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

María José Zúñiga[*], Margarita María Rincón[†], Fernando Ramos[‡]

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)).

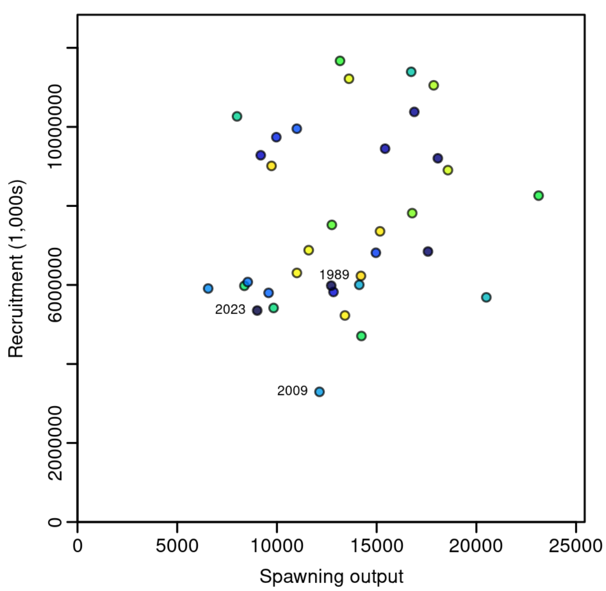

Figure 1: ane.27.9a Southern stock. Stock-recruit curve. Point colors indicate year, with warmer colors indicating earlier years and cooler colors in showing later years.

[*]Centro Oceanográfico de Cádiz (COCAD-IEO), CSIC
[†]Centro Oceanográfico de Cádiz (COCAD-IEO), CSIC
[‡]Centro Oceanográfico de Cádiz (COCAD-IEO), CSIC

According to this classification, B_{lim} estimation is possible according to the standard method and it is assumed to be equal to $Bloss$ ($B_{lim} = B_{loss}$). The value of B_{loss} for the 9a South anchovy corresponds to the estimated SSB in 2010 (6552.06 t), hence B_{lim} is set at 6552.06 t. This value of B_{loss} represents 0.39% of the unfished biomass ($B_0 = 1.6865 \times 10^4$ t). In accordance with ICES guidelines, it is recommended to adjust B_{loss} in such cases, assuming $B_{loss} = B_{pa}$. Following ICES guidelines, B_{pa} is calculated as:

$$B_{pa} = e^{(-1.645\sigma)} B_{lim},$$

where $\sigma_{assessment}$ is the estimated standard deviation of $ln(SSB)$ in the last year of the assessment, accounting for uncertainty in SSB for the terminal year. According to this, $\sigma_{assessment}$ is calculated as:

$$\sigma_{assessment} = \sqrt{\ln\left(1 + \left(\frac{\sigma_{SSB_{2023}}}{\mu_{SSB_{2023}}}\right)^2\right)} = \sqrt{\ln\left(1 + \left(\frac{919.608}{9011.44}\right)^2\right)} = 0.1$$

If this value is unknown, a default of $\sigma = 0.20$ can be used, while the suggested value for small pelagic species is $\sigma = 0.30$. Using 0.2 provides an intermediate solution between the estimated value from assessment 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.

Then $B_{pa} = e^{(1.645\sigma)} B_{lim} = 0.16 B_{lim} = 0.16 * 6552$. According to this, B_{pa} is set at 5542 t.

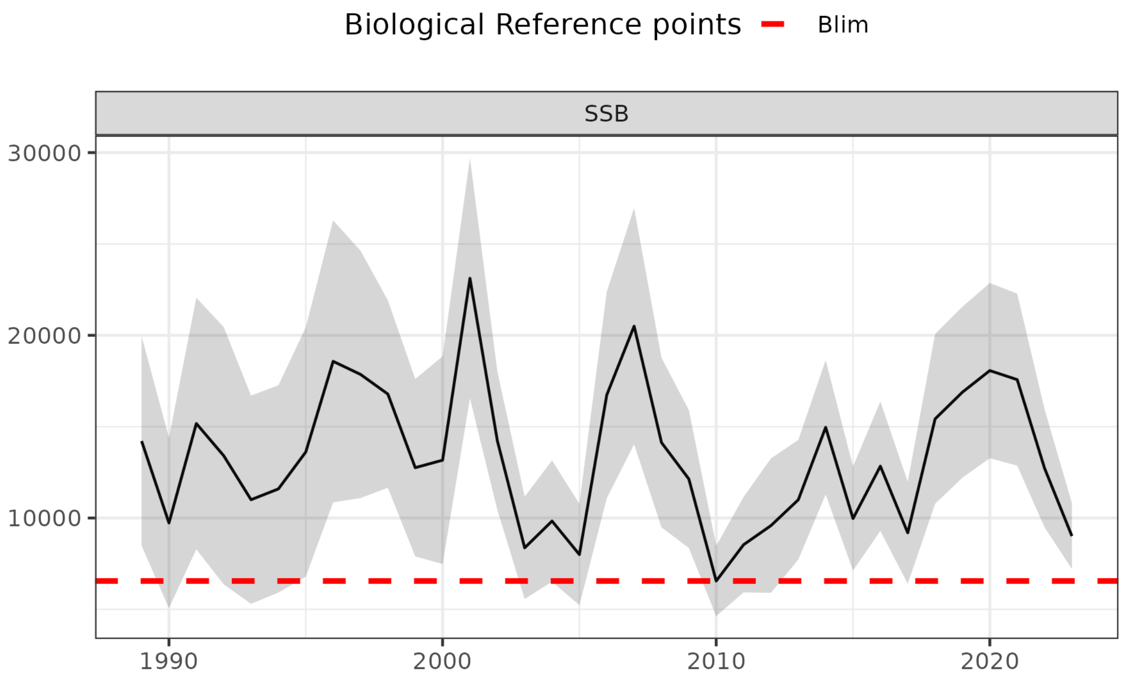

Figure 2: ane.27.9a Southern stock. Time series estimated by the model for spawning biomass (in tons) with Biological reference points

Short-term predictions

SS3 includes a forecast module that enables projections for a specified number of years, linked to the model ending conditions, associated uncertainties, and a specified level of fishing intensity. This tool was used to perform the short-term projections.

The initial stock size was estimated from the abundance by ages (0-3) on January 1 of the final assessment year, and the spawning stock biomass (SSB) on April 1. Natural mortality and maturity rates remained constant, while selectivity and weight-at-age were averaged over the last three years.

The probability of SSB in 2024 and 2025 falling below B_{lim}, $p(SSB_{2025} \leq B_{lim})$, was evaluated under different F_{sq} multipliers, using the standard deviation of the model. The evaluated F multipliers ($FMult$) were 0, 1, 1.2, 1.6, and 2. Additionally, an iterative process identified the $FMult$ that would allow achieving a 2024 catch with probabilities of 5% and 50% that SSB in 2025 falls below B_{lim} ($p(SSB_{2025} \leq B_{lim}) =$ 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 presents the management options derived from the short-term forecasts, evaluated at different fishing mortality levels, corresponding to the catch scenarios described previously.

The Figures , shows two recruitment projection scenarios were considered: the stock-recruitment relationship used in the model to forecast (Table) and the geometric mean of the last three years recruitment (Table). The *status quo* fishing mortality ($F_{sq} = 0.9$) was calculated as the average of the last three years by fleet and season.

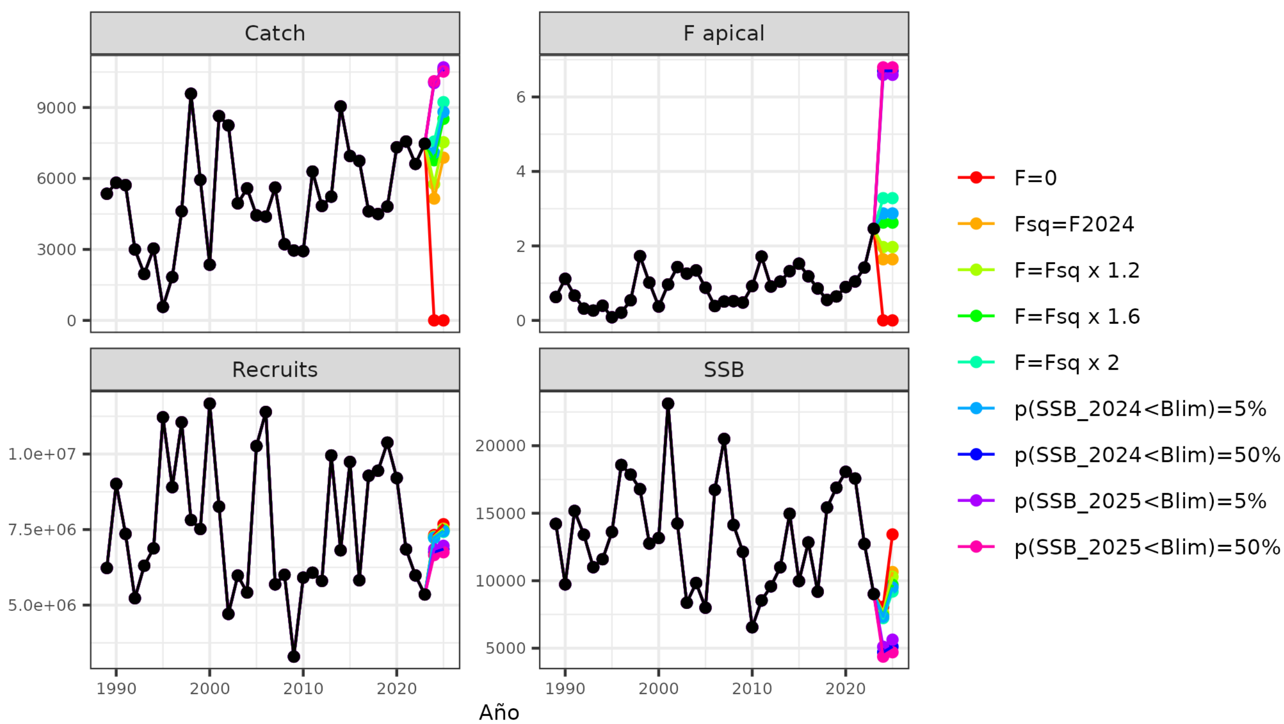

Figure 3: ane.27.9a Southern stock. Short-term predictions of catch and SSB evaluated at different fishing mortality levels, under the recruitment projection scenario based on the **Beverton-Holt (BH)** stock-recruitment relationship.

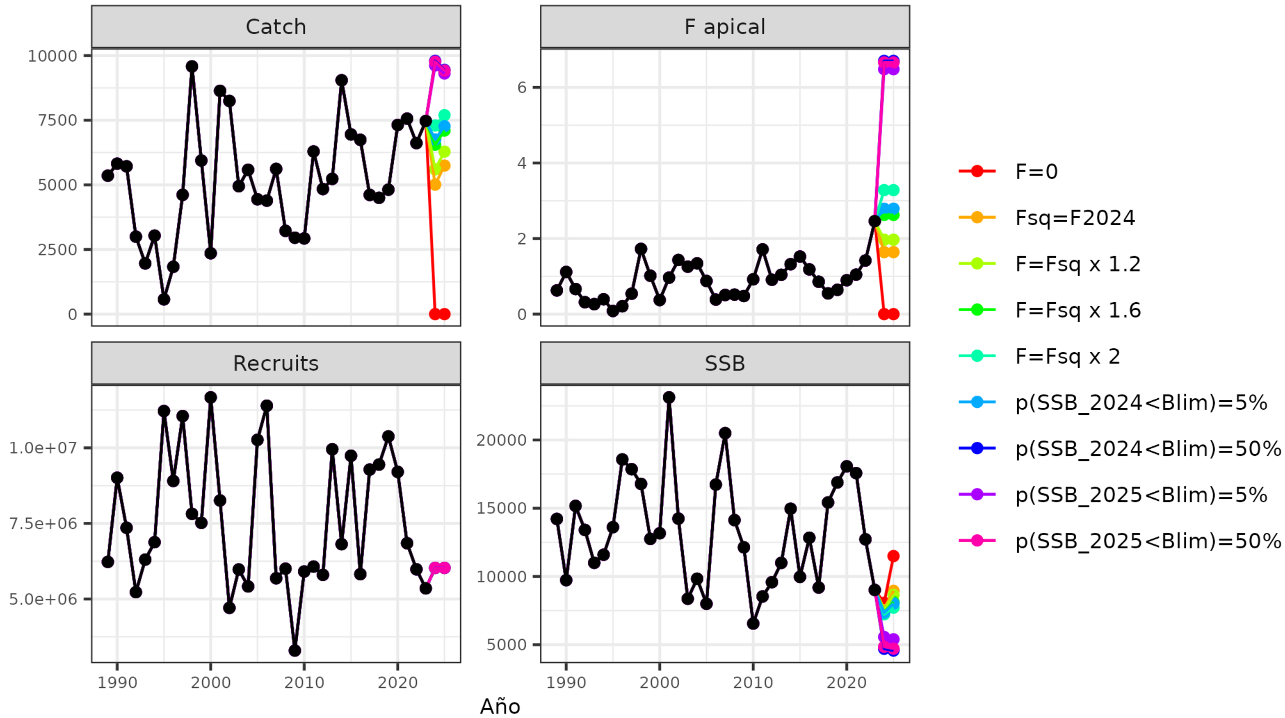

Figure 4: ane.27.9a Southern stock. Short-term predictions of catch and SSB evaluated at different fishing mortality levels, under the recruitment projection scenario based on the **geometric mean** of the last three years recruitment.

Table 1: The table presents apical fishing mortality (F apical 2024), recruitment (Rec) for 2024 estimated as the **Beverton-Holt (BH)** stock-recruitment relationship.

FMult	F_2024	Rec_2024
F=0	0.00	7317300
Fsq=F2024	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 2: The table presents apical fishing mortality (F apical 2024), recruitment (Rec) for 2024 estimated as the **geometric mean** of the last three years recruitment

FMult	F_2024	Rec_2024
F=0	0.00	6029030
Fsq=F2024	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 3: 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 ton, spawning stock biomass (SSB) for 2024 and 2025 in ton, and the probability of SSB falling below B_{lim} in 2024 and 2025.

esc	F_2024	Catch2024	SSB2024	SSB2025	p.SSB2024.Blim.	p.SSB2025.Blim.
F=0	0.00	0.00	8071.69	13427.50	0.03	0.00
Fsq=F2024	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 4: 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.

esc	F_2024	Catch2024	SSB2024	SSB2025	p.SSB2024.Blim.	p.SSB2025.Blim.
F=0	0.00	0.00	8071.69	11494.10	0.03	0.00
Fsq=F2024	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