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)).

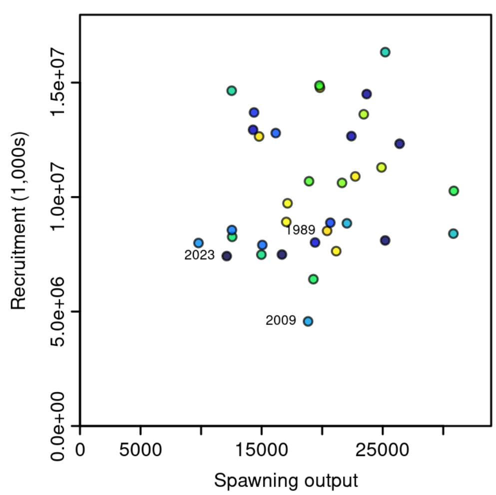

Figure 1: ane.27.9a Southern stock. Stock-recruit curve. Point colors indicate year, with warmer colors indicating earlier years and cooler colors in showing later years.

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

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the estimated SSB in 2010 (9786.95 t), hence B_{lim} is set at 9786.95 t. Note that age 1+ individuals (B_1+) are assumed as mature i.e. B_1+ class is equivalent to Stock Spawning Biomass (SSB).

ICES recommends to calculate B_{pa} as follows:

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

where σ is the estimated standard deviation of $ln(SSB)$ in the last year of the assessment, accounting for the uncertainty in SSB for the terminal year.

In that case assuming that SSB_{2023} and its corresponding standard deviation (sd) are the mean and the sd of a normal distribution, $ln(SSB_{2023})$ is lognormally distributed with standard deviation as follows:

$$\sigma = \sqrt{\ln\left(1 + \left(\frac{\sigma_{SSB_{2023}}}{\mu_{SSB_{2023}}}\right)^2\right)} = \sqrt{\ln\left(1 + \left(\frac{1728.32}{12116.9}\right)^2\right)} = 0.142$$

Then $B_{pa} = e^{(1.645\sigma)} B_{lim} = 0.23 B_{lim} = 0.23 * 9787$. According to this, B_{pa} is set at 1.2361×10^4 t.

Figure 2 shows the biological reference points for spawning biomass.

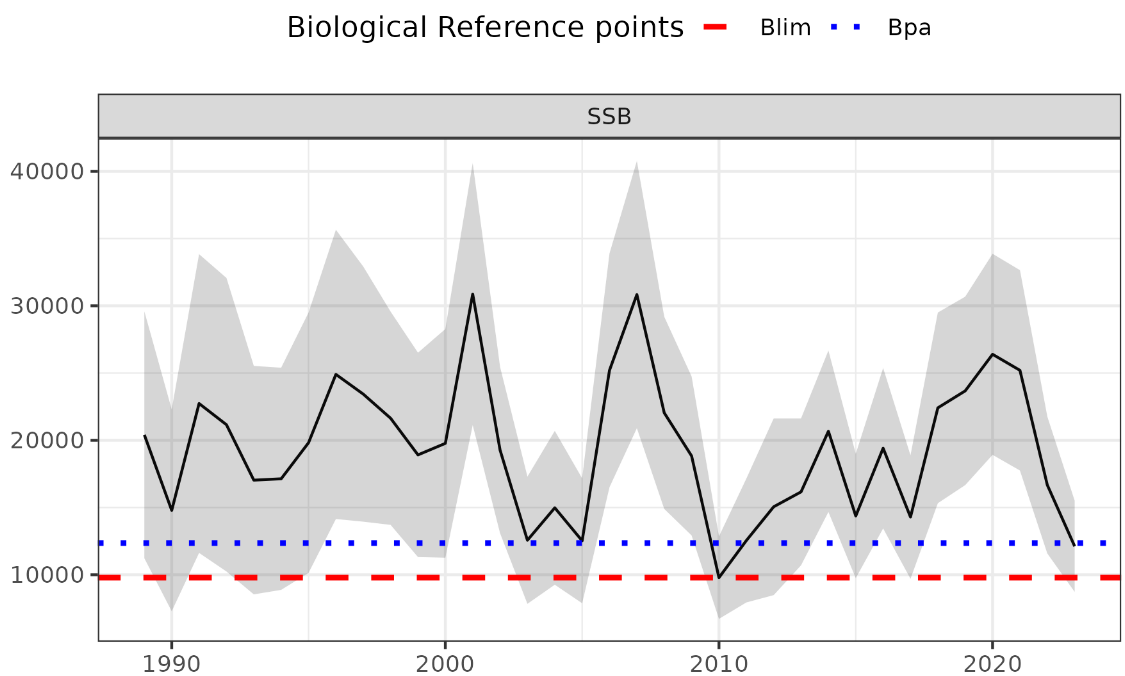

Figure 2: ane.27.9a Southern stock. Time series estimated by the model for spawning biomass (in tons) with Biological reference points

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 Figures 3 and 4, shows two recruitment projection scenarios were considered: the stock-recruitment relationship used in the model to forecast (Table 1) and the geometric mean of the last three years recruitment (Table 2). The *status quo* fishing mortality ($F_{sq} = 0.9$) was calculated as the average of the last three years by fleet and season.

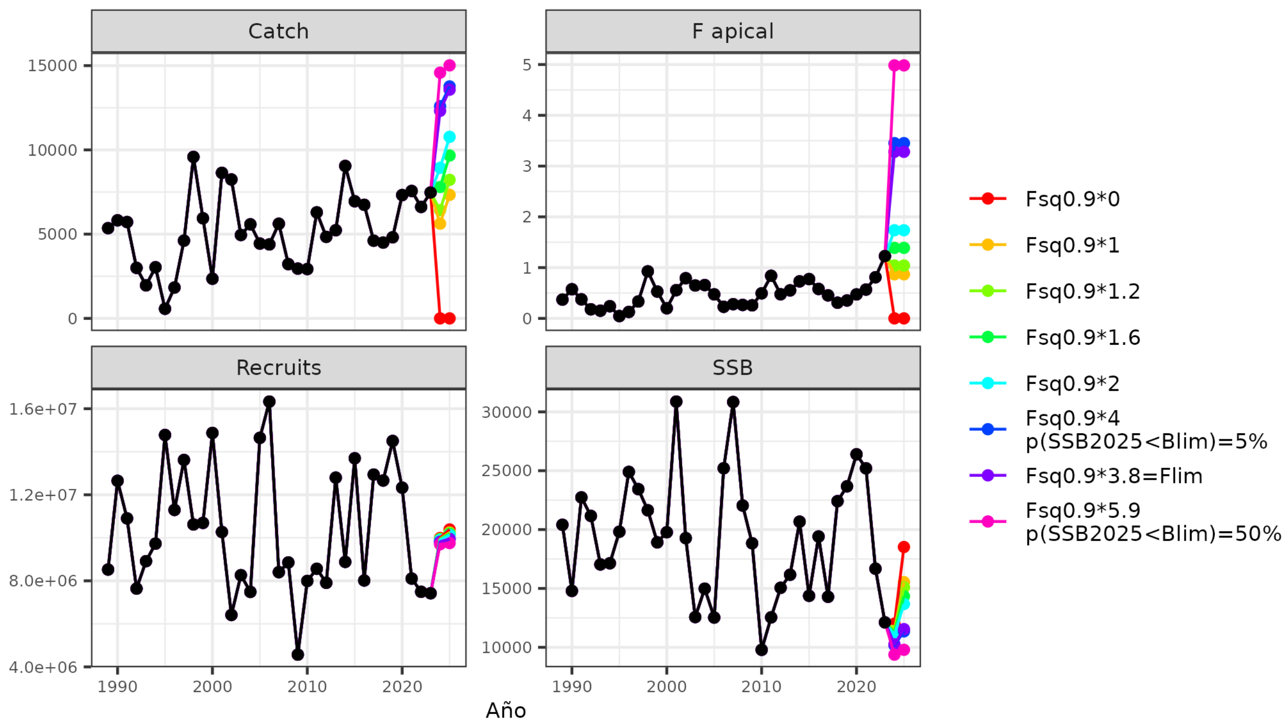

Figure 3: ane.27.9a Southern stock. Short-term predictions of catch and SSB evaluated at different fishing mortality levels, under the recruitment projection scenario based on the Beverton-Holt (BH) stock-recruitment relationship.

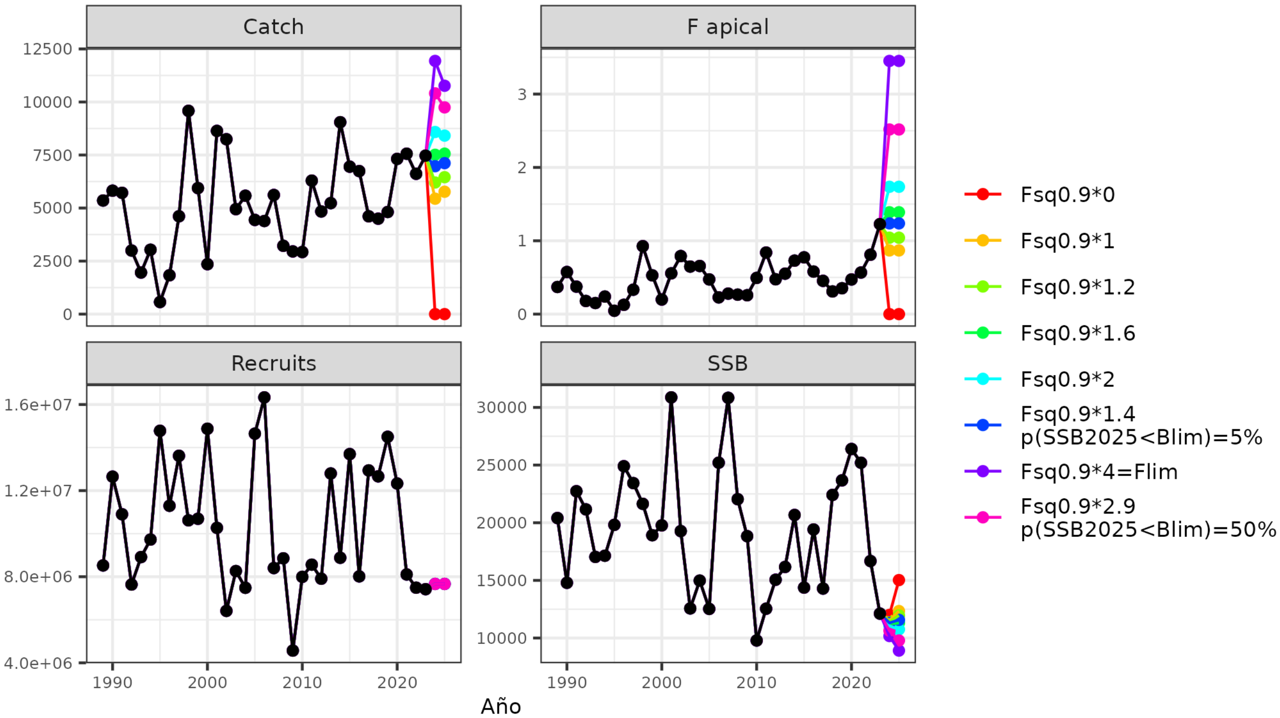

Figure 4: ane.27.9a Southern stock. Short-term predictions of catch and SSB evaluated at different fishing mortality levels, under the recruitment projection scenario based on the geometric mean of the last three years recruitment.

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
Fsq0.9*0	0.00	9993700
Fsq0.9*1	0.87	9948000
Fsq0.9*1.2	1.04	9938680
Fsq0.9*1.6	1.39	9919860
Fsq0.9*2	1.74	9900800
Fsq0.9*4 p(SSB2025<Blim)=5%	3.45	9802940
Fsq0.9*3.8=Flim	3.28	9812970
Fsq0.9*5.9 p(SSB2025<Blim)=50%	4.98	9700120

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
Fsq0.9*0	0.00	7666600
Fsq0.9*1	0.87	7666600
Fsq0.9*1.2	1.04	7666600
Fsq0.9*1.6	1.39	7666600
Fsq0.9*2	1.74	7666600
Fsq0.9*1.4 p(SSB2025<Blim)=5%	1.24	7666600
Fsq0.9*4=Flim	3.45	7666600
Fsq0.9*2.9 p(SSB2025<Blim)=50%	2.52	7666600

The probability of SSB in 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. An alternative scenario considered F_{lim} as the fishing mortality that generates a fraction of spawning biomass B_{lim}/B_0, based on the stock-recruitment relationship. Tables 3 y 4 presents the management options derived from the short-term forecasts, evaluated at different fishing mortality levels, corresponding to the catch scenarios described previously.

Table 3: Short-term management options evaluated for different F multipliers. 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	Catch2024	SSB2024	SSB2025	p(SSB2024<Blim)	p(SSB2025<Blim)
Fsq0.9*0	0.00	12004.6	18520.10	0.21	0.00
Fsq0.9*1	5621.06	11515.0	15535.80	0.25	0.00
Fsq0.9*1.2	6420.15	11419.5	15099.60	0.26	0.00
Fsq0.9*1.6	7796.27	11230.8	14333.30	0.28	0.00
Fsq0.9*2	8935.77	11045.3	13678.50	0.30	0.00
Fsq0.9*4 p(SSB2025<Blim)=5%	12589.99	10172.3	11354.00	0.43	0.07
Fsq0.9*3.8=Flim	12317.45	10256.2	11543.40	0.42	0.05
Fsq0.9*5.9 p(SSB2025<Blim)=50%	14582.19	9377.5	9786.41	0.58	0.50

Table 4: Short-term management options evaluated for different F multipliers. 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	Catch2024	SSB2024	SSB2025	p(SSB2024<Blim)	p(SSB2025<Blim)
Fsq0.9*0	0.00	12004.6	15027.60	0.21	0.00
Fsq0.9*1	5439.87	11515.0	12338.70	0.25	0.02
Fsq0.9*1.2	6204.05	11419.5	11958.80	0.26	0.03
Fsq0.9*1.6	7511.75	11230.8	11302.80	0.28	0.07
Fsq0.9*2	8584.63	11045.3	10754.90	0.30	0.16
Fsq0.9*1.4 p(SSB2025<Blim)=5%	6972.42	11313.0	11574.60	0.27	0.05
Fsq0.9*4=Flim	11936.10	10172.3	8912.55	0.43	0.88
Fsq0.9*2.9 p(SSB2025<Blim)=50%	10407.09	10639.0	9786.74	0.36	0.50