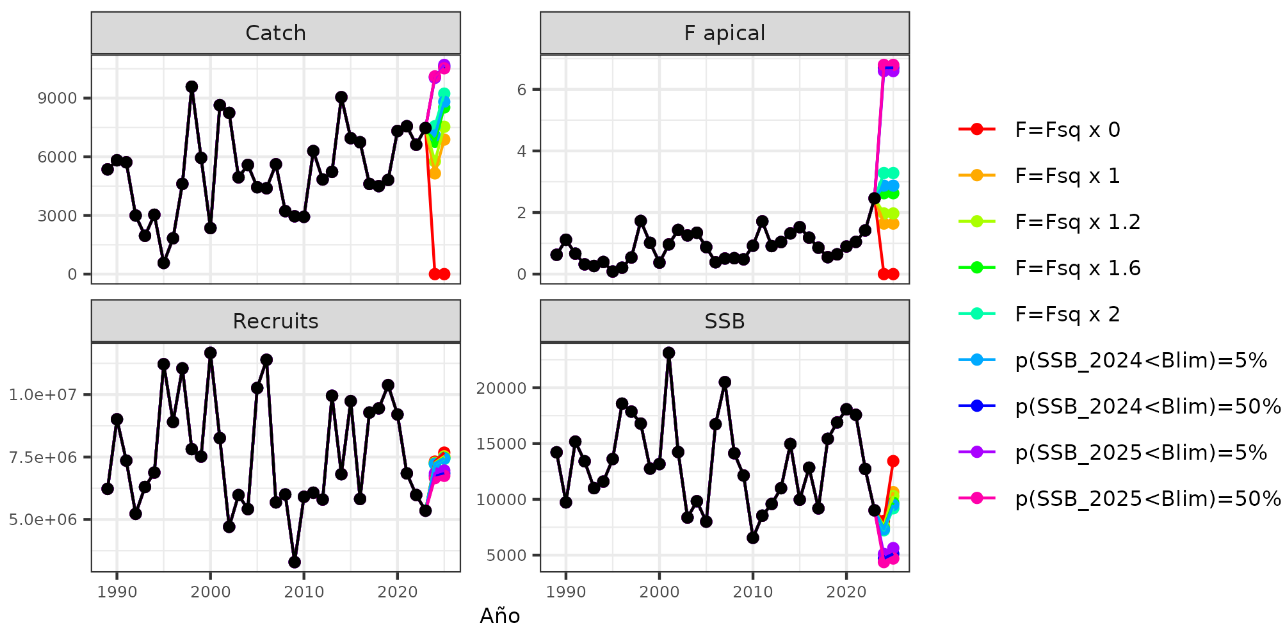

Figure 3: ane.27.9a Southern stock. Short-term predictions of catch and SSB evaluated at different fishing mortality levels, under the recruitment projection scenario based on the **Beverton-Holt (BH)** stock-recruitment relationship.

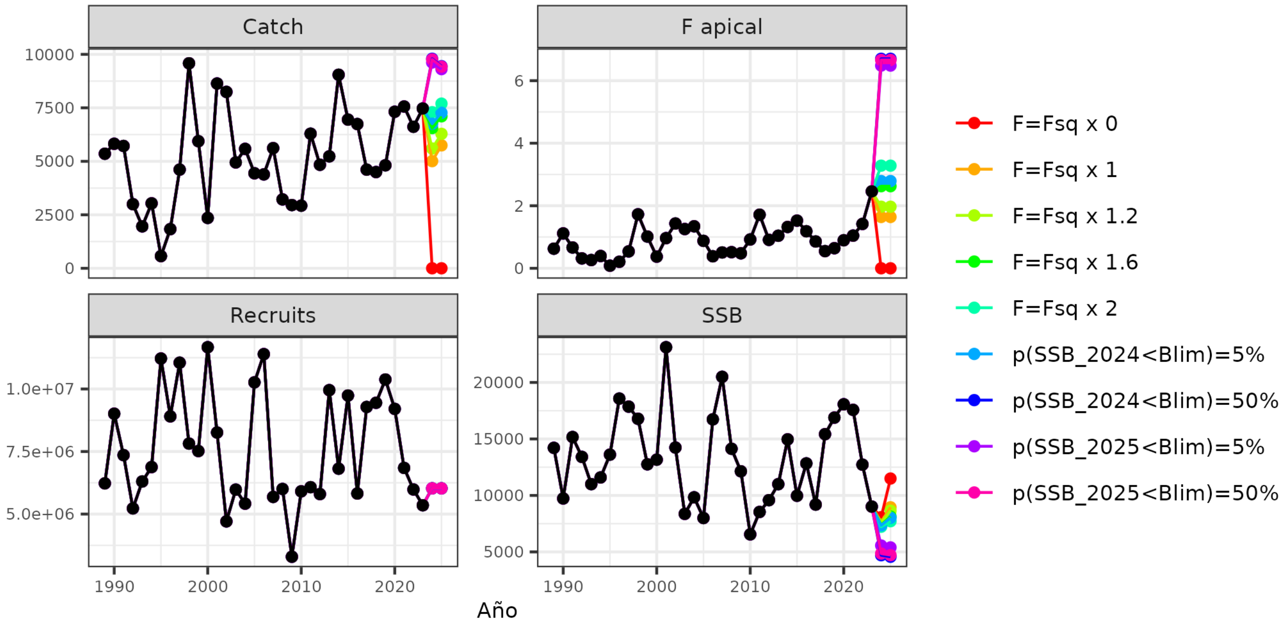

Figure 4: ane.27.9a Southern stock. Short-term predictions of catch and SSB evaluated at different fishing mortality levels, under the recruitment projection scenario based on the **geometric mean** of the last three years recruitment.

Table 2: The table presents apical fishing mortality (F apical 2024), recruitment (Rec) for 2024 estimated as the **Beverton-Holt (BH)** stock-recruitment relationship.

	Fapical 2024	Recruitment 2024
F=Fsq x 0	0.00	7317300
F=Fsq x 1	1.64	7268860
F=Fsq x 1.2	1.97	7258930
F=Fsq x 1.6	2.63	7238820
F=Fsq x 2	3.28	7218390
p(SSB_2024<Blim)=5%	2.87	7231200
p(SSB_2024<Blim)=50%	6.70	6749750
p(SSB_2025<Blim)=5%	6.59	6849810
p(SSB_2025<Blim)=50%	6.80	6656210

Table 3: The table presents apical fishing mortality (F apical 2024), recruitment (Rec) for 2024 estimated as the **geometric mean** of the last three years recruitment

	Fapical 2024	Recruitment 2024
F=Fsq x 0	0.00	6029030
F=Fsq x 1	1.64	6029030
F=Fsq x 1.2	1.97	6029030
F=Fsq x 1.6	2.63	6029030
F=Fsq x 2	3.28	6029030
p(SSB_2024<Blim)=5%	2.79	6029030
p(SSB_2024<Blim)=50%	6.70	6029030
p(SSB_2025<Blim)=5%	6.48	6029030
p(SSB_2025<Blim)=50%	6.66	6029030

Table 4: Short-term management options evaluated for different F multipliers, under the recruitment projection scenario based on the **Beverton-Holt (BH)** stock-recruitment relationship. The table presents, projected catches 2024 in tonnes, spawning stock biomass (SSB) for 2024 and 2025 in ton, and the probability of SSB falling below B_{lim} in 2024 and 2025.

	Fapical 2024	Catch 2024	SSB 2024	SSB 2025	p(SSB 2024 < Blim)	p(SSB 2025 < Blim)
F=Fsq x 0	0.00	0.00	8071.69	13427.50	0.03	0.00
F=Fsq x 1	1.64	5149.28	7639.00	10645.00	0.04	0.00
F=Fsq x 1.2	1.97	5764.95	7555.30	10293.00	0.04	0.00
F=Fsq x 1.6	2.63	6770.10	7390.65	9695.14	0.05	0.00
F=Fsq x 2	3.28	7560.72	7229.62	9196.14	0.06	0.00
p(SSB_2024<Blim)=5%	2.87	7087.19	7329.85	9498.59	0.05	0.00
p(SSB_2024<Blim)=50%	6.70	10077.97	4707.22	5120.50	0.50	0.24
p(SSB_2025<Blim)=5%	6.59	10034.83	5108.24	5632.79	0.36	0.05
p(SSB_2025<Blim)=50%	6.80	10111.38	4376.70	4699.63	0.64	0.51

Table 5: Short-term management options evaluated for different F multipliers, under the recruitment projection scenario based on the **geometric mean** of the last three years recruitment. The table presents, projected catches 2024 in ton, spawning stock biomass (SSB) for 2024 and 2025 in ton, and the probability of SSB falling below B_{lim} in 2024 and 2025.

	Fapical 2024	Catch 2024	SSB 2024	SSB 2025	p(SSB 2024 < Blim)	p(SSB 2025 < Blim)
F=Fsq x 0	0.00	0.00	8071.69	11494.10	0.03	0.00
F=Fsq x 1	1.64	5008.94	7639.00	8949.79	0.04	0.00
F=Fsq x 1.2	1.97	5598.41	7555.30	8642.42	0.04	0.00
F=Fsq x 1.6	2.63	6552.99	7390.65	8130.94	0.05	0.00
F=Fsq x 2	3.28	7295.54	7229.62	7714.61	0.06	0.00
p(SSB_2024<Blim)=5%	2.79	6755.18	7350.06	8019.53	0.05	0.00
p(SSB_2024<Blim)=50%	6.70	9793.97	4703.98	4571.73	0.50	0.63
p(SSB_2025<Blim)=5%	6.48	9619.33	5566.53	5398.19	0.24	0.05
p(SSB_2025<Blim)=50%	6.66	9763.19	4851.67	4713.38	0.45	0.50