Farmed or wild fish? Segmenting European consumers based on their beliefs

Laura López-Mas[a,b]

[a]Institute of Agrifood Research and Technology (IRTA), Food Technology program, Finca Camps i Armet, s/n, 17121, Monells, Spain

[b]Department of Agri-Food Engineering and Biotechnology (DEAB), Universitat Politècnica de Catalunya (UPC), st/ Esteve Terradas, 8, 08860, Castelldefels, Spain

laura.lopezm@irta.cat

Anna Claret[a]

[a]Institute of Agrifood Research and Technology (IRTA), Food Technology program, Finca Camps i Armet, s/n, 17121, Monells, Spain

anna.claret@irta.cat

Machiel J. Reinders[c]

[c]Wageningen University & Research, Wageningen Economic Research, Prinses Beatrixlaan 582 – 528, 2595, The Hague, the Netherlands

machiel.reinders@wur.nl

Marija Banovic[d]

[d]Aarhus University, MAPP Centre, Department of Management, Fuglesangs Allé 4, 8210, Aarhus, Denmark

maba@mgmt.au.dk

Athanasios Krystallis[e]

[e]The American College of Greece, School of Business and Economics, 6 Gravias Street, 153 42, Athens, Greece

akrystallis@acg.edu

Luis Guerrero[a,*]

[a]Institute of Agrifood Research and Technology (IRTA), Food Technology program, Finca Camps i Armet, s/n, 17121, Monells, Spain

lluis.guerrero@irta.cat

*Corresponding author at: Institute of Agrifood Research and Technology (IRTA), Finca Camps i Armet, s/n, 17121, Monells, Spain.

E-mail address: lluis.guerrero@irta.cat (L. Guerrero).

Phone number: +34 97 263 00 52 (Ext. 1494)

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Abstract

Wild fish cannot meet the global demand of fish, making aquaculture the most suitable alternative to support increase in fish consumption. However, farmed fish have a less positive image among consumers than their respective wild-caught equivalents. Food product images can be affected by consumers' beliefs, which are useful to infer the quality of the food product and the consumers' food choices. This paper investigates European consumers' beliefs regarding farmed *versus* wild fish. The goal is to understand not only what hinders farmed fish consumption but also provide guidelines for producers and governments to improve the image of farmed fish. An online questionnaire reaching 2,511 consumers in five European Union (EU) countries (France, Germany, Italy, Spain, and the United Kingdom) assessed 19 beliefs. The results showed that European consumers believed that wild fish had a higher quality, but that farmed fish were superior in terms of control, price, and availability. Even though most consumers were in favour of wild fish, they reported higher consumption of farmed fish, suggesting that positive perceptions of products do not necessarily drive higher consumption. European consumers also believed that farmed fish were less fresh and contained higher concentrations of antibiotics than wild fish. These inferential beliefs that view aquaculture negatively should be addressed in future marketing campaigns to transform them into informational beliefs. Promotional and marketing campaigns should reinforce the positive attributes of farmed fish, including their lower levels of chemical hazards (e.g. heavy metals and marine pollutants) and biological hazards (e.g. parasites). Based on the assessed beliefs, consumers were categorised into five clusters of individuals: pro-wild fish, slightly pro-wild fish, balanced view, open to aquaculture, and pro-aquaculture. The identification of these consumer segments and their profiles should help producers and marketers focus their efforts to enhance the image of the aquaculture.

1. Introduction

Global fish consumption has been increasing owing to world population growth and increased awareness of the health benefits of consuming seafood (APROMAR, 2018). However, the rising demand cannot be met by wild-caught fish alone, mainly because the world's fish stocks are limited and wild fish are becoming scarcer (Atalah and Sanchez-Jerez, 2020; Martin, 2017). Currently, 59.9% of the world's marine fish stocks are fully exploited, and 33.1% are overexploited (FAO, 2018c). Therefore, aquaculture offers the most suitable means of increasing the global fish supply (Cahu et al., 2004; Kole, et al., 2009) while alleviating the pressure on wild fish stocks (Duarte et al., 2007; Martin, 2017; Troell et al., 2014). According to the Food and Agriculture Organization (FAO) (2018c), global aquaculture production reached a new high of 110 million tonnes in 2016, making it the world's fastest-growing food production system since the early 1980s. In 1980, aquaculture provided only 11% of all fish production (i.e. wild catches and aquaculture), whereas in 2016, it reached 54.5% (FAO, 2018a), a proportion that is expected to continue to increase in the future (Troell et al., 2014). However, the growth of aquaculture production is not equally distributed (Engle et al., 2017). In Europe, aquaculture production has yet to be exploited to its full potential (APROMAR, 2018); its growth rate has remained constant, around 16% since the mid-2000s (FAO, 2018a). Only 26% of all fish consumed in Europe comes from aquaculture (APROMAR, 2018; European Commission, 2018).

The low consumption rate and production stagnation of farmed fish in Europe may be because of their less positive image compared to their wild-caught equivalents (Claret et al., 2014; FAO, 2011; Penas, 2016; Reig et al., 2019; Vanhonacker et al., 2013; Verbeke et al., 2007b). Consumers often cannot distinguish many aquaculture species from their wild analogues (Penas, 2016), but they consider farmed fish to be of lower quality (Verbeke et al., 2007b). Claret et al. (2016) found that for different fish species (black spot sea bream, gilthead sea bream, sea bass, and turbot), Spanish consumers preferred farmed fish over the wild option in

a blind tasting; however, they preferred the wild option over farmed fish when they knew the origin (wild or farmed). These findings imply that consumers' food choices may be significantly influenced by their psychological interpretations of a product's properties, not just by its sensory properties (Rozin et al., 1986). Thus, people's sensory perceptions of fish products might be affected not only by the intrinsic cues of fish, like the taste, but also by preconceived ideas or 'beliefs' about its properties (Frewer et al., 2001).

Beliefs and attitudes are core determinants of human behaviour (Fishbein and Ajzen, 2011) and may be used to infer food quality, food intake, and food choices (Fernqvist, 2018). The information provided to consumers and their cognitive processing, which involves beliefs (Underwood, 2009), might bias individuals' analyses of the information and drive their preferences.

Some beliefs endure over time; others are forgotten and new ones are formed (Fishbein and Ajzen, 2011). There are three types of beliefs depending on how they are formed: (a) o*bservational* beliefs arise throughout people's direct observations; (b) *informational* beliefs are based on information received from external sources; and (c) *inferential* beliefs are self-generated through inference processes of mental logical connections (Fishbein and Ajzen, 2011; Pinder, 2008).

Beliefs are subjective notions that can vary between situations and individuals (Wyer and Albarracín, 2005). Personal differences can influence people's experiences, information exposure, and interpretations of information (Fishbein and Ajzen, 2011). Consequently, beliefs may be correct or incorrect, true or false, rational or irrational (Perloff, 2017; Wyer and Albarracín, 2005), depending on the accuracy of the information they are based on. They may be biased (Pinder, 2008) and held with different levels of strength or certainty (O'Keefe, 2006), that is, the perceived likelihood that the object of the belief has a particular attribute (Fishbein and Ajzen, 1975).

115 Beliefs are continuously being modified (Bar-Tal, 1990), and many variables may potentially
116 influence them. However, culture and education have particular relevance in belief formation
117 related to food products. Taste preferences are learned (Perloff, 2017) and are strongly
118 dependent on education, cultural traditions, and culinary habits (Issanchou, 1996); individuals
119 who live in groups tend to share common beliefs (Bar-Tal, 1990).

120 In the context of the present study, exploring consumers' beliefs could clarify why consumers
121 have a less positive image of farmed fish than of wild fish. Understanding consumers' beliefs
122 may be invaluable in designing marketing campaigns to enhance the positive imagery
123 associated with aquaculture and debunk persistent myths (Reig et al., 2019).

124 Most studies comparing wild and farmed fish have focused on physicochemical parameters
125 (Grigorakis et al., 2003; Grigorakis et al., 2007; Johnston et al., 2006; Rincón et al., 2016;
126 Saavedra et al., 2017; Tomić et al., 2017). Others have considered sensory characteristics
127 (Grigorakis et al., 2003; Luten et al., 2002; Rincón et al., 2016; Saavedra et al., 2017). Even so, it
128 is well known that other factors might affect consumers' image of fish. Several studies have
129 outlined significant differences between wild and farmed fish in terms of consumer
130 preferences (Rickertsen et al., 2017; Tomić et al., 2017), country of origin (Claret et al., 2012;
131 Rickertsen et al., 2017), willingness to pay (Bronnmann and Asche, 2017; Bronnmann and
132 Hoffmann, 2018), sustainability, and animal welfare (Bronnmann and Asche, 2017; Bronnmann
133 and Hoffmann, 2018; Rickertsen et al., 2017). However, more relevant for this paper are
134 studies focused on consumers' perceptions, attitudes, and beliefs of farmed fish *versus* wild
135 fish (Claret et al., 2014; Claret et al., 2016; Kole et al., 2009; Reig et al., 2019; Vanhonacker et
136 al., 2013; Verbeke et al., 2005; Verbeke et al., 2007a).

137 Beliefs are dynamic, and they differ among cultures. Therefore, current and cross-cultural
138 research on consumers' beliefs is needed. This study investigates European consumers' beliefs
139 regarding farmed *versus* wild fish not only to determine what hinders farmed fish consumption

but also to provide guidelines for producers and governments to improve the image of farmed fish.

2. Methodology

2.1. Participants

A sample of 2,511 consumers was recruited from five EU countries, with approximately 500 respondents per country (France, Germany, Italy, Spain, and the United Kingdom). A probabilistic sampling method was applied, including quotas for gender (50% female) and age (between 18 and 64 years). All participants were responsible for food purchases and preparation, and all were frequent consumers of both or at least one type of fish (wild or farmed).

2.2 Questionnaire

A subcontracted market research agency conducted all the online cross-cultural surveys. The master questionnaire, developed in English and translated into national languages, included items about the participants' beliefs, subjective and objective knowledge, fish consumption (wild and/or farmed), and sociodemographic characteristics. The beliefs assessed consisted of 19 items comparing wild fish with farmed fish (Claret et al., 2014). All the belief statements were presented in the format 'wild/farmed fish _____ than farmed/wild fish'. Some items were reversed in the questionnaire to reduce yea-saying and nay-saying response bias. The beliefs were measured on a seven-point Likert scale (1 = strongly disagree to 7 = strongly agree).

Consumers' subjective and objective knowledge was assessed in accordance with Pieniak et al. (2007). Subjective knowledge (SK) was self-reported on a seven-point Likert scale (1 = strongly disagree to 7 = strongly agree) and assessed four items: 'I consider that I know more about fish than the average person', 'I think that I know more about fish than my friends', 'I have a lot of knowledge about how to prepare fish', and 'I have a lot of knowledge about how to evaluate

166 the quality of fish'. Objective Knowledge (OK) was assessed using four statements (possible
167 answers: true/false/I do not know): 'fish is a source of omega-3 fatty acids' (true), 'salmon is a
168 fatty fish' (true), 'fish is a source of dietary fibre' (false), and 'cod is a fatty fish' (false). The
169 participants' total consumption frequency of wild and/or farmed fish was self-reported, as was
170 their sociodemographic information (i.e. country, gender, age, education level, perceived
171 economic situation, and presence of children at home).

172

173 **2.3 Data analysis**

174 The beliefs were analysed using a one-way Analysis of Variance (ANOVA) with Tukey's Honestly
175 Significant Difference (HSD) *post hoc* test to determine statistical differences among the
176 countries' data ($p < 0.05$). An agglomerative hierarchical cluster analysis using Ward's method
177 and Euclidean distance was utilized to identify the different clusters of participants based on
178 their belief scores (Chung et al., 2011; Claret et al., 2014). The number of segments to retain
179 was determined based on the obtained dendrogram, considering the homogeneity within and
180 among the segments (Hair et al., 2010) and the principle of parsimony (Vandekerckhove et al.,
181 2015). A discriminant analysis was performed to validate the number of clusters retained by
182 checking how many individuals were properly classified in their corresponding cluster
183 (confusion matrix). An additional one-way ANOVA with Tukey's HSD *post hoc* test was applied
184 to find statistical differences among the selected clusters ($p < 0.05$). Finally, cluster profiling
185 was obtained using a *k* proportion test after a pairwise comparison with the Marascuilo
186 procedure (Agresti, 2013; Marascuilo and Serlin, 1988).

187 After checking its internal reliability using Cronbach's α, the SK construct was analysed by
188 averaging the four items assessed for SK (Claret et al., 2014; Pieniak et al., 2007).
189 Unidimensionality was checked by means of a factorial analysis (principal components
190 method). Three different consumer categories were established according to the individuals'

scores: low SK (< 3), medium SK (3 ≤ SK ≤ 5), and high SK (> 5). The participants' OK was measured by summing the number of correct answers. Failed or 'I do not know' answers were not computed. Three different categories were established: low OK (0 or 1), medium OK (2 or 3), and high OK (4).

The data were analysed using the XLSTAT statistical software, Version 19.6 (2017) (Addinsoft, France).

3. Results and discussion

3.1 Respondent characteristics

The participants' sociodemographic characteristics are presented in Table 1. The final sample closely matched the quotas set for gender and country. The percentage of participants within each age category were similar to that of the five EU countries (EUROSTAT, 2019). The sample was slightly biased towards higher-educated individuals (46.2%), a proportion that exceeded the average score (30.2%) of the selected countries. This trend was also found in other studies (Hall and Amberg, 2013; Kole et al., 2009). According to Claret et al. (2012), this bias could be owing to higher self-confidence and a higher willingness to participate in consumer studies as education level increases. Most participants (59.3%) considered their economic situation to be average; only 27.1% reported having to contend with some economic constraints. In general, the participants reported a higher consumption of farmed fish; some of them never ate wild fish (15.5%), but only 8.2% never ate farmed fish. The categories '2–3 times a month' and 'once a week' had higher percentages for farmed fish. However, the information reported by the participants disagreed with the average EU consumption of farmed fish (26%). The lack of correspondence between both data sources could have been caused by the participants' lack of awareness of the source of the fish they consumed such that the respondents had the perception that they ate more farmed fish than they actually did (Bacher, 2015; Banović et al., 2016). Concerning the subjective knowledge data, which had high internal reliability ($\alpha = 0.94$), most participants had average SK (52.4%) and OK scores (67.3%). In the high SK and high OK categories, more participants showed higher values for SK (33.6%) than for OK (17.4%), suggesting that some participants were overconfident. People's self-perceived product knowledge is relevant for its relation to consumers' beliefs, attitudes, and behaviours, as well as their information gathering, organization, and use (Heide and Olsen, 2017; Pieniak et al., 2007; Pieniak et al., 2010).

222

223 **Table 1. Participants' profile from the five countries expressed as a percentage (N = 2,511).**

Sociodemographic and other characteristics		%	Sociodemographic and other characteristics		%
Country	DE	20.2	**Education level**	No formal education	0.1
	ES	19.9		Primary school	1.2
	FR	19.9		Secondary school	27.2
	IT	19.9		Technical school	25.3
	UK	20.1		University degree	33.7
Gender	Men	49.2		Postgraduate degree	12.5
	Women	50.8	**Children at home**	Yes	45.6
Age	18–30	24.8		No	54.4
	31–40	23.7	**Perceived economic situation**	Lower than average	27.1
	41–50	22.9		About average	59.3
	51–64	28.7		Higher than average	13.6
Consumption of farmed fish	Never	8.2	**Consumption of wild fish**	Never	15.5
	Once a month or less	34.7		Once a month or less	34.3
	2–3 times a month	29.8		2–3 times a month	25.6
	Once a week or more	20.8		Once a week or more	16.9
	I do not know	6.5		I do not know	7.7
OK	Low	15.3	**SK**	Low	13.9
	Average	67.3		Average	52.4
	High	17.4		High	33.6

224 DE: Germany; ES: Spain; FR: France; IT: Italy; UK: United Kingdom.

225

226 **3.2 European consumers' beliefs**

227 Table 2 shows the participants' overall belief values comparing wild fish with farmed fish, as
228 well as the average beliefs within each country. The beliefs are grouped according to the four
229 dimensions defined by Claret et al. (2014): safety, quality, control, and when buying fish.
230 Interpretation of the results was simplified by presenting all the beliefs in the format 'wild fish
231 _____ than farmed fish'.

232

233 **Table 2. Mean values and standard deviation of the selected beliefs comparing wild *versus***
234 **farmed fish per country.**

Dimension	Item	Mean (SD)						
	Wild fish _____ than farmed fish	**Overall**	**F**	**FR**	**DE**	**IT**	**ES**	**UK**
Safety	is safer (R)	3.8	17.8	4.2^{a} (1.5)	3.7^{b} (1.4)	3.6^{b} (1.5)	3.6^{b} (1.4)	3.8^{b} (1.2)
	is more affected by marine pollution (spillages)	4.7	7.8	4.4^{b} (1.5)	4.8^{a} (1.4)	4.8^{a} (1.5)	4.8^{a} (1.5)	4.6^{ab} (1.4)
	contains more heavy metals (R)	4.4	10.6	4.2^{b} (1.4)	4.3^{b} (1.3)	4.6^{a} (1.5)	4.6^{a} (1.4)	4.3^{b} (1.2)
	contains more antibiotics	3.5	12.2	3.5^{a} (1.8)	3.2^{b} (1.7)	3.5^{a} (1.6)	3.8^{a} (1.5)	3.8^{a} (1.5)
	is more affected by parasites (anisakis) (R)	4.4	9.9	4.1^{c} (1.4)	4.3^{bc} (1.4)	4.5^{ab} (1.5)	4.6^{a} (1.4)	4.3^{bc} (1.3)
	has a healthier diet	4.1	11.2	4.5^{a} (1.6)	4.1^{b} (1.5)	4.0^{b} (1.6)	3.9^{b} (1.5)	4.0^{b} (1.3)
	is healthier (R)	4.0	15.9	4.3^{a} (1.5)	4.2^{ab} (1.5)	3.7^{d} (1.5)	3.9^{c} (1.4)	4.1^{bc} (1.3)
Quality	is of better quality	4.3	8.2	4.5^{a} (1.6)	4.1^{c} (1.4)	4.4^{ab} (1.6)	4.2^{bc} (1.4)	4.1^{c} (1.3)
	is fresher (R)	4.2	7.5	4.5^{a} (1.6)	4.1^{b} (1.5)	4.1^{b} (1.6)	4.1^{b} (1.4)	4.1^{b} (1.3)
	is more nutritious	4.2	2.4	4.3 (1.5)	4.2 (1.4)	4.3 (1.5)	4.1 (1.4)	4.1 (1.3)
	is more fatty (R)	4.0	5.2	3.8^{b} (1.6)	4.1^{a} (1.4)	3.8^{b} (1.6)	4.1^{a} (1.4)	3.9^{ab} (1.4)
	tastes better	4.4	7.2	4.6^{a} (1.6)	4.3^{bc} (1.4)	4.6^{ab} (1.6)	4.4^{abc} (1.5)	4.2^{c} (1.3)
	is firmer (R)	4.1	8.2	4.4^{a} (1.5)	4.0^{b} (1.3)	4.2^{ab} (1.5)	4.0^{b} (1.4)	3.9^{b} (1.2)
Control	is more controlled	3.1	7.4	3.4^{a} (1.5)	3.1^{b} (1.4)	3.1^{b} (1.4)	3.0^{b} (1.4)	3.1^{b} (1.3)
	is more handled (R)	3.3	81.8	2.9^{d} (1.5)	3.0^{cd} (1.4)	4.3^{a} (1.6)	3.2^{c} (1.4)	3.4^{b} (1.3)
	is more artificial	3.2	5.1	3.3^{ab} (1.8)	3.0^{b} (1.7)	3.2^{ab} (1.8)	3.1^{b} (1.6)	3.4^{a} (1.6)
	provides more guarantees (R)	3.7	21.2	4.2^{a} (1.5)	3.6^{b} (1.4)	3.6^{b} (1.5)	3.5^{b} (1.4)	3.6^{b} (1.3)

When buying fish	is easier to find	2.9	0.8	2.9 (1.5)	2.9 (1.3)	2.9 (1.5)	3.0 (1.4)	2.9 (1.3)
	is cheaper (R)	3.2	2.2	3.1 (1.5)	3.1 (1.5)	3.0 (1.5)	3.3 (1.5)	3.2 (1.3)

Mean values in a 7-point Likert scale: mean values < 4 indicate disagreement; mean values > 4 indicate agreement. Superscript a–d: different letters in the same row indicate statistically significant differences ($p < 0.05$); the absence of letters within a row indicates no statistical differences. SD: standard deviation. F: F value from the one-way ANOVA. R: reversed beliefs statements in the questionnaire presented as 'farmed fish _____ than wild fish'.

Overall, the European respondents believed that wild fish were more affected by marine pollution, heavy metals, and parasites; at the same time, they believed wild fish had a healthier diet, were of better quality, were fresher, were more nutritious, tasted better, and had a firmer flesh. By contrast, the respondents believed that farmed fish were safer, more controlled, offered more guarantees, were easier to find, and were cheaper; at the same time, they believed that farmed fish contained more antibiotics, were more handled, and were more artificial. Finally, their beliefs about the healthiness and fat content of fish showed values near the midpoint of the scale (4).

Focusing on the Claret's et al. (2014) four dimensions (safety, quality, control, and when buying fish), the EU respondents' attributions of 'quality' tended to favour wild fish, even though most of their answers were close to the scale's midpoint. However, the 'control' and 'when buying fish' dimensions favoured farmed fish. Concerning the 'safety' dimension, the respondents' answers reflected their beliefs about the greater impact of marine pollution (spillages and heavy metals) and parasites on wild fish and their greater distrust in intensive production systems (concerns about the feeding and use of antibiotics with farmed fish). Quality, price, and availability have been found to be among the most important criteria for consumers when buying fish (Claret et al., 2012; Conte et al., 2014; Pieniak et al., 2010). Taking that into consideration, along with the finding that the four dimensions were perceived in a different way for both fish origins (favouring one or the other), it is difficult to predict whether

consumers would buy farmed or wild fish. It is known, however, that for those species for which aquaculture has been well established (e.g. sea bass, sea bream, salmon), most of the fish consumed comes from aquaculture (EUMOFA, 2014; EUMOFA, 2019b; European Commission, 2018). There are at least two possible reasons for this: consumers are unaware of the source of the fish they buy or availability and price weigh more in their choices than the perceived quality.

A comparison of the average belief scores among the five countries revealed significant differences in all but three of the 19 beliefs. In general, consumers perceived farmed fish as easier to find. This belief was consistent with the fact that aquaculture's greater control over the production process delivers a consistent year-round supply in terms of volume, quality, and size (Engle et al., 2017; FAO, 2018c; Hall and Amberg, 2013; Verbeke et al., 2007a). Wild fish was unanimously perceived as more expensive as it suffers significant price fluctuations due to the seasonality of some species (Engle et al., 2017) and the limited availability of supply. These two beliefs arose through the individuals' observations and, therefore, were less likely to be false (Pinder, 2008); people rarely doubt their own perceptions' authenticity (Underwood, 2009). For this reason, observational beliefs usually lead to a higher agreement among consumers. The participants from all five countries agreed that wild fish were more nutritious, in line with the results obtained by Claret et al. (2014) and Verbeke et al. (2007a). According to Verbeke and Brunsø (2005), people's association of wild fish with a higher nutritional value can be explained by the common perception that the most nutritious foods are those that are more 'natural' (less artificial). This perception was observed in the present study.

The participants from four of the five countries agreed that farmed fish were safer (the exception was the French respondents). Some studies have also found that consumers perceive farmed fish as safer (Verbeke and Brunsø, 2005), whereas others have shown no

284 significant differences between people's perceptions of the safety of wild and farmed fish
285 (Claret et al., 2014; Verbeke et al., 2007a). It is possible that the European consumers took for
286 granted their food security and thus paid little attention to the safety of the products during
287 the buying-decision process (Lusk et al., 2014).

288 Generally, consumers have a positive belief that eating fish is healthy (Hall and Amberg, 2013;
289 Pieniak et al., 2010; Vanhonacker et al., 2013), although the intensity of this belief may differ
290 depending on the source of the fish. Verbeke et al. (2007a) stated that people's perceptions
291 that wild fish are healthier and more nutritious is strongly linked to their belief that farmed fish
292 flesh contains high levels of antibiotics. The results from the present study mostly support this
293 theory; however, the respondents from Italy and Spain, overall, believed that wild fish
294 contained lower levels of antibiotics and were more nutritious, but they nevertheless
295 considered farmed fish to be healthier (the difference was not significant in Spain). One
296 contributor to the formation of this belief in favour of farmed fish is that the Mediterranean
297 Sea is known to be one of the world's most contaminated bodies of water in terms of
298 microplastics (Suaria et al., 2016) and other anthropogenic threats (FAO, 2018b). People's
299 overall awareness of pollution could also have affected their safety-related beliefs; the
300 respondents in Italy and Spain perceived, on average, that farmed fish were safer (the
301 numbers were not significant). It should be noted that most consumers do not make a clear
302 distinction between food safety and health, considering them part of the same concept
303 (Morrison et al., 2003).

304 In some cases, the respondents seemed to establish a positive relationship between credence
305 beliefs related to human health and the healthiness of animals' diets. For respondents from
306 France and Germany, the positive relationship was in favour of wild fish, whereas for those
307 from Spain, it was in favour of farmed fish. Conversely, the positive relationship found by
308 Claret et al. (2014) for consumers in Spain was in favour of wild fish. These beliefs may have

been influenced by Spain's multiple campaigns promoting farmed fish between 2009 and 2017 (López-Mas et al., 2019b). The proverb 'we are what we eat' may have contributed to the formation of people's perceptions of the positive relationship between 'healthy diet' and 'healthy' beliefs. Another explanation is that consumers might know that the chemical composition of fish flesh depends, among other factors, on the fish's diet (Grigorakis, 2007).

According to Jennings et al. (2016) some of the main human risks associated with fish consumption are chemical hazards (pesticides, organic pollutants, and heavy metals) and biological hazards (biotoxins, pathogen, and parasites). Except for the French respondents, farmed fish were perceived as being less affected by these hazards; at the same time, farmed fish were seen as offering more guarantees, more control, and safery. In fact, according to Poli (2005), one of the reasons for the increase in consumers' demand for farmed fish is the farms' ability to control the production process and manage potential hazards (Cahu et al., 2004). However, people's perceptions of a high degree of control and handling of farmed fish could have negatively influenced their beliefs of farmed fish as not being 'natural'. As reported by Claret et al. (2014) and Verbeke et al. (2007a), the participants of this study believed that farmed fish were more artificial than wild fish. Consumers seem to consider wild fish more natural because they breed and flourish without human inference (Norwegian Seafood Council, 2018).

Previous studies (e.g. Claret et al., 2014; Stubbe and Yang, 2011; Verbeke et al., 2007a) have reported that, in general, consumers believed that farmed fish contained higher concentrations of antibiotics. The respondents from all five countries likely associated the antibiotic administration that occurs during fish rearing with its presence in the fish products they consumed. Many participants might not be aware that the use of antibiotics in aquaculture is now strictly regulated in most countries of the Organisation for Economic Co-operation and Development (OECD), following revelations of certain irresponsible uses of

antibiotics in animal production (Sekkin and Kum, 2011). The respondents may have inferred that the farmed fish they buy contain antibiotics based on having heard about scandals involving terrestrial animal production systems related to the use of veterinary drugs (Bánáti, 2011; McEvoy, 2016). Consumers' conflation of antibiotic persistence and farmed fish seems to have contributed to the decrease in their confidence in farmed-fish products and may have negatively influenced the global image of aquaculture.

Fish quality is a broad concept that encompasses various factors, including safety, freshness, nutritional, and organoleptic properties (Grigorakis, 2007; Poli, 2005). Several studies have reported differences in perceptions of fish quality among European consumers, with wild fish always being preferred over farmed fish (Claret et al., 2014; Reig et al., 2019; Vanhonacker et al., 2013; Verbeke et al., 2007b). The findings of the present paper corroborated these studies' results, as most consumers in all five countries believed that wild fish were of higher quality and had a better taste. According to Reig et al. (2019), people's perceptions of the lower quality and taste of farmed fish may be caused by the uncertainty generated by the fish diet. Consumers tend to distrust the use of new technologies in food production (Yeung and Morris, 2001). When compared to other terrestrial production systems, aquaculture is considered a relatively new production method for food (Fernández-Polanco and Luna, 2012). Consequently, people's perceptions of the lower quality of farmed fish may relate to their general distrust of the production system. Another factor that might have affected the respondents' perceptions of quality may be that consumers often consider a product's price as an indicator of its quality (Claret et al., 2012; Kole et al., 2009). Therefore, because farmed fish are usually cheaper than wild fish, people may assume that they are of lower quality.

As mentioned before, freshness is a relevant aspect of a product's quality, especially for highly perishable products like fish (Cheng et al., 2014; Grigorakis, 2007; Kole et al., 2009). Engle et al. (2017) found that farmed fish are usually fresher when purchased because the farms' greater

359 control of the production process enhances their ability to meet retailers' demands. However,
360 in line with the findings of other studies (Claret et al., 2014; Vanhonacker et al., 2013), the
361 participants of the present study believed that wild fish were fresher than farmed fish. In fact,
362 for many species and market segments, farmed fish are usually the fresher alternative. As
363 found by Girard and Paquotte (2003), the results of this study revealed that consumers' lack of
364 awareness of the production and distribution channels of the fish they buy.

365 Key aspects for consumers' acceptability when buying fish is its flesh texture and, most
366 importantly, its flesh firmness (Cheng et al., 2014). Wild fish flesh is firmer, both raw (Johnston
367 et al., 2006) and cooked (Saavedra et al., 2017). Interestingly, as stated by Gabr and Gab-Alla
368 (2007), the higher level of acceptability of wild fish could be due to its greater firmness. The
369 participants from all five countries in this study believed that wild fish were firmer than farmed
370 fish. As several factors can affect fish flesh texture, the fish producers might consider
371 introducing modifications during the fish husbandry process. As stated by Rasmussen et al.
372 (2013), the amount of fish activity seems to affect the final flesh characteristics, as does the
373 fish's diet. In addition to rearing conditions, other factors can affect fish flesh texture, such as
374 freshness, storage, processing, and cooking (Johnston et al., 2006). Therefore, not only
375 producers but all stakeholders in the fish farming supply chain should be considered when
376 trying to meet consumers' demands.

377 Concerning perceptions of fatty content, the respondents from Germany and Spain believed
378 that wild fish were fattier than farmed fish, but those from France and Italy thought the
379 opposite. In general, farmed fish have a higher total fat content (Cahu et al., 2004; Johnston et
380 al., 2006) because of their diet, feeding frequency, and reduced physical activity (Rincón et al.,
381 2016; Saavedra et al., 2017). People's perceptions of fat content in fish can be a complex and
382 ambiguous aspect. In general, health-conscious people avoid high fat consumption because of
383 the corresponding high calorie intake. However, many people know that the type of fat found

384 in fish helps prevent cardiovascular diseases (Cahu et al., 2004), and that may improve its rate
385 of acceptance. Thus, people's observational beliefs about fishes' fat content (whether wild or
386 farmed) is not straightforward; can have opposite effects on the perception of the product
387 depending on the individual. Multiple factors affect consumers' food fat preferences (i.e.
388 geographical, genetic, physiological, cultural, attitudinal, and economic factors) (Drewnowski
389 and Almiron-Roig, 2010); therefore, further investigation is needed to know whether fat
390 content is perceived as a driver or barrier to fish consumption.

391

392 **3.3 Cluster analysis**

393 Although most of the 19 beliefs differed significantly across the five countries in the study, the
394 average scores were around the midpoint of the scale (4±1). There are two main reasons for
395 this: (a) there were groups of participants with similar beliefs within each country, and (b)
396 increasing globalization has favoured a convergence of food-consumption patterns across
397 countries (Rozin, 2007). It should be noticed, as suggested by López-Mas et al. (2019a), that
398 the average differences among countries may be equal or even smaller than the differences
399 among regions within a country. Accordingly, the country variable may not be discriminant
400 enough to segment the respondents and identify different belief patterns clearly.
401 Consequently, this study performed an *ex post* segmentation based on cluster analysis.

402 The participants were grouped according to their beliefs about wild and farmed fish (Table 3).
403 Five clusters were retained because the discriminant analysis allowed the classification of
404 81.7% of the respondents in the corresponding clusters established earlier. The resulting
405 clusters were labelled depending on the group members' average beliefs: pro-wild fish, slightly
406 pro-wild fish, balanced view, open to aquaculture, and pro-aquaculture. All the participants'
407 beliefs were significantly different among the clusters.

408

409 **Table 3. Mean cluster values and standard deviation of the selected beliefs comparing wild**

410 ***versus* farmed fish.**

Dimension	Item		Mean (SD)				
	Wild fish _____ than farmed fish	F	Cluster 1 (n = 360)	Cluster 2 (n = 997)	Cluster 3 (n = 458)	Cluster 4 (n = 408)	Cluster 5 (n = 288)
Safety	is safer (R)	697.8	5.8^{a} (1.2)	4.1^{b} (0.9)	3.1^{c} (1.2)	3.1^{c} (0.9)	2.1^{d} (0.9)
	is more affected by marine pollution (spillages)	308.4	3.3^{e} (1.8)	4.3^{d} (1.1)	5.7^{b} (1.1)	4.8^{c} (1.0)	6.0^{a} (0.8)
	contains more heavy metals (R)	285.1	3.1^{e} (1.6)	4.1^{d} (0.9)	5.0^{b} (1.3)	4.7^{c} (1.1)	5.8^{a} (1.0)
	contains more antibiotics	318.4	2.2^{e} (1.6)	3.4^{c} (1.3)	2.9^{d} (1.5)	4.5^{b} (1.0)	5.4^{a} (1.2)
	is more affected by parasites (anisakis) (R)	344.8	2.9^{e} (1.5)	4.0^{d} (1.0)	5.0^{b} (1.4)	4.7^{c} (0.9)	5.8^{a} (0.9)
	has a healthier diet	643.5	6.1^{a} (1.0)	4.4^{b} (1.0)	3.9^{c} (1.4)	3.3^{d} (0.9)	2.2^{e} (0.9)
	is healthier (R)	715.3	6.1^{a} (1.0)	4.3^{b} (0.9)	3.7^{c} (1.3)	3.3^{d} (0.9)	2.1^{e} (0.9)
Quality	is of better quality	644.0	6.1^{a} (1.0)	4.6^{b} (1.0)	4.3^{c} (1.3)	3.4^{d} (0.9)	2.2^{e} (0.9)
	is fresher (R)	484.0	5.9^{a} (1.2)	4.4^{b} (1.0)	4.3^{b} (1.4)	3.3^{c} (0.9)	2.3^{d} (1.0)
	is more nutritious	585.9	6.0^{a} (1.1)	4.4^{b} (1.0)	4.4^{b} (1.3)	3.4^{c} (0.9)	2.3^{d} (0.9)
	is more fatty (R)	277.5	2.6^{d} (1.7)	3.8^{c} (1.1)	3.8^{c} (1.5)	4.6^{b} (0.9)	5.7^{a} (1.0)
	tastes better	611.1	6.2^{a} (0.9)	4.6^{b} (1.1)	4.7^{b} (1.3)	3.4^{c} (0.9)	2.4^{d} (1.0)
	is firmer (R)	497.8	5.7^{a} (1.3)	4.3^{b} (0.9)	4.2^{b} (1.3)	3.3^{c} (0.9)	2.2^{d} (1.0)
Control	is more controlled	243.2	4.3^{a} (1.9)	3.5^{b} (1.1)	2.3^{d} (1.1)	3.0^{c} (1.0)	2.0^{e} (0.8)
	is more handled (R)	49.1	3.7^{a} (2.3)	3.6^{a} (1.2)	3.2^{b} (1.7)	3.2^{b} (1.0)	2.4^{c} (1.1)
	is more artificial	449.5	1.9^{d} (1.5)	3.2^{c} (1.3)	1.9^{d} (1.0)	4.4^{b} (1.2)	5.2^{a} (1.5)
	provides more guarantees (R)	615.7	5.6^{a} (1.3)	4.0^{b} (0.9)	2.9^{d} (1.2)	3.1^{c} (0.9)	2.0^{e} (0.8)
When buying fish	is easier to find	133.5	3.2^{b} (2.0)	3.4^{a} (1.2)	2.0^{c} (1.0)	3.1^{b} (1.1)	2.1^{c} (1.0)
	is cheaper (R)	101.3	3.3^{b} (2.1)	3.6^{a} (1.3)	2.4^{c} (1.2)	3.4^{ab} (1.1)	2.3^{c} (1.1)

411 Mean values in a 7-point Likert scale: mean values < 4 indicate disagreement; mean values > 4 indicate agreement.

412 Superscript a–e: different letters in the same row indicate statistically significant differences (p < 0.05); the absence

413 of letters within a row indicates no statistical differences. SD: standard deviation. F: F value from the one-way

414 ANOVA. Cluster 1: pro-wild fish; Cluster 2: slightly pro-wild fish; Cluster 3: balanced view; Cluster 4: open to

aquaculture; Cluster 5: pro-aquaculture. R: reversed beliefs statements in the questionnaire presented as 'farmed fish _____ than wild fish'.

Cluster 1 (n = 360) was labelled 'pro-wild fish' since that group's beliefs favoured the positive characteristics of wild fish and disfavoured the negative aspects, showing extreme values. However, some of Cluster 1's beliefs seemed to disagree with facts and may have been based on stereotypes and emotions (Verbeke and Brunsø, 2005; Verbeke et al., 2007a). The 'when buying fish' dimension was an exception since observational beliefs usually lead to a higher agreement among consumers. In general, the same trend was shared by the respondents in Cluster 2 (n = 997), the biggest group. However, Cluster 2's beliefs favouring wild fish were not as strong as those of the members of Cluster 1. Cluster 2's values were nearer to the midpoint of the scale; hence, they were labelled 'slightly pro-wild fish'.

Cluster 3 (n = 458) shared certain characteristics with the other segments. Most of the group members' beliefs relating to the 'safety', 'control', and 'when buying fish' dimensions were in favour of farmed fish. By contrast, most of their 'quality' dimension beliefs favoured wild fish. This cluster was labelled as 'balanced view' because most of the participants' beliefs agreed with scientific evidence; the sole exception was their belief that wild fish are fresher, even though farmed fish tend to be fresher.

Cluster 4 (n = 408) was labelled 'open to aquaculture' because its members held mostly positive beliefs about aquaculture but did not exhibit extreme values. Finally, Cluster 5 (n = 288) was labelled 'pro-aquaculture' because its members strongly valued the positive aspects of farmed fish and strongly devalued the negative. The Cluster 5 participants rated farmed fish more favourably even in areas where wild fish are normally considered better among consumers (e.g. taste, quality) (Claret et al., 2014; Hall and Amberg, 2013; Norwegian Seafood Council, 2018; Verbeke et al., 2007a; Verbeke et al., 2007b).

In general, the respondents' opinions favoured wild fish because most of them (54%) fell into Cluster 1 or Cluster 2, whose beliefs were demonstrably pro-wild fish, except for the 'when buying fish' dimension. However, a better valuation of a food product does not necessarily imply greater consumption, as evidenced by the finding that, although most of the participants in this study preferred wild fish, they reported higher consumption of farmed fish (Table 1). As mentioned earlier, food choice is a complex process involving multiple factors. Nevertheless, the analyses of this study's respondents' beliefs suggest that the participants placed a higher value on the greater availability and lower price of farmed fish than on the perceived higher quality of wild fish (assuming the simultaneous availability of both farmed and wild fish).

3.4 Cluster profiling

There were significant differences among the clusters by country, age, presence of children at home, fish consumption (farmed and wild), and knowledge (objective and subjective) (Table 4). By contrast, no significant differences were observed when the clusters were compared by the perceived economic situation, gender, or education level. Interestingly, both gender and education level often influence fish consumption (Pieniak et al., 2010; Verbeke and Vackier, 2005). However, in the present study, the effects of both of these were observed but were statistically significant only in two cases: male participants reported higher consumption of wild fish, and the higher the education level, the higher the farmed fish consumption.

Table 4. Individuals' percentage by cluster affected by significant classification variables.

Variable	Percentage					Individuals
	Cluster 1 (n = 360)	Cluster 2 (n = 997)	Cluster 3 (n = 458)	Cluster 4 (n = 408)	Cluster 5 (n = 288)	Total

Country	DE	13.0^{b}	39.3^{ab}	21.2^{a}	16.2	10.3^{ab}	506
	ES	11.0^{b}	37.8^{ab}	20.6^{a}	18.6	12.0^{ab}	500
	FR	22.2^{a}	45.6^{a}	11.4^{b}	12.6	8.2^{b}	500
	IT	14.2^{b}	32.4^{b}	22.0^{a}	16.6	14.8^{a}	500
	UK	11.3^{b}	43.4^{a}	16.0^{ab}	17.2	12.1^{ab}	505
Age	Mean	42.4^{a}	42.0^{a}	43.5^{a}	39.7^{b}	37.7^{b}	2,511
Children at	Yes	13.9	37.5^{b}	16.2^{b}	17.8	14.6^{a}	1,145
home	No	14.7	41.6^{a}	19.9^{a}	14.9	8.9^{b}	1,366
Consumption	Never	20.3	44.4^{ab}	14.0	14.5	6.8^{c}	207
of farmed	Once a month or less	13.1	45.0^{a}	17.9	14.5	9.5^{bc}	871
fish	2–3 times a month	14.0	34.9^{b}	18.9	18.6	13.6^{ab}	748
	Once a week or more	15.9	32.8^{b}	19.2	16.7	15.4^{a}	521
	I do not know	9.8	49.4^{a}	19.5	15.9	5.5^{c}	164
Consumption	Never	9.8^{b}	39.4^{ab}	22.7^{a}	18.3	9.8^{abc}	388
of wild fish	Once a month or less	13.2^{ab}	43.0^{a}	17.4^{ab}	16.9	9.4^{bc}	862
	2–3 times a month	17.4^{a}	34.6^{b}	17.7^{ab}	16.8	13.5^{ab}	644
	Once a week or more	18.9^{a}	37.0^{ab}	14.2^{b}	13.4	16.5^{a}	424
	I do not know	8.3^{b}	48.2^{a}	23.8^{a}	13.5	6.2^{c}	193
SK	Mean	4.3^{cd}	4.2^{d}	4.4^{bc}	4.6^{b}	5.4^{a}	2,511
OK	Low	12.7^{b}	39.7^{ab}	12.0^{c}	20.8^{a}	14.8^{a}	436
	Average	13.4^{b}	41.0^{a}	18.2^{b}	15.9^{ab}	11.5^{ab}	385
	High	19.3^{a}	34.6^{b}	24.1^{a}	13.8^{b}	8.3^{b}	1,690

461 Superscript a–d: different letters in the same column (cluster) and classification variables indicate statistically
462 significant differences ($p < 0.05$). The absence of letters within a column indicates no statistical differences. Cluster
463 1: pro-wild fish; Cluster 2: slightly pro-wild fish; Cluster 3: balanced view; Cluster 4: open to aquaculture; Cluster 5:
464 pro-aquaculture.

465

Most of the participants from France fell into Cluster 1, and they had a low presence in Cluster 5; these two results suggest that participants from France perceived wild fish as superior to farmed fish. Their more positive perception of wild fish led to higher consumption; Cluster 1 members often ate wild fish. As previously found by Hall and Amberg (2013), there is a close relationship between the belief that wild fish are superior and a higher purchase intention. Other studies have shown that higher fish consumption leads to a better evaluation of wild fish (Vanhonacker et al., 2013; Verbeke et al., 2007b). Interestingly, in this study, that finding was supported for the participants from France but not those from Spain; France and Spain are the third- and second-major fish consumers in Europe, respectively (European Commission, 2018).

Participants from France and the United Kingdom had a higher presence in Cluster 2 but there were less respondents from Italy. This supports the idea that the French participants had a more positive view of wild fish and reveals a slight tendency for the Italian participants to favour farmed fish.

Cluster 3 members were older and were less likely to have children living at home. Cluster 3 participants reported a low consumption of wild fish and a high OK, which suggests that the participants whose beliefs mostly agreed with scientific evidence were the ones who consumed less wild fish. This finding highlights the importance of consumers' information and knowledge and suggests that providing more information and enhancing consumer knowledge about aquaculture could lead to an increase in the consumption of farmed fish. According to Reig et al. (2019), agents involved at all levels of the farmed-fish supply chain negatively perceive the lack of information about aquaculture, a fact that can hinders its social acceptability. However, the image of aquaculture could be improved by increasing consumers' knowledge through information, communication, and marketing campaigns that emphasise its quality (Altintzoglou et al., 2010; Reig et al., 2019). These campaigns should target not only consumers but fish sellers, as they are the most-used information source by Europeans buying

491 fish for consumption (52%) (EUMOFA, 2017) and one of the most-trusted (Pieniak et al., 2007),
492 as well as other parties involved in the supply chain (e.g. frontline employees) (Nijssen et al.,
493 2021).

494 Cluster 4 presented few differences from the other clusters. Finally, Cluster 5 included many of
495 the participants from Italy, confirming that country's more positive perception of farmed fish.
496 This positive view of farmed fish could be related to Italy's higher proportion of aquaculture
497 production (44%) in its total fish production (i.e. wild catches and aquaculture) when
498 compared with the other studied countries (European Commission, 2018). Cluster 5 members
499 were younger and had more chances to have children at home. Interestingly, households with
500 children were more likely to report that wild fish taste better than farmed fish (Verbeke et al.,
501 2007a). Paradoxically, although Cluster 5 participants showed a more positive perception of
502 farmed fish, they reported the frequent consumption (once a week or more) of both wild and
503 farmed fish. This fact questions the close relationship that usually exists between beliefs and
504 food choices (Lusk et al., 2014). Of course, some species are mostly found in the wild and do
505 not have aquaculture counterparts (e.g. cod, hake) (EUMOFA, 2019a); therefore, it is possible
506 that if Cluster 5 participants could purchase farmed fish of those species, they would. Finally,
507 the participants in Cluster 5 reported the highest SK, suggesting overconfidence in themselves
508 because most of them had low or average OK.

509 The participants of Clusters 1, 2, and 3 were older. In addition, respondents in Clusters 1 and 2
510 seemed to have a more positive view of wild fish. Verbeke et al. (2007a) reported the
511 preference among older consumers for wild fish and suggested that this may be because they
512 are more habituated to wild fish. Remarkably, consumers are usually conservative and
513 traditional when it comes to eating fish. Typically, their preferences are based on their
514 familiarity with the products (Claret et al., 2016; Engle et al., 2017). In the same vein, food
515 habits are usually stable over time (van't Riet et al., 2011) and seem to shape individual

preferences (Guerrero et al., 2012). Perhaps older consumers tend to prefer wild fish because aquaculture is a relatively new food source; it was not until 1980 that its expansion began (FAO, 2016).

4. Conclusions

This study sought a better understanding of European consumers' beliefs about wild *versus* farmed fish. The lack of information about aquaculture could be a barrier to its social acceptability. This highlights the need to increase consumers' knowledge about aquaculture through communication and marketing campaigns. Most of the survey respondents agreed that wild fish were more affected by marine pollution, heavy metals, and parasites. Therefore, information and promotion campaigns should emphasise that farmed fish are less affected by these hazards. Many of the participants held beliefs that contradicted scientific knowledge. Therefore, producers and marketers should provide more information to sway consumers' beliefs based on scientific evidence rather than preconceptions and misinformation. Because farmed fish are generally fresher than wild fish—contrary to common public perceptions—a greater emphasis should be placed on the faster farm-to-table distribution channels. Producers and marketers should also focus their efforts on refuting the widely-held belief that most farmed fish contain antibiotic residues and communicate the benefits of the farms' greater control over production, both of which may improve consumers' views on farmed fish.

Fish producers should be aware of how their animal husbandry practices affect consumers' opinions and fish flesh quality. Considering that people may prefer wild fish because of its higher firmness, aquaculture producers should consider modifying their fish-rearing conditions and practices to improve the firmness of farmed fish, such as making dietary changes and promoting fish exercise, as flesh firmness has been linked to the higher activity levels of wild fish. Because people often express concerns about the quality of farmed fish diet, informing the public with greater transparency about the farmed-fish production process could help to improve its reputation.

This study has offered educated guidance to help producers and marketers design more effective aquaculture communication campaigns and build more effective marketing strategies

544 tailored to specific consumer segments identified herein as ‘pro-wild fish’, ‘slightly pro-wild
545 fish’, ‘balanced view’, ‘open to aquaculture’, and ‘pro-aquaculture’. The cluster profiling will
546 help them identify and describe the potential campaign targets.

547

548 **5. Limitations of the study**

549 Supplementary investigations are needed to know if the belief statements’ format
550 (wild/farmed fish _____ than farmed/wild fish) could influence the participants’ responses.
551 There are other phenomena that should be considered as well, such as the effect of social
552 desirability when online questionnaires are used. As people’s attitudes towards the fat in fish
553 can be a complex aspect, focused in-depth investigations are needed to determine the role of
554 fat in fish consumption; that is, more studies are needed to know whether people perceive fat
555 content as a driver or barrier to fish consumption. Consumer beliefs related to animal welfare,
556 sustainability, and ethical issues are also essential areas for future research given the
557 increasing concern and awareness generated among consumers. This study’s participants were
558 categorised by country; studies using ‘region’ variable are needed to complement participants’
559 nationality information.

560

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