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Review of the Growth Parameters and Length Metrics Used for the Assessment of the Peruvian Stock of Jack Mackerel (Far-North Stock) with the JJM Model Under the Two Stocks Hypothesis

Peru

REPORT

REVIEW OF THE GROWTH PARAMETERS AND LENGTH METRICS USED FOR THE ASSESSMENT OF THE PERUVIAN STOCK OF JACK MACKEREL (FAR-NORTH STOCK) WITH THE JJM MODEL UNDER THE TWO STOCKS HYPOTHESIS

1. Introduction

During the last Jack mackerel Benchmark Workshop, held in hybrid format between Monday 4 and Friday 8 July 2022, it was noted that "...*there is no need to transfer length frequencies to different metrics as long as the growth parameters are estimated with the same length metrics as the length frequencies*" (Paragraph 19 of the Workshop Report (SPRFMO 2022). In other words, as part of model configurations, metrics for length frequencies and growth parameters must be the same, whatever they are used: fork length (FL) or total length (TL).

As a result of this remark, we reviewed the growth parameters and length metrics used for the assessment of the Peruvian stock of Jack mackerel (the Far-north stock) with the JJM model under the two stocks hypothesis. According to this review, we found that growth parameters L_{inf} (asymptotic length) and L_0 (mean length at age 1) did not match those proposed by Dioses (2013) (**Table 1**). Moreover, regarding the metrics, we found that in most of the cases (excepting 2014) the metric used for the length frequencies data was expressed in FL, while the growth parameter metrics were expressed in TL (see **Table 2**).

Table 1. Growth parameters used for the assessment of the Peruvian stock of Jack mackerel (Far-north stock) under the two stocks hypothesis

	L_{inf}	t_0	k	L_0
Before review	80.40	-	0.16	18.00
After review (according to Dioses 2013)	80.77	-0.356	0.16	15.31

Table 2. Metrics used for length frequencies data and growth parameters for the assessment of the Far-north stock of Jack mackerel with the JJM model under the two-stock hypothesis

Year	Metric of data	Metric of growth parameters
1980-2013	FL	TL
2014	TL	TL
2015-2022	FL	TL

2. Methods

2.1. Description of analyses

Based on the findings described above, we proceeded to:

1) Standardize: i) the growth parameters used for the different model configurations to those proposed by Dioses (2013) and ii) the metrics for length frequencies data and growth parameters to FL for convenience regarding the current model configurations.

2) Update the data for the 2022 assessment.

3) Compare the use in the assessment of FL and TL as standard metric of data and growth parameters.

2.1.1 Standardization of growth parameters and metrics

The growth parameters used for the assessment of Jack mackerel are taken from Dioses (2013) which are expressed in TL. The L_{inf} parameter (in TL) was converted to FL using the equation of Cubillos and Arancibia (1995), where: $TL_{cm} = 0.514 + 1.091\, FL_{cm}$. The L_0 (mean length at age 1) was re-estimated in terms of TL using parameters of Dioses (2013), where: $Lt = 80.77(1 - e^{-0.155(t+0.356)})$, to later transformed it to FL using the equation of Cubilos and Arancibia (1995).

Regarding the standarization of data, we also used the equation of Cubillos and Arancibia (2005) to convert the length frequencies data for the year (i.e. 2014) that were in TL to FL.

We analyze the effect of the standardization of growth parameters and metrics on the trends of B, SSB, R and F series.

2.1.2 Update information for the 2022 assessment

Information about catch, catch at length, mean weight at age and CPUE were updated to June 2022, with estimated total catch projected to December 2022 according to the method used by the Scientific Committee-SPRFMO (that for the case of Peru corresponds to a 34.34% additional to the catch reported at the time of the SC meeting). Data description and parameters used for the 2022 assessment are presented in **Table 3**. More precise information regarding the 2022 assessment is provided in the Peruvian National Report N°2 (IMARPE 2022).

The effect of the progressive addition of updated data was also analyzed on the trends of B, SSB, R and F series.

Table 3. Data used in the 2022 assessment of the Peruvian (far-north) Jack mackerel stock

Type	Data	Details
From the fishery	Catch	1970-2022
	Catch-at-length	1980-2022
	CPUE	2002-2022
	Selectivity	Dome shaped
Fishery independent	Echo-abundance	1985-2014
	Selectivity	Logistic
Biological parameters	As those presented in Table 1 (after revision)	

2.1.3 Comparison of metrics (FL and TL) in the assessment

We also evaluated the effect of using the two metrics in the assessment, i.e., using growth parameters and size frequencies in FL but also in TL. The aim of this exercise was to verify the effect of the metric in the results of the assessment which in theory should be the same.

2.2 Model configurations

Model configurations for the analyses proposed in **2.1.1**, **2.1.2** and **2.1.3**, are presented in Table 4.

Table 4. Model configurations implemented in the 2022 JJM assessment of the Peruvian stock of Jack mackerel (Far-north stock)

Model	**Description**
Standardization of metrics	
model 0.0	As 2021 configuration and data
model 0.1	As in model 0.0 but with standardized metrics for fishery length composition data and growth parameters to fork length (FL)
Data update	
model 1.0	As model 0.1
model 1.1	As in model 1.0 but with revised catches through 2021 and projected 2022 catch estimates
model 1.2	As in model 1.1 but with updated length composition data to 2022
model 1.3	As in model 1.2 but with updated mean weight at age (2013-2022)
model 1.4	As in model 1.3 but with updated CPUE (2002-2022)

Comparison of metrics	
model 2.0	As model 1.4
model 2.1	As in model 2.0 but using the metric of TL for configuration and data

3. Results

We show the results of the Jack mackerel assessment to 2021 using growth parameters and size frequency as in 2021 (model 0) vs with the standardization of growth parameters and metrics (model 0.1) (**Figure 1**). This standardization produced an important change in the levels of total and spawning biomass, especially at the beginning and end of the series but not in the general trend (**Figure 1a** and **Figure 1b**). A smaller change is observed in the recruitment (**Figure 1c**) while fishing mortality did not show significant changes (**Figure 1d**).

The results of the Jack mackerel assessment for 2022 are in **Figure 2**. As data are updated in the assessment, Jack mackerel population indicators remain almost the same, although there are differences in the levels of total and spawning biomass in the first decades. The model 1.4 stands out for having included the more completed information for assessment (**Figure 2**).

The effect of the metric selection on the standardization (model 2.0 vs model 2.1) is presented in **Figure 3**. These results confirm that the assessment using data and parameters in TL or FL do not show significant changes. Besides, a summary of the results provided above in terms of total biomass and fishing mortalities are also presented in **Figure4**.

Finally, regarding the BRP as long as the parameters and data have standardised metrics this does not affect the calculation of BPRs (**Table 5**). This was corroborated in the results ofmodel 2.0 vs model 2.1.

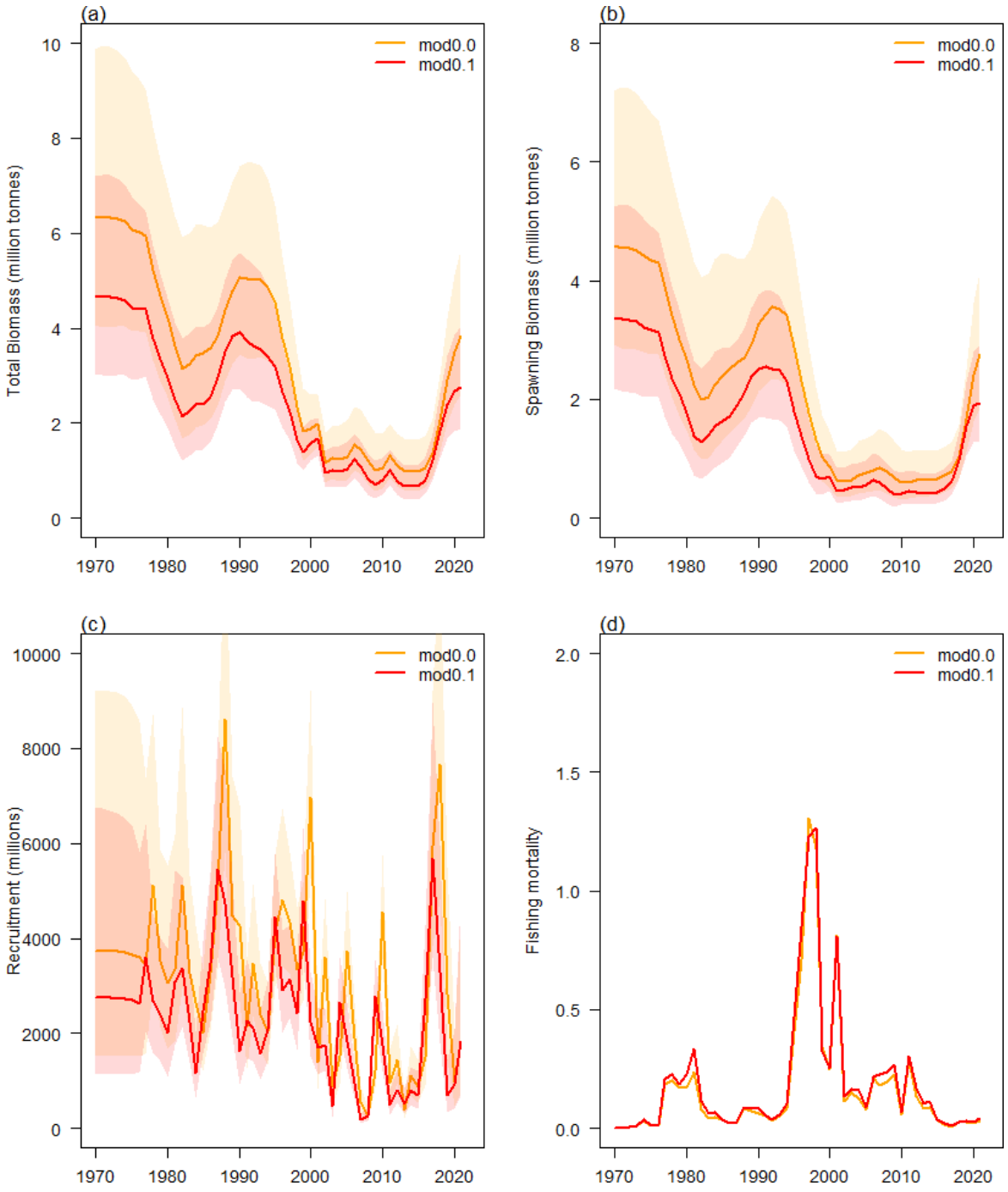

Figure 1. Estimated population indicators for the Peruvian stock of Jack mackerel resulting from the standardization of growth parameters and length metrics: a) total annual biomass; b) total annual spawning biomass; c) total annual recruitment and d) total annual fishing mortality rate.

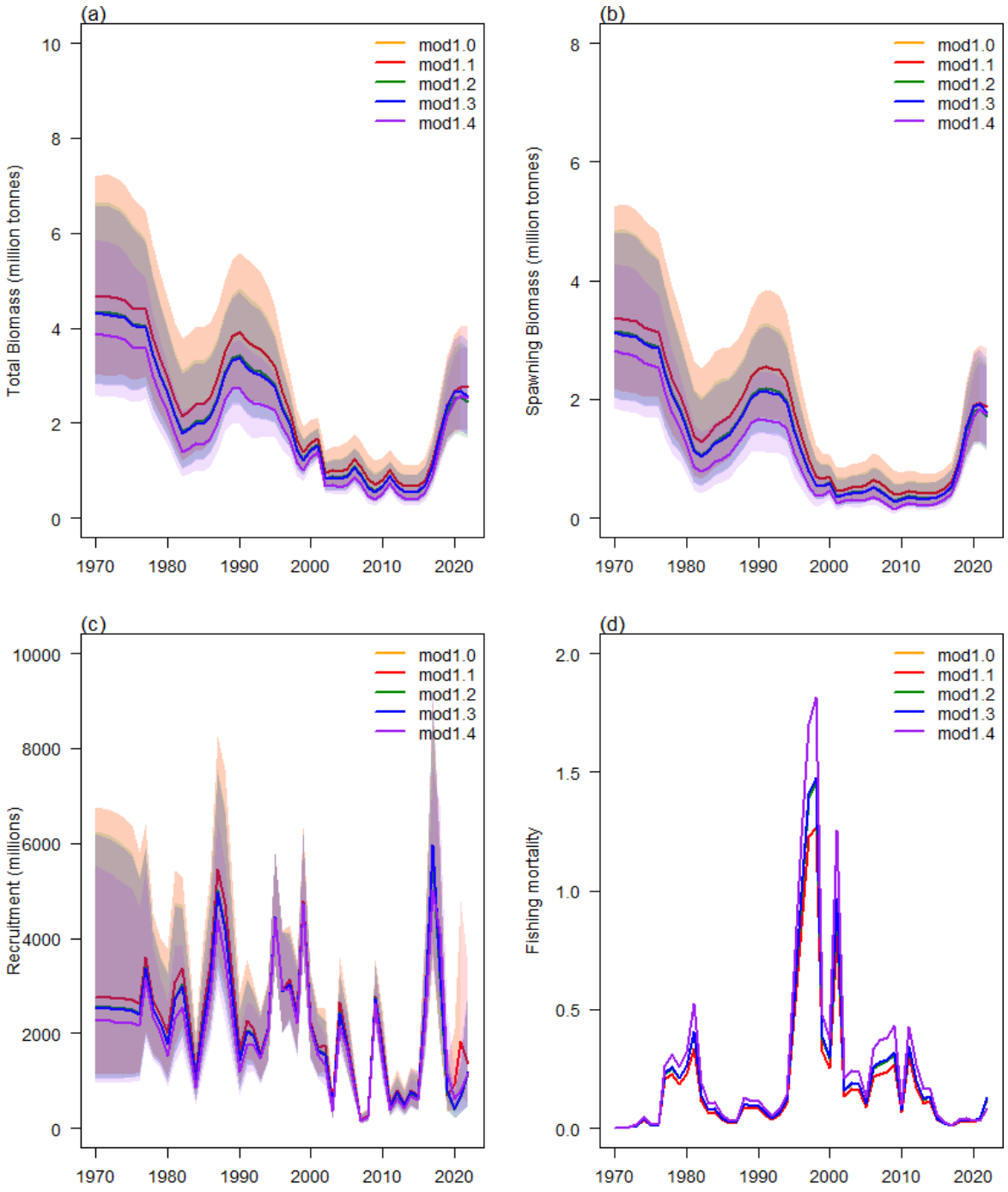

Figure 2. Estimated population indicators for the Peruvian stock of Jack mackerel resulting from the addition of updated data: a) total annual biomass; b) total annual spawning biomass; c) total annual recruitment and d) total annual fishing mortality rate.

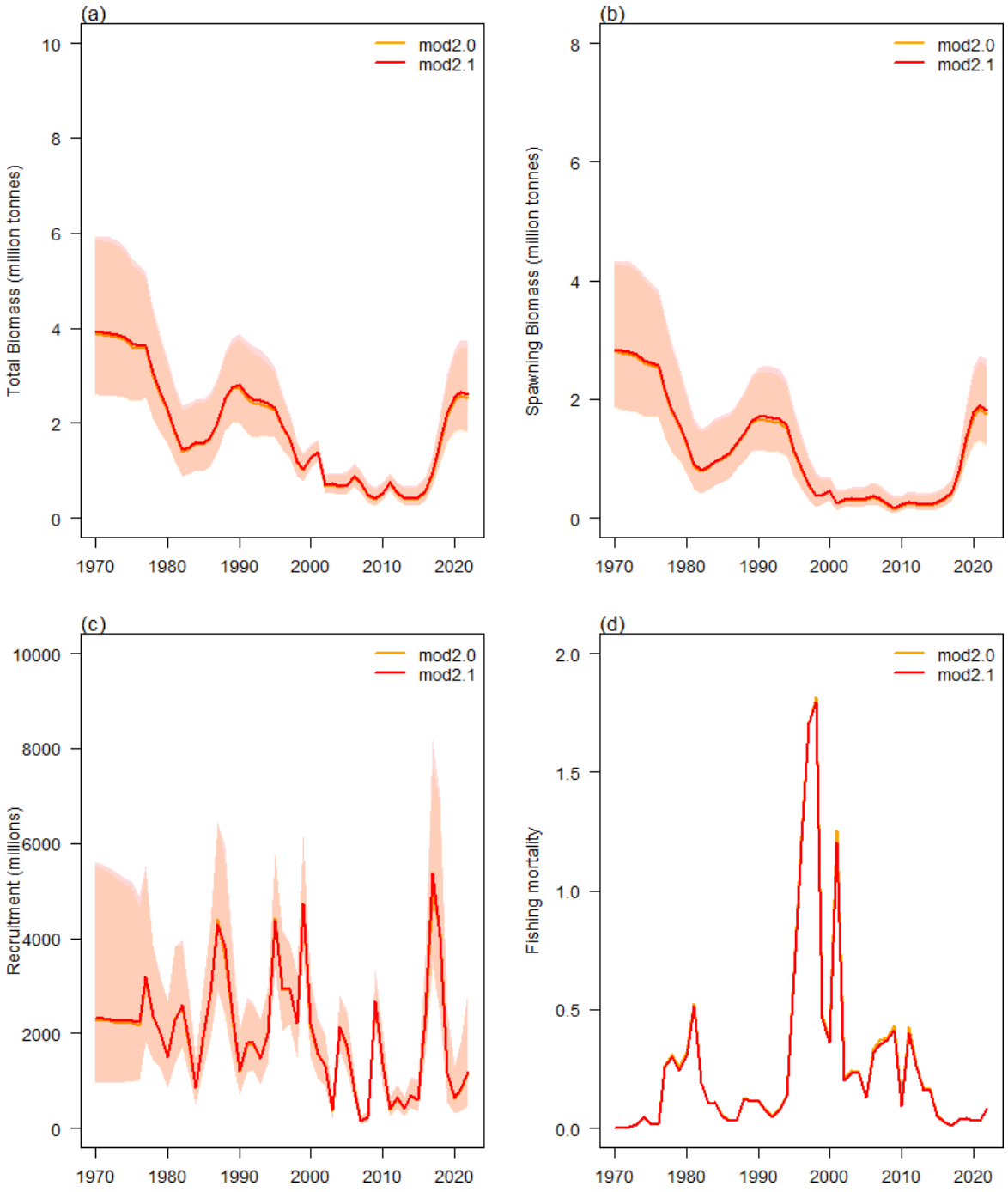

Figure 3. Estimated population indicators for the Peruvian stock of Jack mackerel resulting from the use of different length metrics: a) total annual biomass; b) total annual spawning biomass; c) total annual recruitment and d) total annual fishing mortality rate.

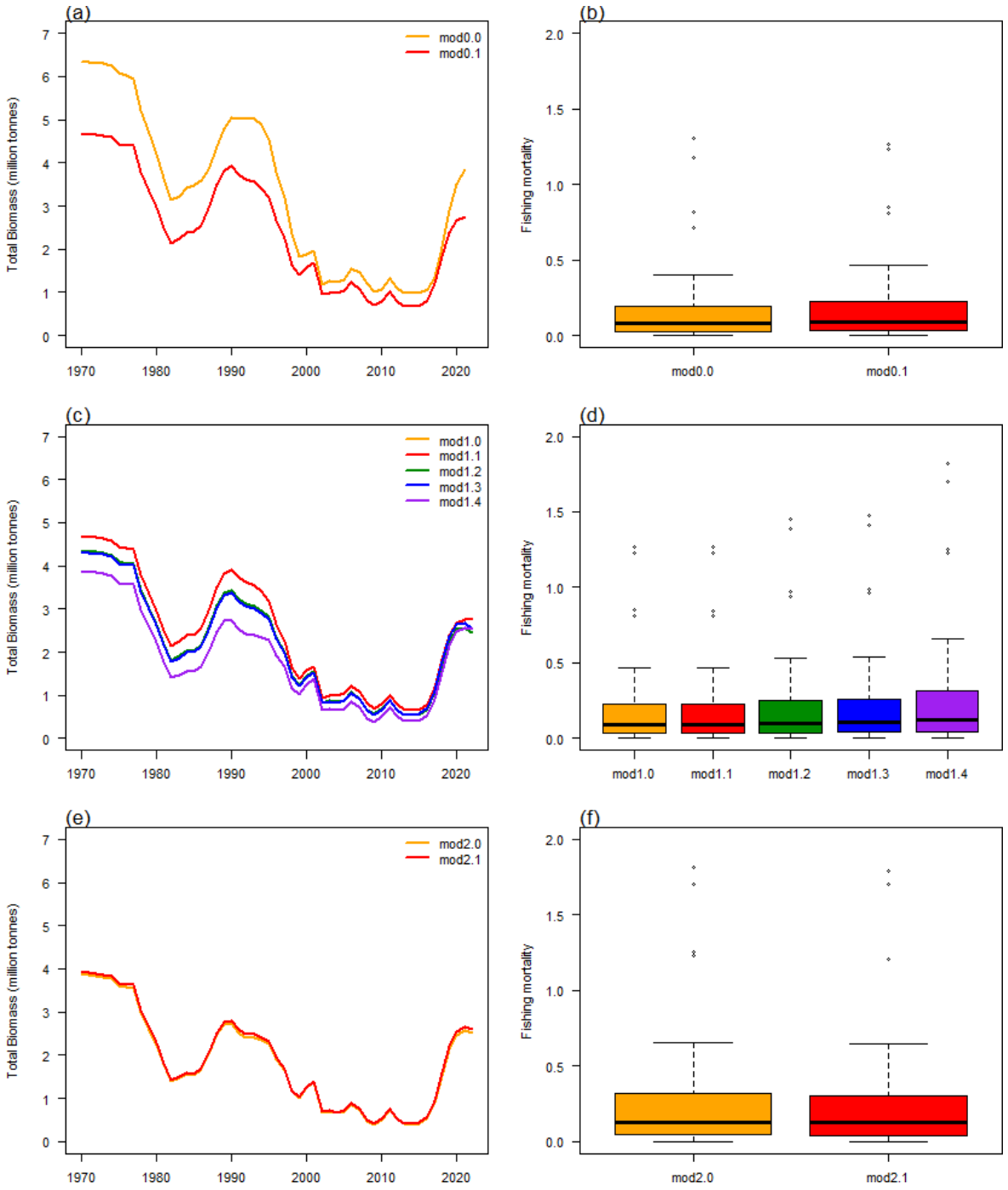

Figure 4. Results of the final JJM model configuration showing the estimated total biomasses of Jack mackerel (panels a, c and e) and boxplots of fishing mortality (panels b, dand f) for the three model groups respectively.

Tabla 5. Estimated biological reference points according to evaluation model

	Fmsy	Bmsy	Catch Fmsy
mod2.0	0.230	278.30	208.32
mod2.1	0.228	283.02	215.15

4. Conclusion

The present analysis has allowed us to standardize the growth parameters and the metrics of size frequency data for the assessment of the Peruvian stock of Jack mackerel with the JJM model under the two-stocks hypothesis. The effect of this standardization was observedas an important change in the levels of total and spawning biomass (but not in the general trend), a smaller change in the recruitment and almost no change in the level of fishing mortality. We also demonstrate that the use of FL or TL as standard metric for data and parameters do not produce significant changes in the assessment outputs. Finally, we highlight the importance of data quality review in order to improve the assessment of Jack mackerel.

5. References

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