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Meta-Estimation of Araucanian Herring, *Strangomera bentincki* (Norman, 1936), Biological Indicators in the Central-South Zone of Chile (32°–47° LS)

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Araucanian herring, *Strangomera bentincki*, is ecologically and economically important. Its complexity, like that of other pelagic fish, arises from seasonal population changes related to distribution with different spatial dynamics and demographic fractions, subject to strong environmental and fishing exploitation variations. This implies the necessity for a thorough understanding of biological processes, which are interpreted with the help of various activities, and directly or indirectly allow to infer and deliver adequate indicators. These activities facilitate a correct technical analysis and consistent conclusions for resource management and administration. In this context, the present study identified and addressed the need to integrate information on Araucanian herring lengths made available in historical series from commercial fleet fishing and sources such as special monitoring, hydroacoustic cruises, and monitoring during closed seasons. The study focused on methodologies widely used in biostatistics that allow analyzing the feasibility of integrating data from different origins, focused on evaluating the correct management of size structures that vary by origin, sample size, and volumes extracted. We call this tool meta-estimation. It estimates the integration of biological-fishery size indicators that originated mainly from commercial fishing and research fisheries for central-south pelagic fishery with data of catch between January and July 2018.

Keywords: Bayesian analysis, meta-analysis, meta-regression, pelagic fish, size structure, Araucanian herring

1 INTRODUCTION

The Humboldt Current System (HCS) in the South Pacific Ocean (SPO) is among the most productive in the world (Gilly et al., 2013). Chile has a continental coastline of around 4,200 km with a north–south orientation, crossing different environmental conditions strongly associated with latitude, and whose atmospheric circulation is forced by the Pacific anticyclone.

This system, characterized by its high climatic variability, makes small pelagic populations fluctuating, with alternating inter- and intra-annual preponderance leading to relatively dense shoal formations with a marked daily cycle. Shoalings are highly aggregated during the day and dispersed at night together with less dense surface aggregations (Castillo et al., 2009). Catches show marked seasonality with maximums between February and May, supported by the annual summer season recruitment impulse (Cubillos et al., 2002). This incorporation of juveniles, dominated by the zero age group, defines the highest catches for the first half of the year (Aranis et al., 2016). This links the activity closely to recruitments, which are highly variable and vulnerable, as growing and maturing individuals are mostly removed from the population (Aranis et al., 2015). These high recruitment fluctuations make these populations especially difficult to manage, further complicated by environmental conditions that play an important role in all stages of their life cycle and in determining the success of reproduction and recruitment (Hjort, 1914; Lasker, 1975; Iles and Sinclair, 1982; Cury and Roy, 1989; Yáñez et al., 1990; Bakun, 1996; Cubillos, 1999; Cubillos and Arcos, 2002; Arcos et al., 2004; Castillo-Jordán et al., 2010).

These small pelagic species have a coastal distribution within 50 nautical miles (nm) from the coast. Biological productivity is generally high due to seasonal upwelling events, mainly from mid-September to March, the austral spring–summer period (Arcos and Navarro, 1986; Arcos, 1987; Cubillos et al., 2001). Spatial expression of spawning (eggs and larvae) does not exceed 20 nm and 20–30 nm in the case of juveniles and adults, mainly on the continental shelf, whose catches do not exceed 500-m depth in the water column, preferably between 3 and 80 m (Castillo et al., 1995; Frimodt, 1995; Cubillos et al., 2007; Castillo et al., 2009). Araucanian herring, *Strangomera bentincki* (Norman, 1936), and anchovy, *Engraulis ringens* (Jenyns, 1842), are more abundant within the first 5–10 nm associated with upwelling foci and the mouth of rivers (Cubillos and Arancibia, 1993). Industrial and artisan catches are clearly focused on the continental shelf, mainly in the Biobío Region (62%) and secondarily in the Araucanía and Los Ríos Regions (35%). From an environmental, oceanographic, and biological perspective, differences exist between both areas. North of Punta Lavapié (37° 08′ 57″S, 73° 35′ 00″W), the coastline tends toward the northwest, platform width is greater than 130 nm, cut by the Biobío Canyon, the Itata Canyon, the Arauco Gulf, and the Concepción and Coliumo Bays.

Administratively, extraction has been regulated since 2001 through fishing quotas and biological reproductive and recruitment periods since 1996. Although these measures strongly regulate fishing, they also led to periods of different intensities both in the industrial and artisan sectors (Aranis et al., 2015).

Total pelagic landings in the zone were sustained for some 15 years by Araucanian herring stock, a resource that spurs fishing operations mixed with anchovy. The average catch from 2010 to 2016 was 479,000 t, mainly by the artisan fleet (78%). A hegemonic presence of the species is evidenced in artisan fishery, partly reflecting the magnitude ratio of biomass and assigned quotas.

Recruitment or entry processes of juvenile Araucanian herring have been detected since 1999 using hydroacoustic methods (Castillo et al., 2010), while spawning biomass has been evaluated since 2002 *via* the daily egg production method (Cubillos et al., 2007), which incorporates reproductive dynamics and egg production. Such studies have yielded data on Araucanian herring spatial distribution of different developments in the southern region, as well as abundance quantifications, spatial spawning, and recruitment characterization (Castro et al., 1997; Castillo et al., 2010).

Size structure is a key biological trait of the population. To be contrasted correctly with other structures of different strata, it requires weighing upon capture. Hence, frequency-to-size measurements expand from catch in weight or number, representing the biomass or abundance by size class. This procedure requires the concurrence of the three main sampling components, catch or landing, length, and weight of the specimens. However, the imbalance of catch magnitudes affects the correct representation and entails uncertainty about the correct decision when integrating data that can vary spatially, temporally, and in relation to origin (artisan-industrial). In this context, average weights are not always available, though these data are essential for estimating various indices, functions, and statistics. To solve this problem, it is necessary to establish decision criteria regarding the feasibility of finding or obtaining alternative information and assessing another potential and representative solution that replaces the missing one. Lacking any of these estimates implies that significant volumes of catch or fraction landed cannot be processed, with potentially important consequences for the assessment of population structure, demographic fractions, and state of the fisheries. This has led to the need to define criteria for a different estimate of the length–weight relationship, first allowing to resolve the relevance of integrating data and second to offer the best solution for correct integration and representation. In sum, to set a goal for evaluating the validity of integrating pelagic fish length information from samples obtained from various sources, exploring, designing a statistical procedure that allows integrating different data sources or clusters, and incorporating the meta-analysis approach (Pearson, 1904; Plackett, 1958; O'Rourke, 2007; Nordmann et al., 2012) to estimate size distribution by combining catch data from commercial vessels and research fisheries are key. However, to integrate information from commercial and artisan vessels in order to apply the meta-analysis to estimate size distribution, we need to face zero-probability estimates due to non-catch of certain lengths, since zero probability does not indicate the non-existence of a specific length. To solve this issue before the meta-analysis, we carried out a Bayesian estimation of the capture probability for each length. To our knowledge, this is the first study using the meta-analysis technique to estimate the length distribution of Araucanian herring, integrating samples of different types of vessels. This procedure can be used in other fish species sampled in the catch.

2 MATERIALS AND METHODS

In this section, we introduce the data set and study area where the samples have been collected. Afterward, we present the Bayesian procedure to estimate the probability of catch of each length and describe the meta-analysis method to estimate the length distribution. Finally, we present the meta-regression used to test whether there are significant differences between vessel types for each length.

2.1 Data and Study Area

The maritime space of Chile's central-south is immersed in the Humboldt System, home to highly diverse pelagic species. Among the species with coastal distribution, Araucanian herring and anchovy stand out. In latitudinal extension, pelagic fishing in the zone is taking place in the area between 32°10′S (Punta Molles, north of Valparaíso Region) and 47°00′S (Punta Armando, Aysén Region), including inland waters of Los Lagos and Aysén Regions. Also in latitudinal terms, Araucanian herring and anchovy habitats extend approximately 1,600 km. In longitudinal terms, both species are distributed between the coast and 30 nm on the continental shelf, bathymetrically living up to 50 m, moving to the surface at night due to nictemeral migration. The natural habitat of pelagic species corresponds to relatively shallow waters, 50–100 m deep. Surface fishing, together with the high density of shoalings of commercial interest, means that these fisheries generate intense activity.

The study area included the maritime area from (lat-long) to (lat-long), 200 nm from the coast. Biological data came from routine samplings of the main central-south pelagic fisheries monitoring program, developed by the Fisheries Development Institute [Instituto de Fomento Pesquero (IFOP)]. The research was carried out with the help of artisan and industrial fleets in the ports of San Antonio (Valparaíso Region), Talcahuano, San Vicente, Lota and Coronel (Biobío), Valdivia (Araucanía), and Corral (Los Ríos), as detailed in **Figure 1** and **Tables 1**, **2.**

Catches of Araucanian herring were preferably obtained in a normal fishing environmental period in summer–autumn in coastal and protected areas, favorable to upwelling and greater availability of food, such as the Gulf of Arauco and the Bay of Concepción, frequent areas of fishing for the commercial fleet and special monitoring in which during the summer period concentrations of chlorophyll greater than 1 μg/l are normally found. In areas adjacent to the coast, with higher primary productivity (>1 μg/l) and food, which leads to a higher concentration of zooplankton, such as euphausiids and copepods (Aranis et al., 2019).

Biological data comprise lengths of sampled individuals that originated mainly from commercial fishing (high-catch vessels) and research fisheries (low-catch vessels) catch between January and July 2018. The nets widely used in this small pelagic fishery are virtually the same in terms of length and mesh size of the 12.7-mm fine bodies, which is the most frequent. We used the meta-analysis technique to estimate the distribution of Araucanian herring catch length with data from 18 vessels, three commercial fishing (high-catch vessels) and 15 research fisheries (low-catch vessels). The data set is presented in **Table 3**.

Usually, the sampling design to estimate the size structure corresponded to two-stage random stratified sampling, where the stratum represented the port or fishing area and the month (Gulland, 1966). The stages in this case corresponded to a selection of trips and copies obtained during the trips (Miller et al., 2007).

The sampling design associated with landing size structure corresponded to a two-stage design within a study stratum or domain. First-stage units were from trips, and second-stage units were from samples. The size structure of catches sampled onboard corresponded to a three-stage design, in which first-stage units were from trips, second-stage units were from sets, and third-stage units were specimens (Aranis et al., 2017).

The fishing platforms are operating under similar designs, which are similar for both activities (structural characteristics and fishing power). This made it possible to have comparative information without bias and supported by extensive institutional technical experience.

2.2 Bayesian Estimation of Probability of Catch

Before the meta-estimation process, we first modeled the random vector $(X_1, X_2, \ldots, X_{19})$ that represented the quantity of Araucanian herring caught per vessel for each of the 19 lengths, 8.5, 9, 9.5, … , 16.5, 17. We assumed that the random vector X described above has a multinomial distribution with parameter $p =(p_1, p_2, \ldots p_{19})$, that is

$$X|p \sim Multinomial(n; p_1, p_2, \ldots, p_{19}),$$

with $p_i \geq 0$, $\sum_{i=1}^{19} p_i = 1$, $(p_1, p_2, \ldots, p_{19})$ is the vector of capture probabilities for lengths, 8.5, 9, 9.5, … ,16.5, 17 cm and $n = \sum_{i=1}^{19} X_i$. The maximum likelihood estimator of p_i is $\hat{p}_i = X_i/n$ (Casella and Berger, 2002). If $X = 0$, for any $i = 1, 2, \ldots, 19$, then $\hat{p}_i = 0$, which is a limitation, since we would be estimating that the probability of catching Araucanian herring for unobserved length i is 0. But only because Araucanian herring of a certain length has not been observed does not mean individuals of that length do not exist. To avoid estimations $\hat{p}_i = 0$, we considered a Bayesian approach to estimate the vector parameters $(p_1, p_2, \ldots, p_{19})$ of the multinomial distribution and their corresponding variances. The Bayesian formulation of the model is represented by:

$$X|p \sim Multinomial(n; p_1, p_2, \ldots, p_{19})$$

$$p \sim Dirichlet(\alpha_1, \alpha_2, \ldots, \alpha_{19}),$$

that is, the $X \mid p$ distribution is a multinomial distribution, and the *priori* distribution of the vector of parameters p is the Dirichlet distribution of parameter $\alpha = (\alpha_1, \alpha_2, \ldots, \alpha_{19})$. Then, the posterior distribution of $p \mid X$ is given by:

$$p \mid X \sim Dirichlet(X_1 + \alpha_1, X_2 + \alpha_2, \ldots, X_{19} + \alpha_{19}). \quad (1)$$

We had a closed expression for the posterior distribution of vector p. Then, using the properties of the Dirichlet distribution, we got:
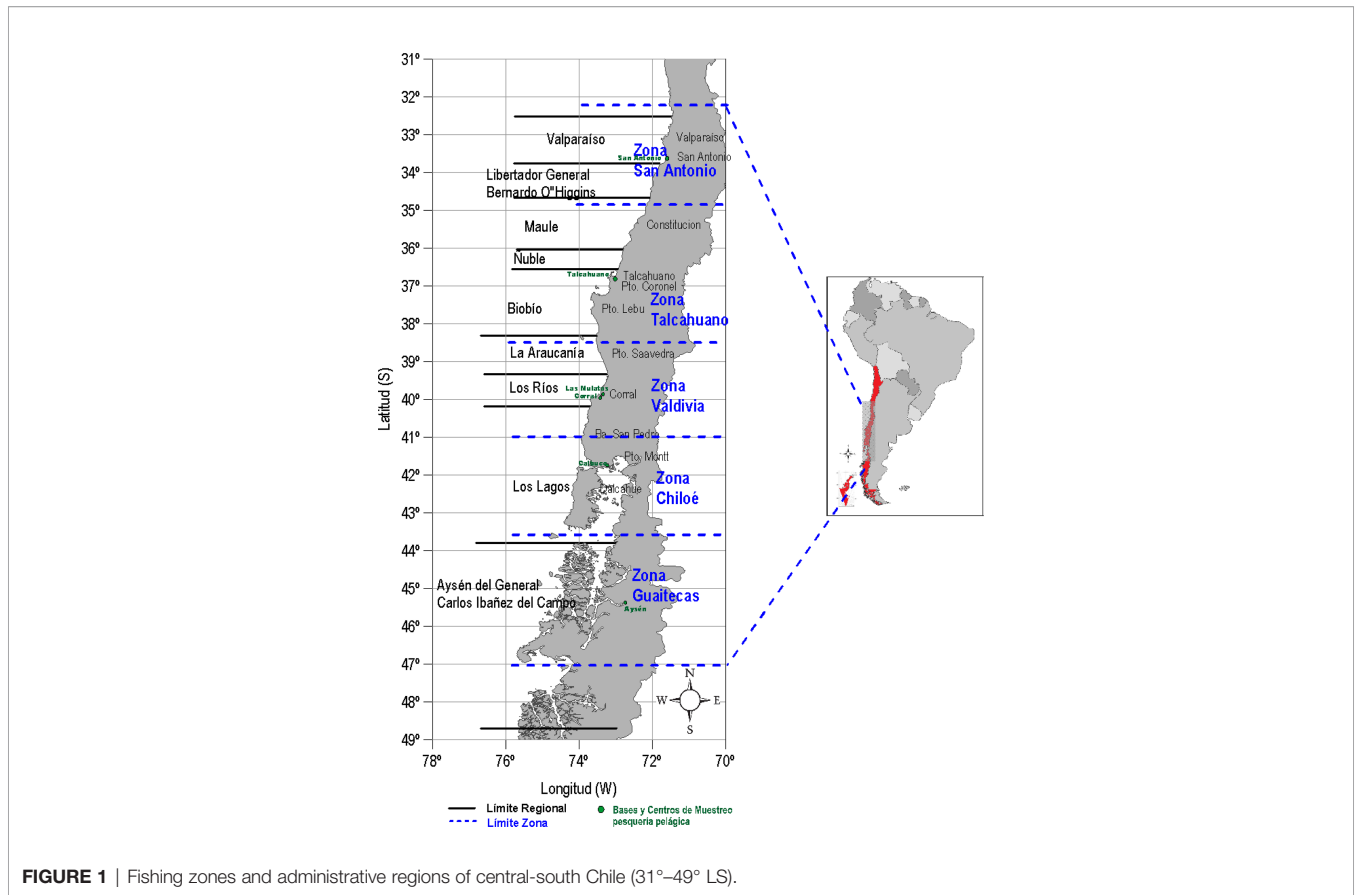
FIGURE 1 | Fishing zones and administrative regions of central-south Chile (31°–49° LS).

$$E(p_i|X) = \frac{X_i + \alpha_i}{n + \sum_{i=1}^{19} \alpha_i}$$

and

$$Var(p_i|X) = \frac{(x_i + \alpha_i)\left(n + \sum_{i=1}^{19} \alpha_i - x_i - \alpha_i\right)}{\left(n + \sum_{i=1}^{19} \alpha_i\right)^2 \left(1 + n + \sum_{i=1}^{19} \alpha_i\right)}.$$

When $\alpha_1 = \alpha_2 = \cdots = \alpha_{19} = 1$, which meant using a non-informative *priori* distribution for *p*, we obtained:

$$E(p_i|X) = \frac{x_i + 1}{n + 19}$$

and

$$Var(p_i|X) = \frac{(x_i + 1)(n + 18 - x_i)}{(n + 19)^2 (n + 20)}.$$

TABLE 1 | Fishing area in the central-south macrozone.

Fishing areas	Latitude (S)
San Antonio	32° 10' -34° 50'
Talcahuano	34° 50' -38° 30'
Valdivia	38° 30' -41° 00'
Chiloé	41° 00' -43° 30'
Guaitecas	43° 30' -47° 00'

We calculated the variance of each parameter $p_i | X$ using samples from that posterior distribution for each vessel with a sample size of 10,000 from the posterior Dirichlet distribution (1).

After carrying out the Bayesian estimation, we obtained a probability matrix $P = (p_{ij})$, $i = 1, \ldots, 19$, and $j = 1, \ldots, 18$. The rows of matrix P represent the 19 lengths, and the columns represent the 18 vessels. Associated with matrix P, there is a matrix $D = (d_{ij})$, $i = 1, \ldots, 19$ and $j = 1, \ldots, 18$, where d_{ij} represents the variances of each p_{ij} calculated using a simulation of the posterior distribution (1). Below, we use the notation $d_{ij} = Var(p_{ij})$.

2.3 Meta-Estimation

We used the meta-analysis technique proposed by DerSimonian and Laird (1986) in each of the rows of matrix p_{ij} with its corresponding variances d_{ij} to obtain a global estimate of p_i, which represented the meta-estimation of the probability of catching Araucanian herring of length i, $i = 1, 2, \ldots, 19$. Doing the analysis by rows was pertinent because we combined the estimates of each vessel for specific length i.

The meta-analysis integrated data from 18 vessels to generate a common estimate for each length i . That is, the process was repeated for each value of $i = 1, 2, \ldots, 19$. For simplicity, we dispensed with subscript i that denotes the i-th length and we defined p_j as the probability that vessel j, $j = 1, \ldots, J = 18$, caught

Regions	North	South
Valparaíso	32° 10' 23"	33° 53' 43"
Libertador General Bernardo O'Higgins	33° 53' 43"	34° 41' 00"
Maule	34° 41' 00"	36° 00' 39"
Ñuble	36° 00' 39"	36° 26' 35"
Biobío	36° 26' 35"	38° 28' 35"
Araucanía	38° 28' 35"	39° 23' 12"
Los Ríos	39° 23' 12"	40° 14' 30"
Los Lagos	40° 14' 30"	43° 44' 17"
General Carlos Ibáñez del Campo Region of Aysén	43° 44' 17"	48° 49' 25"

Araucanian herring of any length. For any length p_j, $j = 1, …,18$, was considered to have three components:

$$p_j = p + \tau_j + \in_j \qquad (2)$$

Where p is the common estimate we were seeking for any length (that is, the probability of catch for a length of Araucanian herring) using the catch information of $J = 18$ vessels, τ_j is the effect to be estimated in the j-th vessel, measuring the variation between vessels assumed to have normal distribution with mean 0 and variance τ^2, and $\in_j$ is the error made in the estimation with normal distribution of mean 0 and variance d_j. Also, we assume that τ_j and $\in_j$ are independent random variables. Model (2) is a random-effects model, and the vessels, $j = 1, … , J = 18$, in the estimate constituted a random sample of vessels.

To estimate the variance τ^2 of model (2), there are several methods. One that is relatively easy to implement, since it does not require an iterative process or complex calculations, is the estimator by the moment method proposed by DerSimonian and Laird (1986) that estimated τ^2 as:

$$\hat{\tau}^2 = \max\left\{0, \frac{Q - (J-1)}{\sum_{j=1}^{J} w_j - \frac{\sum_{j=1}^{J} w_j^2}{\sum_{j=1}^{J} w_j}}\right\}.$$

The global effect was estimated as weighted average of each vessel's individual estimators, where weights were calculated as the inverse of the sum of the variance of the individual vessel plus the variance between vessels, that is,

$$\hat{p} = \frac{\sum_{j=1}^{J} w_j p_j}{\sum_{j=1}^{J} w_j},$$

with $w_j = 1/(d_j + \hat{\tau}^2)$. The variance of $\hat{p}$ is given by $Var(\hat{p}) = 1/\sum_{j=1}^{J} w_j$. A 95% confidence interval for p is given by $\hat{p} \pm 1.96\sqrt{Var(\hat{p})}$. In the estimator $\hat{\tau}^2$, Q is the heterogeneity statistic, which is obtained by:

$$Q = \sum_{j=1}^{J} w_j(p_j - \hat{p})^2.$$

To obtain the estimate of $\hat{p}$ for each length $i = 1, … ,19$, we repeat the process 19 times corresponding to the 19 lengths considered in the study.

2.4 Meta-Regression

Meta-regression (Higgins and Thompson, 2004) can be used to study if heterogeneity between the catch of different vessels is related to specific characteristics of these vessels; however, there are other characteristics that affect catches (environment, seasonality, behavior, and demography of the resource, gear, operation, and fishing area), but in this study, samples were selected that avoided this problem and that these effects were not relevant. These characteristics can be included in model (2) as covariates and can be both continuous and categorical. They can be used to explain the heterogeneity of the effects between vessels. Crucially, because of residual heterogeneity, it was problematic to explain all of the heterogeneity (Thompson and Higgins, 2002). If we denote as $x_j^{'} = (1, x_{j1}, x_{j2}, …, x_{jk})$ the vector containing information from a set of k covariates (including the constant term for the global mean) for each vessel, model (2) can be expressed as:

$$p_j = x_j^{'}\beta + \tau_j + \in_j \qquad (3)$$

with distributional assumptions $\tau_j \sim N(0, \tau^2)$ and independent $\in_j \sim N(0, \sigma_j^2)$. All model (3) parameters can be estimated using methods for random-effects models such as restricted maximum likelihood (Thompson and Sharp, 1999). In this study, we include a covariate indicating the type of vessel taking value 1 for research fisheries and 0 for commercial fishing (vessels 13, 16, and 17). Our objective is to test whether there are statistically significant differences between vessel types (commercial vs. research) for each fish length.

All analyses were performed with the R programming language using the MCMCpack and metafor packages. The code is available upon request from the authors.

3 RESULTS

The data used to estimate Araucanian herring catch for 19 lengths for each of the 18 vessels through meta-estimation are detailed in **Table 3**. Of the 18 vessels, three (13, 16, and 17) were commercial fishing. Many lengths exhibited zero captures. Due to the presence of 0 values (**Table 3**), the probability of capture for each length of each vessel was estimated through the Bayesian methods. The variance of each estimate was calculated using a sample size of 10,000 from the posterior distribution for each vessel.

After obtaining the Bayesian estimates for each length {8, 8.5, 9, … ,16.5, 17}, the estimates for each of the 18 vessels were combined using the previously described meta-analysis methodology. The process was repeated 19 times for each length. The meta-estimate was first performed by separating the data from the samples obtained by each type of vessel (commercial and research ones). Then, a meta-estimate was
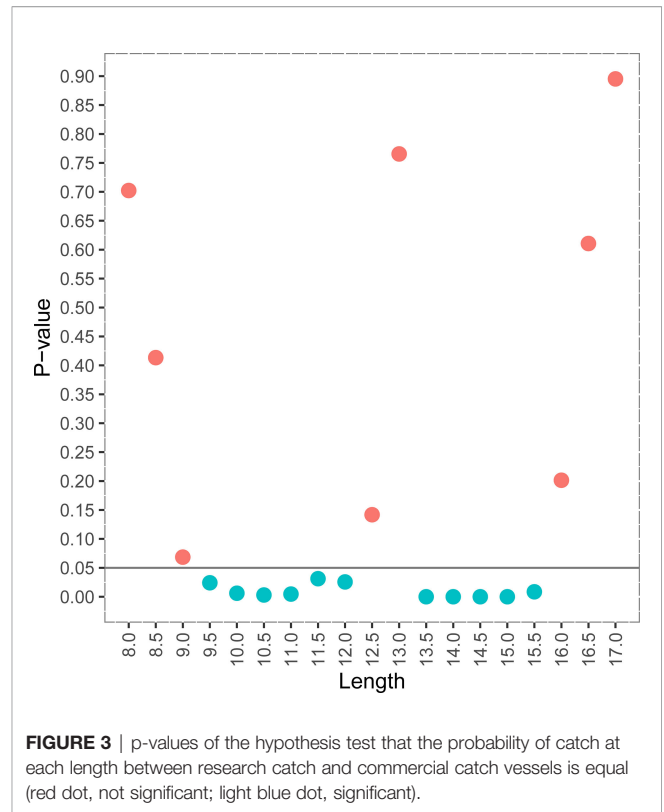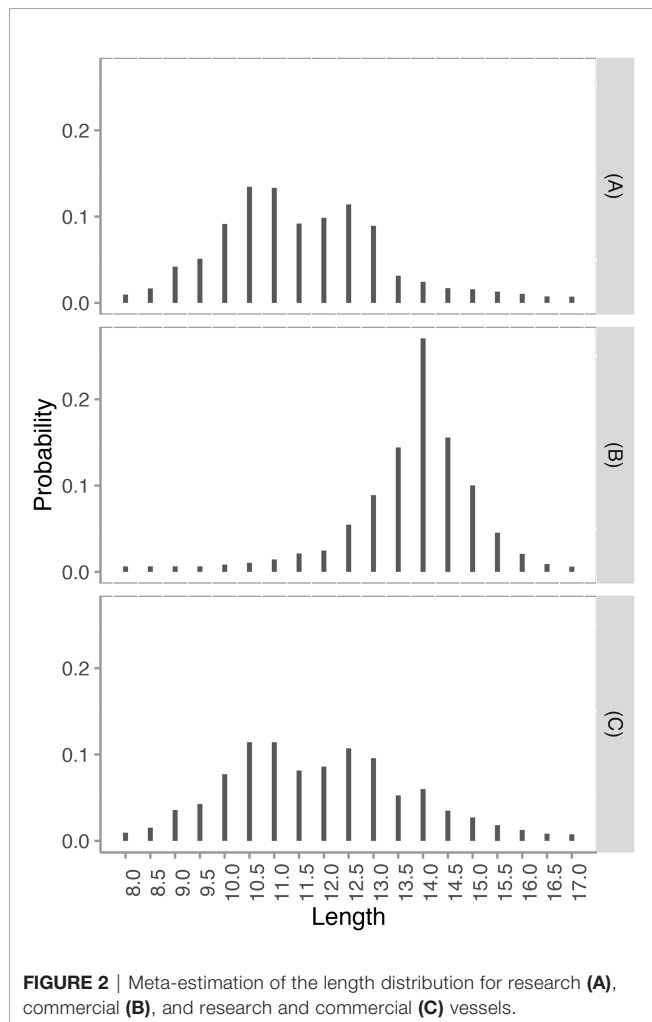
TABLE 3 | Biological data of commercial fishing (vessels 13, 16, and 17) and research fisheries. For each vessel and length, the number of sample individuals is reported.

	Vessels												
Length	1	2	3	4	5	6	7	8	9	10	11	12	13
8	0	0	14	0	22	0	0	0	0	0	0	0	0
8.5	0	0	32	0	48	2	0	0	0	0	0	0	0
9	0	0	67	14	57	10	8	0	2	0	0	0	0
9.5	0	0	42	27	50	12	23	0	16	0	0	0	0
10	3	29	24	58	19	34	40	2	41	0	0	0	0
10.5	61	76	10	48	7	38	52	2	41	0	0	4	0
11	84	62	1	34	0	47	30	3	45	0	0	7	0
11.5	24	21	0	17	0	26	19	8	38	0	1	11	0
12	2	10	0	2	0	22	9	9	12	16	11	25	0
12.5	0	2	0	0	0	10	12	33	6	14	18	13	0
13	0	1	0	0	0	0	3	27	1	19	12	29	2
13.5	0	0	0	0	0	0	0	10	1	0	6	8	11
14	0	0	0	0	0	0	0	10	0	0	5	5	22
14.5	1	0	0	0	0	0	0	16	0	0	0	0	41
15	7	0	0	0	0	0	0	31	0	0	0	0	35
15.5	8	0	0	0	0	0	0	42	0	0	0	0	16
16	5	0	0	0	0	0	0	30	0	0	0	0	4
16.5	5	0	0	0	0	0	0	7	0	0	0	0	1
17	3	0	0	0	0	0	0	2	0	0	0	0	0
Total	203	201	190	200	203	201	196	232	203	49	53	102	132

	Vessels				
Length	14	15	16	17	18
8	0	0	0	0	0
8.5	0	0	0	0	0
9	0	0	0	0	0
9.5	0	0	0	0	0
10	0	0	1	1	0
10.5	0	0	10	2	0
11	0	7	25	4	0
11.5	8	10	33	8	0
12	29	22	47	10	0
12.5	66	62	35	27	2
13	66	48	25	41	8
13.5	26	27	17	37	24
14	18	18	10	35	83
14.5	4	10	8	11	38
15	0	2	1	2	41
15.5	0	0	0	1	13
16	0	0	0	0	7
16.5	0	0	0	0	1
17	0	0	0	0	0
Total	217	206	212	179	217

performed considering the samples jointly from both types of vessels. **Figure 2** shows the distribution of the probability estimate for each length for research (**Figure 2A**), commercial (**Figure 2B**), and research and commercial (**Figure 2C**) vessels. Differences in the estimation of some probabilities between the research and commercial catch vessels are evidenced.

Research catch vessels showed a higher probability of catching Araucanian herring of lengths ranging from 9 to 13 cm. Commercial catch vessels showed a higher probability of catching Araucanian herring of lengths from 12.5 to 15.5 cm. To verify the existence of statistically significant differences in the probability of capture for the different lengths, a meta-regression was used considering a covariate that indicated the type of vessel. **Figure 3** shows the contrast *p*-values for each length. Statistically significant differences in the estimation of capture probability were evidenced for 11 lengths (light blue dot).

Results show differences in the distribution of Araucanian herring length between fishing with commercial and research catch levels for certain sizes.

FIGURE 3 | p-values of the hypothesis test that the probability of catch at each length between research catch and commercial catch vessels is equal (red dot, not significant; light blue dot, significant).

4 DISCUSSION

The meta-analysis methodology combined with Bayesian methods provides a framework to integrate information on Araucanian herring lengths from commercial and research catch vessels in order to estimate the size distribution structure. Our findings were applied in the reports that are delivered to the undersecretary of fisheries and its scientific committee in order to define the modifications of the biological closures of recruitment. According to the results, there are differences in the distribution of Araucanian herring length between commercial and research catch fishing related to certain sizes.

The correct application of a method that overcomes the feasible integration difficulties of sizes in pelagic fish will allow solving a technical issue. Results will also be applied in practical terms for better data interpretation and management, especially for recruitment processes in which diverse population components coexist, making analysis and result difficult. In sum, these results allow to improve, integrate, or segregate information under an objective statistical criterion. For example, this has been applied to the commercial fishing activity and studies under design and scientific methods; it also allows verifying the correct use of information from different vessels, fleets, and fishing gear.

Particular attention should be paid to data corresponding to oceanographic thermal anomalies that could alter

FIGURE 2 | Meta-estimation of the length distribution for research **(A)**, commercial **(B)**, and research and commercial **(C)** vessels.

biological conditions, especially average specimen weights. It is important to be careful with successive approximations when data are inserted in studies during a warm event (*El Niño*), when biological processes change strongly, probably resulting in weight decreases of some species. Additionally, care must be taken to exclude years with abnormal processes or estimates.

The practical application can be useful for similar studies of fishery analysts or of another nature, in which there must be contrasted levels of information that are very dissimilar in terms of the size of the sample or universe that they represent, being relevant *a priori* to see the real feasibility of integrating that information or not.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article. Further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

Conceived and designed the study: AA, RDLC, and CM. Data curation: AA, MR, LC, AG, and KW. Analyzed the data: RDLC. Interpreted the data and wrote the paper: AA, RDLC, CM, MR, LC, AG, and KW. All authors reviewed the article. All authors contributed to the article and approved the submitted version.

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