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Upgrade of Chilean jack mackerel growth model

Chile

UPGRADE OF THE CHILEAN JACK MACKEREL GROWTH MODEL

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Introduction

In the last benchmark workshop emerged an observation about it the Chile's vB parameters had uncertainty. For this reason, the current report tries to reply at that observation, with evidences that support, the parameter estimated and growth pattern of Chilean jack mackerel. In addition, we made an improve of vB parameters with some data available that also emerge from age validation studies.

Estimation of the growth parameters

In report SCW14-WD04 "Life History Parameters of Jack Mackerel" the vB growth parameters were estimated using the age-at-length data validated by Cerna et al. (2022) and Araya et al. (2019). Now, we carried out an upgrade of the vB parameters in order to improve the estimation of curve for juveniles' fish less than 1 year old. First, we included the age-at-length data with only one ring (winter ring) formed when fish had 0.5-year-old (Table 1; Figure 1A). Secondly, we used the age-at-length data with only one ring (winter ring) formed when fish had 0.5-year-old, and false ring between the first and second annulus formed when fish had 1.5-year-old (Table 2; Figure 1B). The vB parameters estimation was made using fork length and total length data. To estimate vB parameters for total length, fork length data were transformed to total length data using the equation of Cubillos and Arancibia (1995).

Table 1

Growth parameters with their standard error, confidence interval at 95% and significance, estimated with the von Bertalanffy model, for jack mackerel age-length data collected in 2008 in the national fishing ground off Chile. The age-at-length includes data the winter ring formed when fish had 0.5-year-old.

				Confidence interval 95%		Statistical significance			
Type of data	Para-meters	Value	Est. Error	Lim. Inf.	Lim. Sup.	t value	Pvalue	-Loglik.	R^2
	L_∞	62.58	0,6799	61.17	64.04	92.03	<2e-16	-7743.1	0.80
Age-fork	K	0.11	0,0029	0.11	0.12	39.58	<2e-16		
length	t_0	-2.32	0,0537	-2.43	-2.21	-43.30	<2e-16		
	n	3,194							
Age-total	L_∞	69.33	0,7665	67.96	62.01	90.46	<2e-16	-8031.9	0.81
length	K	0,11	0,0029	0.11	0.12	39.01	<2e-16		
	t_0	-2,41	0,0552	-2.51	-2.31	-43.63	<2e-16		
	n	3,194							

Table 2

Growth parameters with their standard error, confidence interval at 95% and significance, estimated with the von Bertalanffy model, for jack mackerel age-length data collected in 2008 in the national fishing ground off Chile. The age-at-length data includes the winter ring formed when fish had 0.5-year-old, and false ring between the first and second annulus.

				Confidence interval 95%		Statistical significance			
Type of data	Para-meters	Value	Est. Error	Lim. Inf.	Lim. Sup.	t value	Pvalue	-Loglik.	R^2
	L_∞	60.95	0.5663	59.88	62.01	107.61	<2e-16	-7573.7	0.82
Age-fork	K	0.12	0.0027	0.12	0.13	44.66	<2e-16		
length	t_0	-2.09	0.0471	-2.18	-2.00	-44.38	<2e-16		
	n	3,194							
Age-total	L_∞	67.53	0.6424	66.24	68.83	105.11	<2e-16	-7850.0	0.83
length	K	0,12	0.0028	0.12	0.13	43.85	<2e-16		
	t_0	-2.12	0.0487	-2.28	-2.09	-44.913	<2e-16		
	n	3,194							

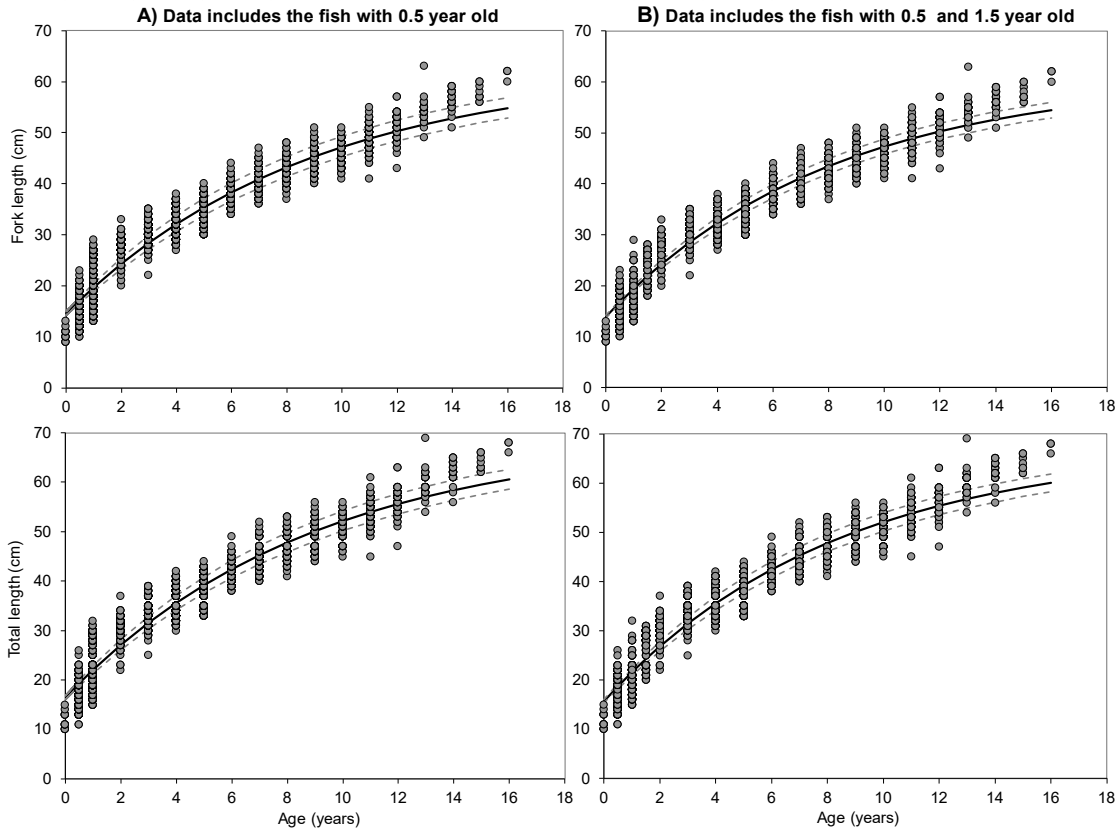

Figure 1. Growth curve of the von Bertalanffy model for jack mackerel for the age-length data collected in 2008 in the national fishing zone off Chile. The curve shows the 95% confidence interval as a dashed line. A) The age-at-length data includes the winter ring formed when fish had 0.5-year-old. B) The age-at-length data includes the winter ring formed when fish had 0.5-year-old, and false ring between the first and second annulus.

DISCUSION

Age determination in fish is done by analyzing annual or daily scale increments in calcified structures such as otoliths. However, age determination is invariably accompanied by various sources of error, some of which can have a serious effect on age-structured calculations (Campana 2001). Then, the applying of the best available validation methods for insuring ageing accuracy and precision, that support large-scale ageing is mandatory.

The ageing of jack mackerel has been carried out since the 70's and only in the last decade was it possible to validate the age to improve the accuracy of age determination. Ages of Chilean jack mackerel (*Trachurus murphyi*) in the southern Pacific Ocean were validated using three methods: 1) daily microincrement readings in sagittal otoliths of young-of-the year (YOY) fish to validate the first annulus; 2) modal progression of strong year-classes (PSYC) to validate the first, second and third annuli, and 3) bomb radiocarbon analysis of otolith cores to validate the absolute age in older fish >38 cm fork length (FL). The comparison between daily age with annual growth bands from whole otoliths, showed a false increment formed at 185 ± 34 days and a second translucent increment formed at 352 ± 79 days, corresponding to the first annulus for fish with the mean FL of 21.4 ± 1.8 cm. The PSYC coinciding with the recruits of 2008 (age 0), was tracked through three subsequent years with high accuracy, attaining 23, 27 and 30 cm FL in 2009, 2010 and 2011, respectively. These modes identified as age 1, age 2 and age 3 in the PSYC, matched to the mean length of fish with 2,4 and 5 translucent increments in sagittal otoliths. Results from bomb radiocarbon analysis confirmed that most of the ages were correct, because the Δ14C content of adult otolith core matched the reference chronology. The absolute mean ages for the assayed otoliths, based on the comparison with the reference chronology, ranged from 7 to 13 years for sizes between 39 and 60 cm FL (Cerna et al. 2022).

The Chile vB parameters are adequate to represent the growth of jack mackerel, because they are supported by validation studies. In this sense, the vB growth parameters and mean of lengths match with the historical series of age lengths keys data, their lengths and weights mean. The comparison between the current Chilean and Peruvian vB parameters (Dioses 2013) (Figure 2), shows that Peruvian curve has a slower growth rate for 1-yr-old and 2-yr-old fish, which is not consistent with validation studies conducted in Chile and Perú. In the Peruvian validation study,

based on microincrements, Goicochea et al. (2013), validated the 1-yr-old fish total length at 19.5 cm while Dioses (2013) estimated this total length at 15 cm.

In summary, the Chilean data age-at-length of CJM is supported by the best current available validation methods, and therefore, the Chilean growth model is less uncertainty than the one of Doises (2013). Furthermore, the inclusion of 0,5 and 1,5 yr-old fish data (false rings) in Chilean model increased the estimations k and t_0 parameters.

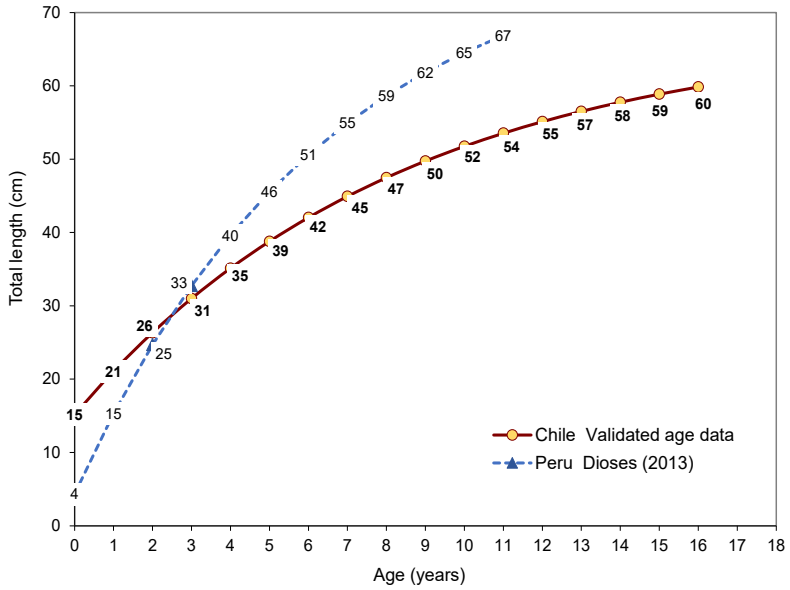

Figure 2. Comparison of von Bertalanffy growth curves of Chile and Peru. The number over the lines correspond at the mean of total length estimated by each equation.

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