

Length–weight relationships for two abundant rocky reef fishes from northern Patagonia, Argentina: *Sebastes oculatus* Valenciennes, 1833 and *Pinguipes brasilianus* Cuvier, 1829

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Summary

The Patagonian rockfish *Sebastes oculatus* and the Brazilian sandperch *Pinguipes brasilianus* are two of the most abundant, conspicuous reef fishes in the northern Patagonian gulfs of Argentina. This study provides separate length–weight relationships for males, females and pooled individuals of these species for the North Patagonian region, based on samples collected between 2009 and 2014 throughout the year between 42°S and 45°S. No length–weight relationships for *P. brasilianus* were heretofore available in the literature. Although one relationship was published for *S. oculatus* from Chilean waters, the limited number of fish and size range did not allow an accurate estimate of the model parameters.

1 | INTRODUCTION

The rocky reef fish assemblage from the North Patagonian gulfs of Argentina, which sustains recreational and commercial activities such as artisanal, and recreational hook-and-line and spear-fisheries, as well as SCUBA diving (Sanabra, 2002; Venerus, Irigoyen, Galván, & Parma, 2014), is composed of 29 species belonging to 21 families (Galván, Venerus, & Irigoyen, 2009). However, only four of those species, primary target of those activities, are very common or abundant in the reefs located within the gulfs San Matías, San José, Nuevo and San Jorge: the Argentine sandperch *Pseudoperca semifasciata* (Cuvier, 1829), the Argentine seabass *Acanthistius patachonicus* (Jenyns, 1840), the Brazilian sandperch *Pinguipes brasilianus* Cuvier, 1829 and the Patagonian rockfish *Sebastes oculatus* Valenciennes, 1833 (Galván et al., 2009). Although length–weight relationships are available for *P. semifasciata* (González, 2006) and *A. patachonicus* (Dell'Arciprete & Denegri, 1990), [(see Irigoyen, Cavaleri Gerhardinger, & Carvalho-Filho, 2008 for taxonomic status clarification of the genus *Acanthistius* in the South-West Atlantic Ocean)], which are also targeted by commercial trawlers (Navarro, Rozycki, & Monsalvo, 2014), such relationships had yet to be estimated for *P. brasilianus* and *S. oculatus* from the Argentine coast (Froese & Pauly, 2016). Here, we fill that information

gap by presenting the length–weight relationships for *P. brasilianus* and *S. oculatus* in northern Patagonia, useful for biomass estimation, stock assessment and monitoring.

2 | MATERIAL AND METHODS

Fishes were sampled from the catches of commercial and recreational fisheries, or were captured by spear-fishing, pole-hooking (Irigoyen & Venerus, 2008) or angling during scientific surveys. Samples were collected between 2009 and 2014, throughout the annual cycle (a few fishes were sampled in the austral autumn, from April to June), between 42°S and 45°S. Fishes were sexed (whenever possible), measured to the nearest 0.1 cm and weighed to the nearest g. *S. oculatus* bearing the dark and light chromatic morphotypes (*sensu* Venerus et al., 2013) were pooled for the analyses.

Before deciding which algorithm was more appropriate (i.e., linear regression on log-transformed data vs. non linear regression on raw data), we evaluated the error distribution (additive vs. multiplicative) of the entire dataset for each species by likelihood analysis, following Xiao, White, Hooten, and Durham (2011). As the assumption of multiplicative log-normal error was better supported for both data

sets (results not shown), the parameters of the length–weight relationship $W = a TL^b$, where W = weight in g, and TL = total length, in cm, were estimated by fitting linear regressions to the log transformed data ($\log[W] = \log[a] + b\log[TL]$). In addition, we tested for differences in length–weight relationships between sexes, as recommended by Froese (2006), by comparing two ANCOVA models for each species. The maximal model contained four parameters (an intercept and a slope for each sex); the minimal model indicating no effect of sex at all contained just two parameters (common intercept and slope) (Crawley, 2013). Based on these comparisons, separate length–weight relationships were estimated for all pooled data and for each sex (see Results).

All analyses were made with R software (R Core Team, 2014). A preliminary inspection of the data allowed removal of a few aberrant values before fitting the models. The Akaike Information Criterion (AIC) was used for model selection (Burnham & Anderson, 2004).

3 | RESULTS

A total of 226 *S. oculatus* (74 males, 73 females, 79 unsexed), ranging in TL from 4.9 and 40.8 cm, and 169 *P. brasiliensis* (74 males, 75 females, 20 unsexed), ranging in TL between 11.6 and 43.5 cm, were used (Table 1). The comparison between ANCOVA models suggested the occurrence of sexual dimorphism in the length–weight relationship for both species (*S. oculatus*: $\Delta AIC = AIC_{\text{minimal model}} - AIC_{\text{maximal model}} = 5.14$; *P. brasiliensis*: $\Delta AIC = 3.69$), with females heavier than males from 30 cm TL in *S. oculatus* and from 23 cm TL in *P. brasiliensis* (Table 1).

4 | DISCUSSION

Here we provide length–weight relationships for two abundant rocky reef fishes from northern Patagonia. Our samples covered the size range found for both species in the region. Although the maximum

size recorded for *P. brasiliensis* was 70 cm TL (Roux, 1973; cited in Rosa & Rosa, 1997), as far as we know, no other fish larger than ca. 45 cm were ever recorded for the Argentinean coast (e.g., Cousseau & Perrotta, 2013; Villanueva Gomila, Macchi, Ehrlich, Irigoyen, & Venerus, 2015). Moreover, the maximum TL for *S. oculatus* reported here (40.8 cm TL for a male) exceeded the Fishbase record.

As we did for *P. brasiliensis*, González Kother (2001) also reported sexual dimorphism in the length–weight relationship for the congeneric species *Pinguipes chilensis* Valenciennes, 1833. Although the parameters of a length–weight relationship were already published for *S. oculatus* from Chilean waters, the limited number of fish ($n = 3$) and the size range covered in that study (20–28 cm TL) did not allow the authors to make an accurate estimate of the model parameters, and the slope for the log-transformed data did not differ from zero (Pérez-Matus, Carrasco, & Ospina-Alvarez, 2014).

Our work accomplished the recommendations of Froese (2006): a) different fishing gear were used, and the samples contained a rather homogeneous representation of all size-classes; and b) samples were captured homogeneously throughout the year, particularly *P. brasiliensis*. Finally, as fish sampling encompassed different seasons and years, and covered roughly three latitude degrees, the estimated parameters should be considered as mean values for the northern Patagonian region.

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TABLE 1 Descriptive statistics and length–weight parameters for two abundant rocky reef fishes, northern Patagonia, Argentina. Samples obtained throughout the annual cycle between 2009 and 2014

Species	Sex	Sample size	Total length range (cm)	Weight range (g)	Parameters [CI 95% _{inf} ; CI 95% _{sup}]		R ²
					a	b	
<i>Sebastes oculatus</i> Valenciennes, 1833	Male	74	17.1–40.8	101–1041	0.0197 [0.0117; 0.0333]	2.9536 [2.8012; 3.1061]	.9539
	Female	73	15.0–39.5	24–1107	0.0056 [0.0031; 0.0104]	3.3237 [3.1424; 3.5050]	.9496
	All	226	4.9–40.8	2–1107	0.0116 [0.0103; 0.0132]	3.1104 [3.0715; 3.1492]	.9911
<i>Pinguipes brasiliensis</i> Cuvier, 1829	Male	74	12.8–43.5	30–1037	0.0083 [0.0067; 0.0104]	3.0964 [3.0306; 3.1622]	.9919
	Female	75	11.6–42.0	16–975	0.0060 [0.0050; 0.0072]	3.2007 [3.1467; 3.2547]	.9948
	All	169	11.6–43.5	16–1037	0.0065 [0.0057; 0.0075]	3.1694 [3.1300; 3.2089]	.9934

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