

Four spot megrim (*Lepidorhombus boscii*) weight-length and weight-weight relationships in northern Iberian waters (stock 8.c, 9.a)

Landa, J., Fontenla, J., Reparaz, M., Castro, B., Gancedo, R., Rodríguez-Fernández, L., Loureiro, I., Gómez, A.

– Landa, J., Gancedo, R., Loureiro, I.: Instituto Español de Oceanografía, Centro Oceanográfico de Santander (IEO, CSIC), Promontorio de San Martín s/n, 39080 Santander, Spain.

– Fontenla, J., Rodríguez-Fernández, L., Gómez, A.: Instituto Español de Oceanografía, Centro Oceanográfico de Vigo (IEO, CSIC), Spain

– Reparaz, M., Castro, B.: Instituto Español de Oceanografía, Centro Oceanográfico de A Coruña (IEO, CSIC), Spain

Correspondence to J. Landa: tel: +34 942 291716; fax: +34 942 275072; e-mail: jorge.landa@ieo.es.

Abstract

Total weight-length, gutted weight-length and total weight-gutted weight relationships were fitted for the Iberian Atlantic stock of four spot megrim (*Lepidorhombus boscii*) and their temporal variations were analyzed. The large sample size, size range and time-series available allowed obtaining robust somatic parameters of combined sexes for the total weight-length relationships ($a=0.0043$, $b=3.2008$), for the gutted weight-length relationships ($a=0.0055$, $b=3.1139$), and the weight conversion factors (1.062). They are considered to best fit the current biometric relationships and most appropriate to be used in the stock assessment of the status of the stock and they contribute to a deeper knowledge of the life history traits of this species.

Keywords

Iberian; condition factor; weight-length relationships; weight conversion factor; *Lepidorhombus boscii*; Four spot megrim;

1. Introduction

Lepidorhombus boscii is a relevant commercial flatfish in southern European waters. The Iberian Atlantic stock (Div. 8.c and 9.a) is the main of the four spot megrim stocks for the Spanish and Portuguese fleets (ICES, 2020a; ICES, 2020b). The stock assessment procedures of this species in ICES utilize the biological knowledge available to predict variations in the population parameters. Weight-length relationships as well as the weights conversion factors (total-gutted weight relationship) are commonly used in those procedures, and allow predicting weights of individuals from measurements of length or of other weights, and for estimation of the stock biomass. Understanding the biological parameters of the stocks is of great importance. However, there are scarce studies on condition and weight-length relationships of megrim in Iberian Atlantic waters (Fuentes, 1978; Costa, 1986; Alperi, 1992; Pérez, 1998; Azevedo in Pereda et al., 1998) although these studies are mostly working documents or project reports. In fact, the estimates currently in use in assessment (Pérez, 1998) were obtained in an European Union study project (BIOSDEF) (Pereda et al., 1998), more than twenty years ago. It is quite evident the need research on biological traits of this species and for a robust and updated information on these biological parameters before their incorporation into the assessment process of megrim stocks, that will lead to a more adequate management of them.

This aim of this study is to provide robust and updated weight-length relationships and weight conversion parameters of this species in Iberian Atlantic waters, that can be incorporated in the oncoming stock assessment process and fishery management.

2. Materials and methods

2.1. Sampling

The studied area, the northern Iberian Atlantic waters (Div. 8.c, 9.a.2) belongs to the stock 8.c, 9.a and it is the main Atlantic area for the Spanish commercial fleet catching four spot megrim.

A total of 2099 individuals were sampled from a time-series of 22 years, from 1998 to 2019 were obtained by Instituto Español de Oceanografía (IEO, CSIC). The 97% of the specimens came from the landings of the commercial fleet and only a small sample (194 individuals <32 cm in length) came from two research fishing surveys “Cormol I”, carried out by IEO in northern Iberian Atlantic waters, during May 2012.

The temporal variation of the parameters in the time-series for periods of 5 years (quinquennium): 2000-04, 2005-09, 2010-14, 2015-19, and the previous period of 1998-99, was analyzed. For gutted weight, the periods 2000-04, 2005-09 only had 8 and 1 specimens respectively with weight information, so they were not included in the analysis of the gutted weight–length and total weight–gutted weight relationships.

Total length [Lt (cm), length class of 1 cm], total weight [Wt (g)], gutted weight [Wg (g)], sex and maturity were collected from each specimen. The numbers of specimens studied are shown in detail in Table 1, Table 2 and Table 3.

2.2. Data analysis

Weight-length relationships for combined sexes were calculated for the total weight and gutted weight. Regression functions were tested and the power function showed the best coefficient of determination (r^2) for the two weight-length relationships studied (Wt-Lt; Wg-Lt):

$$W = a(Lt)^b$$

where: W = total weight [Wt (g)], or gutted weight [Wg (g)]; Lt = total length (cm); a , b = parameters of the regression.

Weight conversion factor for combined sexes was estimated by the linear function that relate the total and gutted weights with values “0” to intercept with the x-axis:

$$Wt = aWg$$

where: Wt = total weight (g); Wg = gutted weight (g); a = parameter of the regression.

The temporal factor, year and quinquennium, relevant for stock assessment process, was considered in the weight-length and in the weight-weight models. The “five-year period (quinquennium)” showed a more adequate sample representativeness than the “year”. The role of the quinquennium was analyzed in each stock using the following Linear Models (LMs):

$$\log(Wt) \sim \log(Lt) * \text{quinquennium}$$

$$\log(Wg) \sim \log(Lt) * \text{quinquennium}$$

$$Wt \sim Wg * \text{quinquennium}$$

LMs were performed using the stats library in the R statistical software version 4.0.5 (R Foundation for Statistical Computing, 2021).

3. Results

3.1. Weight-length relationships

The parameters of the total weight-length relationship and gutted weight-length relationship are shown in Table 1 and Table 2. Significant differences ($p < 0.001$) also were found among quinquennia in the total weight-length relationship. In the gutted weight-

length relationship, only the two quinquennia with a relevant sample size (2010-14; 2015-19) are shown in Figure 1. Quinquennium slopes showed differences up to 8% between the most different quinquennia.

3.2. Weight conversion factors

Weight conversion factors are shown in Table 3. Only the two quinquennia with a relevant sample size (2010-14; 2015-19) are shown in Figure 1. Quinquennium slopes showed differences of 4% between both quinquennia.

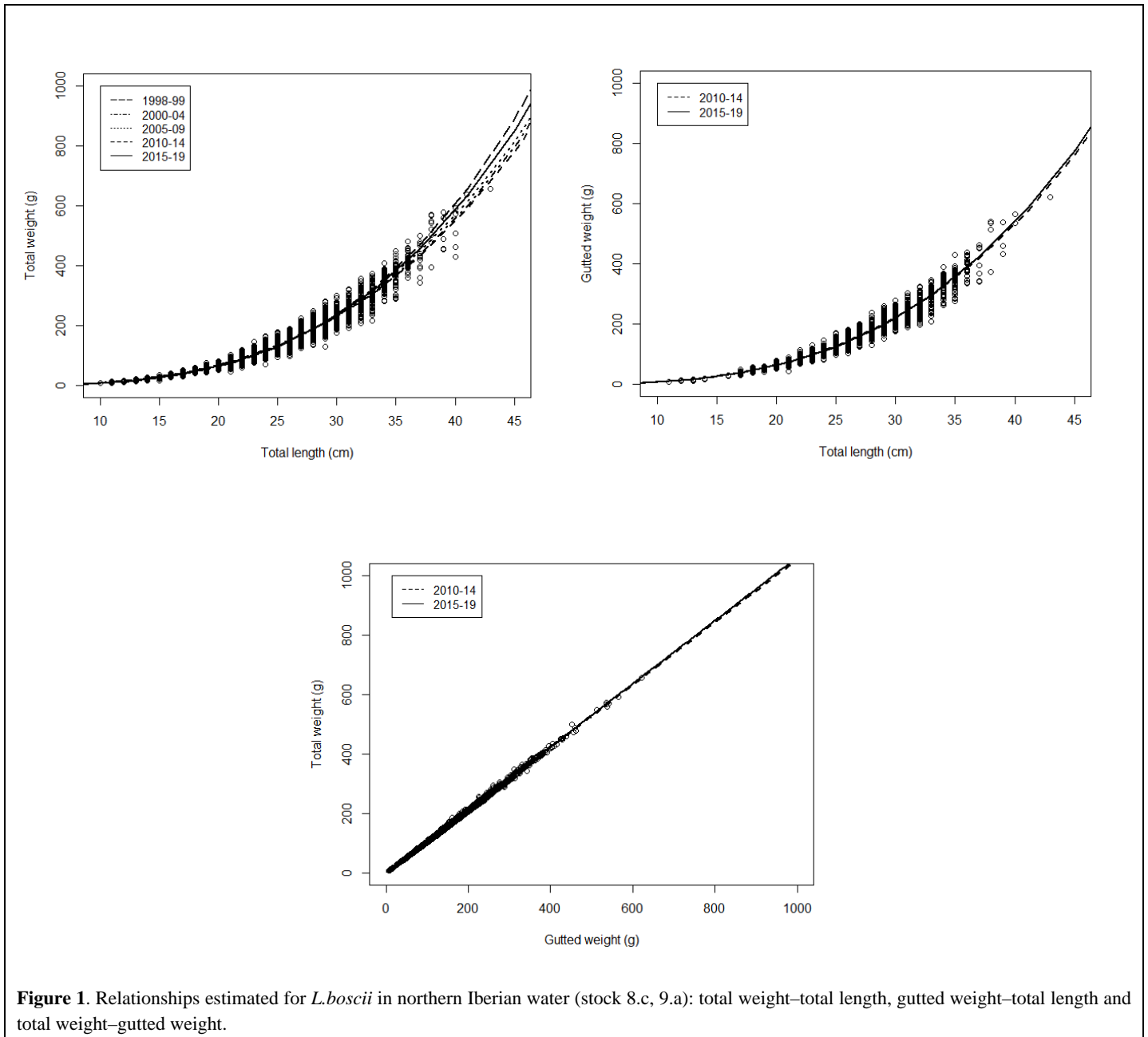


Figure 1. Relationships estimated for *L. boscii* in northern Iberian water (stock 8.c, 9.a): total weight–total length, gutted weight–total length and total weight–gutted weight.

4. Discussion

The large sample size and time-series have allowed obtaining robust weight-length relationships and weight conversion factors, and analyze the temporal variation of the total weight–total length relationship. A more accurate and reliable assessment of the stock status will be possible having the updated information her presented, allowing a better management of this population.

4.1. Weight-length relationships

The parameters of the total weight-length relationship and gutted weight-length relationship from the most recent quinquennium (2015-19) are underlined in Table 1 and Table 2. They show a complete representation of the commercially exploited size range of four spot megrim (4-43 cm and 17-40 cm in total weight-length and gutted weight-length relationships respectively) and are based on the large sample size (1921 and 1833 individuals in total weight-length and gutted weight-length relationships respectively) studied so far in this stock. The estimated parameters of combined sexes of four spot megrim for the total weight-length relationships ($a=0.0043$, $b=3.2008$) and for the gutted weight-length relationships ($a=0.0055$, $b=3.1139$) are considered to best fit the current biometric relationships and most appropriate to be used in the stock assessment process of the status of the stocks, replacing the old values from 1998 currently used (Table 1, Table 2). The differences between the relationships currently proposed for stock assessment and the current ones are small (0.3% and 4%, in the slopes of total weight-length and gutted weight-length relationships respectively) are shown in Figure 2.

4.2. Weight conversion factors

The weight conversion factor (1.062) from the most recent quinquennium (2015-19) are underlined in Table 3, based on a complete size range of four spot megrim (32-592 g in total weight), representative of the commercially exploited weight range, and also based on the largest sample size studied so far in this stock. This value would replace that old value (1.042) currently used (Pereda et al.(1998); Pérez, 1998). The small differences between the conversion factor currently proposed for stock assessment and the old ones (2%) are shown in Figure 2.

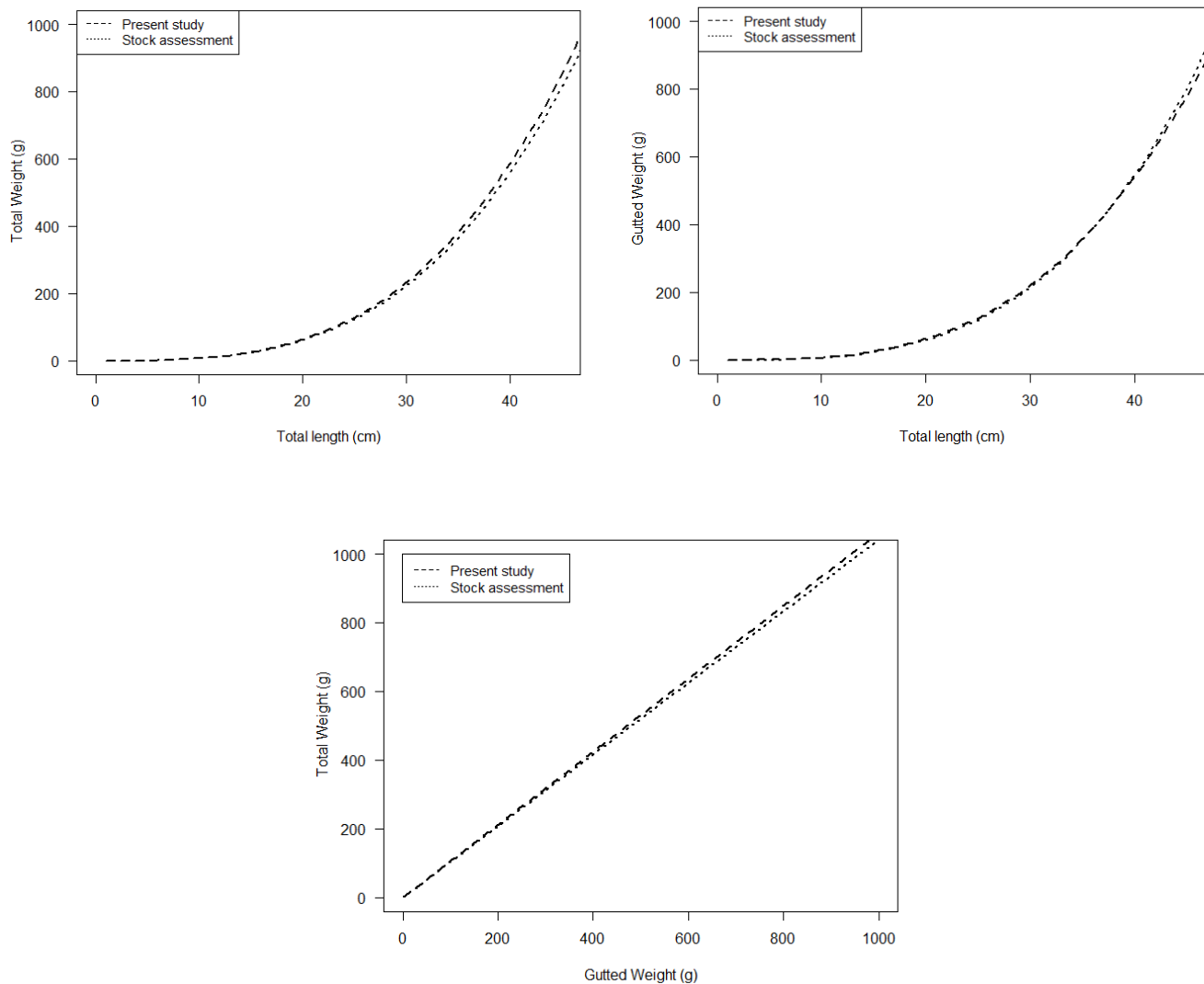


Figure 2. Differences between the relationships from the present study proposed for stock assessment and those currently used from 1998, for *L. boschii* in Iberian Atlantic stock (ICES Div. 8.c, 9.a).

A complete study covering a relevant area of distribution of the species and a wide period, thus allowing the analysis of its temporal variability, was not available until now. The parameters estimated here are in the range of those obtained in previous works, mostly grey literature (Table 1, Table 2, Table 3) and are considered the most appropriate to be used in the upcoming stock assessment.

Regarding the total weight-length relationship, the parameter b (slope) in the studies performed in the Iberian Atlantic stock varies between 3.03 and 3.29 (Table 1).

The slopes of the gutted weight-length relationship compared between studies vary from 3.07 to 3.55, and the value of the slope of the study of Pereda et al.(1998) and Pérez (1998) was the same than that estimated here in the later period 1998-99 (Table 2).

In relation to the total weight- gutted weight relationship, the slopes of the studies showed values between 1.042 and 1.062 (Table 3).

This study provides new biological parameters in the main fishing stock of four spot megrim and the main Atlantic fishery areas for the fleets catching this species, necessary for its accurate annual stock assessment process and stock management. The new somatic parameters from weight-length relationships and weight conversion factor are available to be used in the ICES Benchmark Workshop for selected Megrim Stocks (WKMegrim) and it is recommended that they replace the ones used so far,

which are outdated. The continue monitoring of these parameters is essential to detect possible long-term shifts due to the fisheries pressure or environmental variations and to deeper understanding of the specific causes of these variations.

Author	ICES Div.	Area	Period	Sex	Coefficients		n	r^2	Length (cm)		Weight (g)		Stock assessment
					a	b			min	max	min	max	
Present study	8.c, 9.a2	Southern Bay of Biscay & Galician waters	<u>2015-19</u>	<u>combined</u>	<u>0.004</u>	<u>3.201</u>	<u>1921</u>	<u>0.98</u>	<u>4</u>	<u>43</u>	<u>0</u>	<u>657</u>	<u>new proposed</u>
			2010-14	combined	0.008	3.027	2552	0.97	6	39	3	570	
			2005-09	combined	0.007	3.068	1283	0.96	15	37	23	440	
			2000-04	combined	0.007	3.068	370	0.96	19	41	48	638	
			1998-99	combined	0.003	3.293	30	0.97	21	36	74	428	
Pereda et al.(1998); Pérez Alperi (1992)	8.c, 9.a2	Southern Bay of Biscay & Cantabrian Sea	1997	combined	0.004	3.190	631	0.99	8	39			currently used
Fuertes (1978)	8.c1, 9.a2	Galician waters	1975	females	0.000	3.120	1118	0.98	13	38			
Pereda et al.(1998) (Azevedo)	9.a	Portuguese waters	1997	combined	0.004	3.230	631	0.99	5	40	1	639	
Costa (1986)	9.a	Portuguese waters		females	0.003	3.200	251						

Table 1. Parameters of the total weight - total length relationship for *L. boscii* estimated in the present study and previous studies in Iberian Atlantic stock (ICES Div. 8.c, 9.a). The underlined parameters are considered as the most appropriate to be used in the next stock assessment process.

Author	ICES Div.	Area	Period	Sex	Coefficients		n	r^2	Length (cm)		Weight (g)		Stock assessment
					a	b			min	max	min	max	
Present study	8.c, 9.a2	Southern Bay of Biscay & Galician waters	<u>2015-19</u>	<u>combined</u>	<u>0.006</u>	<u>3.114</u>	<u>1833</u>	<u>0.98</u>	<u>17</u>	<u>40</u>	<u>30</u>	<u>565</u>	<u>new proposed</u>
			2010-14	combined	0.006	3.067	227	0.96	17	39	39	541	
			1998-99	combined	0.004	3.245	30	0.97	21	36	72	408	
Pereda et al.(1998); Pérez (1998)	8.c, 9.a2	Southern Bay of Biscay & Galician waters	1997	combined	0.003	3.245	624	0.99	8	39	-	-	currently used

Table 2. Parameters of the gutted weight - total length relationship for *L. boscii* estimated in the present study and previous studies in Iberian Atlantic stock (ICES Div. 8.c, 9.a). The underlined parameters are considered as the most appropriate to be used in the next stock assessment process.

Author	ICES Div.	Area	Period	Sex	Coefficient a	n	r^2	Total weight (g)		Gutted weight (g)		Stock assessment
								min	max	min	max	
Present study	8.c, 9.a2	Southern Bay of Biscay & Galician waters	<u>2015-19</u>	<u>combined</u>	<u>1.062</u>	<u>1833</u>	<u>0.999</u>	<u>32</u>	<u>592</u>	<u>30</u>	<u>565</u>	<u>new proposed</u>
			2010-14	combined	1.054	227	0.999	40	570	39	541	
			1998-99	combined	1.057	30	0.999	74	428	72	408	
Pereda et al.(1998); Pérez (1998)	8.c, 9.a2	Southern Bay of Biscay & Galician waters	1997	combined	1.042	-	-	-	-	-	-	currently used
Alperi (1992)	8.c2	Cantabrian Sea	1989	combined	1.044	-	-	-	-	-	-	

Table 3. Parameters of the total weight - gutted weight relationship for *L. boscii* estimated in the present study and previous studies in Iberian Atlantic stock (ICES Div. 8.c, 9.a). The underlined parameters are considered as the most appropriate to be used in the next stock assessment process.

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