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► To cite this version:

Jean-François Dewals, Fabienne Daures, Pascal Le Floc'H. The role of fisheries and aquaculture products in ensuring sustainable and healthy food consumption in France. *Aquatic Living Resources*, 2024, 37, 16 (14p.). <10.1051/alr/2024014>. <hal-04937484>

HAL Id: hal-04937484

<https://hal.science/hal-04937484v1>

Submitted on 11 Feb 2025




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The role of fisheries and aquaculture products in ensuring sustainable and healthy food consumption in France

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Received 31 May 2024 / Accepted 5 November 2024

Handling Editor: Verena Trenkel

Abstract – The consumption of Fisheries and Aquaculture Products (FAP) can contribute to the transition of our food system towards greater sustainability. However, in order to implement effective food policies aimed at promoting sustainable FAP consumption, data on individual consumption behavior are lacking. Based on a consumer survey carried out on the French market in 2023, the aim of this article was to gain a deeper understanding of the current consumption patterns in place in France in order to identify potential levers for aligning French FAP consumption with public health and resource conservation objectives. Using an ordered probit model and Welch's *t*-tests, our results show that French FAP consumption is currently driven by few people (the elderly, connoisseurs, and high-income households). In line with our findings, actions are proposed to guide French FAP consumers towards more sustainable behavior. In particular, we discuss the need to inform and educate consumers better. The promotion of local “under-utilized” species, the integration of environmental considerations into existing food policies, or even the need to exploit “out-of-home” consumption venues to promote sustainable FAP consumption among occasional consumers are discussed as interesting possibilities.

Keywords: Food systems / seafood / sustainable and healthy diet / consumer behavior / consumption patterns

1 Introduction

In recent decades, the sustainability of our food systems has come under intense scrutiny. From production to consumption, food systems contribute to 34% of global greenhouse gas (GHG) emissions worldwide (Crippa et al., 2021) and are also directly linked to land use, water use, biodiversity loss, etc. (IPBES, 2019). Moreover, their ability to provide quality food for the world's growing population is being questioned (FAO et al., 2022). While malnutrition is a global issue, current food consumption patterns in developed countries are linked to the rise of diseases such as obesity, diabetes and cardiovascular diseases (FAO et al., 2022). Meat production and consumption occupy a special place in the ongoing debate, being heavily criticized for their impact on the environment and public health, leading to a “lose-lose” diet. This vision is particularly acute in developed countries, where meat consumption is widespread. According to the latest EU report (European Commission, 2021a), Europeans consume about 67.7 kg of meat per year. Despite a recent downward

trend in consumption, there is an urgent need to reduce it more drastically. According to Willett et al. (2019) “*Transformation to healthy diets by 2050 will require substantial dietary shifts, including a greater than 50% reduction in global consumption of unhealthy foods, such as red meat and sugar [...]*”.

To achieve a “win-win” scenario, public policies encourage, among other things, dietary changes (Irz et al., 2018). As discussed by Perignon et al. (2017), the choice of substitute products is essential as these products also have their own externalities from the environmental and the health perspective. In line with this reasoning, vegetarian diets are generally presented as viable alternatives (Perignon et al., 2017; Vieux et al., 2018; Springmann, 2020) that have the least environmental impact relative to their nutritional content (Willett et al., 2019). However, plant-based diets can meet resistance, notably in developed countries. Mixed diets also offer an interesting alternative. In this particular case, Fishery and Aquaculture Products (FAP) can be an interesting protein substitute.

FAP are considered nutrient-rich foods, containing essential nutrients such as omega-3 fatty acids, zinc, calcium, iodine, and vitamins (Carlucci et al., 2015; Golden et al., 2021; Koehn et al., 2022). These nutrients are essential for metabolic

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function as well as for fighting diseases such as obesity and cardiovascular disease. More than that, FAP have been described as being “greener” than meat (Gephart et al., 2021; Crona et al., 2023)¹, although they are also associated with well-known environmental externalities (overfishing, eutrophication, etc.). Despite the current limitations of our food systems, FAP occupy a marginal place in food policy (Koehn et al., 2022). As stated by the Food Policy Coalition in 2020, “...seafood production is almost completely ignored in the Farm to Fork Strategy”. In the EU, their inclusion is often limited to weekly nutritional recommendations (at least one or two portions per week in most European countries (European Commission, 2024), with different portion sizes).

While FAP can provide solutions to some of the problems faced by our current diet, the main challenge for existing policies is to reconcile the environmental sustainability issues raised by their consumption with the nutritional benefits they can bring to the population. One of the obstacles to the effective integration of FAP into these policies is the lack of knowledge about consumption patterns and habits at the individual level. In order to formulate effective public policy recommendations to promote sustainable consumption behaviors, it is therefore imperative to improve our understanding of the characteristics and determinants of FAP consumption (Birch and Lawley, 2012; Szolnoki and Hoffmann, 2014; Milford and Muiruri, 2024).

At the EU level, the current average consumption of FAP is significant (23.3 kg per capita in 2020) (EUMOFA, 2022), but with large disparities between Member States (57.7 kg per capita on average in Portugal compared to 5.7 kg in the Czech Republic). We also know that some of the most consumed species may come from endangered stocks (e.g. tuna (ICCAT, 2022) and cod (ICES, 2024) or from unsustainable aquaculture production (e.g. salmon according to Ziegler and Hilborn (2023)). Finally, recent studies have highlighted some disparities within EU countries. On average, 11% of EU consumers never eat FAP, 5% eat FAPs less than once a year, 19% eat FAP several times a year, and 64% eat FAPs at least once a month (European Commission, 2021b). This reality raises questions about the capacity of some European citizens to follow the above-mentioned nutritional recommendations (Pieniak et al., 2010; Clonan et al., 2012; Carlucci et al., 2015), including in countries where FAP consumption is important.

The limited knowledge of FAP consumption patterns also concerns France, which among the countries with the highest consumption of FAP in Europe. (31.8 kg per capita in 2021) (FranceAgriMer, 2023a). According to FranceAgriMer, French FAP consumption relies on a limited number of species. Tuna represent 15.5% of the annual FAP consumption per capita, salmon 14.5%, cod 7.6%, Alaska Pollack 7.2% and mussels 6.9%. These six species account for over half of the global French consumption (FranceAgriMer, 2023b). Further, this consumption relies on imports, with a trade deficit of 5.5 billion € in 2021, despite one of the highest levels of primary production (fisheries and shellfish) at EU level (FranceAgriMer, 2023b).

In terms of prices, species such as salmon or cod are, on average, quite expensive: around 20 € per kilo for fresh salmon or fresh cod (FranceAgriMer, 2023a). By way of comparison, the average price of meat in France in 2021 was 11.6 € per kilo (FranceAgriMer, 2021). However, the price depends on the preservation method. For example, fresh tuna is sold for an average of 23 € per kilo, while canned tuna is less expensive (9.9 € per kilo) (FranceAgriMer, 2023a). Regarding ongoing trends, French consumers tended to consume less fresh products and more delicatessen products over time (FranceAgriMer, 2023a). Canned and frozen FAP consumption remained stable. (FranceAgriMer, 2023a).

Apart from annual public information on FAP purchases (FranceAgriMer, 2023a, 2023b), little is known about the diversity of purchasing behaviors (frequency, location, etc.) and the different consumption profiles (socio-demographic characteristics, preferences, knowledge, etc.) in place on the French market. As mentioned, these elements are essential for the implementation of public policies aimed at achieving both health equity objectives and the environmental sustainability of the system. Obtaining more precise information at the individual level is an essential step in the attempt to guide French consumers towards more virtuous behavior. For example, it is complex to put in perspective current consumption rates on the French market (close to 305 g per week) with the French National Agency for Food, Environment and Health (ANSES) recommendations that individuals should consume two portions of FAP per week (i.e., 200g) (Ministry of Labor, Health and Solidarity, 2019).

Based on a literature review on the drivers of FAP consumption and the results from a consumption survey, this article aims to i) provide a better understanding of current FAP consumption patterns in France in order to assess their consistency with global public health and environmental objectives; ii) identify the drivers and the consumer profiles behind the diverse consumption behaviors (based on the frequency of FAP consumption); iii) propose recommendations for public policies to encourage consumers to adopt a more sustainable consumption of FAP.

2 Materials and methods

2.1 FAP consumption determinants

Several explanations can be put forward for why current consumption patterns of FAP are unsustainable and current policies fall far short of their objectives. The heterogeneity of consumers in terms of consumption behaviors is one of them. To better understand this heterogeneity, we first identified essential determinants of FAP consumption from the literature. Govzman et al. (2021) and Cantillo et al. (2021) provided a comprehensive overview of these determinants using the existing literature (Govzman et al., 2021) and survey data from the EU market in 2018 (Cantillo et al., 2021). We complemented these reviews with other published sources to identify pertinent determinants regarding our research objectives. The determinants that we have chosen to highlight in this work can be divided into three categories: consumers’ socio-characteristics, preferences for credence attributes and preferences for FAP characteristics (Tab. 1). Table 1

¹ Nevertheless, this result should be nuanced. There is a wide variety of species and production methods with different impacts.

Table 1. Determinants of FAP consumption.

	Factor	Influence on FAP consumption	Supporting studies
<i>Consumers' socio-characteristics</i>	Age	Older consumers tend to consume more FAP than younger consumers	Olsen, 2003; Brunso et al., 2008; Murray et al., 2017; Thong and Solgaard, 2017; Cantillo et al., 2021 and Govzman et al., 2021;
	Gender	Female tend to consume more FAP than male No real effect	Thong and Solgaard, 2017 Govzman et al., 2021
	Income	Higher-income households consume more FAP than lower-income households	Verbeke et al., 2005; Thong and Solgaard, 2017; Cantillo et al., 2021
	Level of education	Consumers with a higher education level consume more FAP than consumers with lower education level	Jahns et al., 2014; Cantillo et al., 2021; Govzman et al., 2021; Marinac Pupavac et al., 2022
	Living in a coastal area	Households located in coastal areas consume more FAP than other households, notably due to better availability and familiarity	Birch and Lawley, 2012; Govzman et al., 2021; Marinac Pupavac et al., 2022; Menozzi et al., 2023; Dewals et al., 2024
	Knowledge	Consumers with a high knowledge (objective and subjective) of the sector consume more FAP than consumers with a low knowledge of the sector	Olsen, 2008; Birch and Lawley, 2012; Pieniak et al., 2010; Almeida et al., 2015; Menozzi et al., 2023
	Household structure	Households with children consume more FAP than household without children (child development reasons) Households with children consume less FAP than household without children (safety reasons)	Verbeke et al., 2005; Olsen, 2008 Birch and Lawley, 2012.
	Determinants	Influence on FAP consumption	Supporting studies
<i>Credence attributes</i>	Health	The perceived health benefits by consumers increase FAP consumption	Verbeke et al., 2005, 2007b; Brunso et al., 2008, 2009; Pieniak et al., 2010; Carlucci et al., 2015; Béné et al., 2019; Cantillo et al., 2021; Bimbo et al., 2022; Crona et al., 2023
		The perceived safety risks by consumers decrease FAP consumption	Birch and Lawley, 2012; Govzman et al., 2021
	Country of Origin	Consumers prefer domestic FAP to imported ones	Brécard et al., 2009; Claret et al., 2012; Uchida et al., 2014; Feucht and Zander, 2017; Rickertsen et al., 2017; Santeramo et al., 2018; Banovic et al., 2019; Maesano et al., 2020; Marinac Pupavac et al., 2022
	Environmental impact	Perceived environmental impacts can reduce FAP consumption	Brécard et al., 2009, 2012; Salladarré et al., 2010; Lucas et al., 2021
	Animal welfare	Perceived impacts on animal welfare can reduce FAP consumption	Alfnes et al., 2018; Zander and Feucht, 2018a; Maesano et al., 2020; Waley et al., 2021
	Production method	Consumers tend to prefer wild products compared to farmed products	Verbeke et al., 2007b; Cardoso et al., 2013; Rickertsen et al., 2017; Maesano et al., 2020; Bimbo et al., 2022
<i>Products characteristics</i>	Sensory qualities	Perceived taste increases FAP consumption	Brunso et al., 2008, 2009; Murray et al., 2017; Zander et al., 2018b; Cantillo et al., 2021
	Product presentation	Perceived taste decreases FAP consumption Consumers tend to prefer fresh FAP compared to frozen FAP	Brunso et al., 2008 Brunso et al., 2009; Cantillo et al., 2021
	Cooking skills	Difficulty in cooking FAP reduces consumption	Govzman et al., 2021
	Price	Increased price reduces FAP consumption	Brunso et al., 2009; Thong and Solgaard, 2017; Bimbo et al., 2022; Marinac Pupavac et al., 2022

Table 2. Characteristics of questionnaire respondents ($N=1895$).

	Respondents	
	Male	Female
Gender (%)	47.1	52.9
Socio-professional category (%)		
Farmers	0.4	
Craftsmen, retailers and business owners	4.0	
Managers and higher intellectual professions	11.9	
Intermediate professions	12.4	
Employees	29.9	
Workers	5.9	
Retirees	21.6	
Other non-working people	13.9	
Age categories (%)		
[18–34]	44.2	
[35–49]	18.6	
[50–64]	18.4	
[65+]	18.8	

summarizes the determinants we have chosen to focus on and how they influence the consumption of FAP. The list of determinants were then used in our statistical analysis, to gain a deeper understanding of the prevailing consumption patterns in the French market at the individual scale.

2.2 Data collection

The data used in this article comes from a consumer survey carried out in 2023 on the French market. This survey was carried out by KantarWorldPanel among its panel of FAPs consumers *via* an online questionnaire in all regions of metropolitan France except Corsica. Based on the literature review, specific questions were formulated to assess the influence of consumer characteristics, motivation and preferences on their reported FAP consumption. The 72 survey questions were divided into six blocks: 1) FAP consumption habits (7 questions); 2) FAP consumption behavior for fresh products (3); 3) consumer preferences for FAPs (25); 4) motivations, knowledge and implication of FAP consumers (9); 5) bidding processes (18); and, lastly, 6) consumer characteristics (10). The response consisted of 1,895 FAP consumers who eat at FAP at home. Consumers who did not eat FAPs at home were excluded from the survey. The characteristics of questionnaire respondents are presented in [Table 2](#).

The survey respondents included an oversampling of young people (18–34 yr) and employees compared to their share in the French population. In order to adjust for it, we applied weighting coefficients (0.55 for 18–34 yr old, 0.6 for employees) to these two respondent categories. These weighting coefficients were only applied to our ordered probit model (see next section) in order to match the actual structure of the French population.

2.3 Statistical analysis

To test the influence of consumer characteristics on their reported FAP consumption frequency (dependent variable), we used ordered probit models. From the literature review we know that consumer age, gender, presence of children under 18 in the household, place of residence, household income, objective knowledge of the sector, attention paid to price when buying FAPs, preferences for FAP and perceptions of four specific attributes (health, taste, expensive, difficulty to cook) can impact consumption frequency. These factors were therefore explored as potential explanatory variables for FAP consumption frequency. These variables were tested for multicollinearity before performing the ordered probit ([Tab. A1](#)). No multicollinearity was found.

2.3.1 Ordered probit model

The ordered probit model is built around a latent regression ([Greene, 2018](#)). If we note i the respondents ($i = 1-1895$), and k the three ordered choice modalities (1= at least once a week, 2= at least once a month, 3=less than once a month), the probability that individual i chooses alternative k can be written as follows:

$$P(y_i = k) = F(X_i\beta) \quad (1)$$

where F is the distribution function, X_i is the matrix of characteristics for individual i , and β is the vector of the model parameters.

As we use an ordered probit model, we can first state that:

$$y_i = \begin{cases} 1 & \text{if } -\infty < y_i^* \leq \gamma_1 \\ 2 & \text{if } \gamma_1 < y_i^* \leq \gamma_2 \\ 3 & \text{if } y_i^* > \gamma_3 \end{cases} \quad (2)$$

where, y_i represents our dependent variable and y_i^* a latent variable. γ_k are constants delimiting the intervals of values of the latent variable.

The general formula for the ordered probit model can be written as follows:

$$\text{Prob}(y_i = k) = F(\gamma_k - X_i\beta) - F(\gamma_{k-1} - X_i\beta). \quad (3)$$

The coefficients presented in this article will be the marginal effects. These coefficients are easier to interpret compared to the standard coefficient as they provide information about the change in predicted probabilities regarding a change in a particular variable ([Wulff, 2015](#)). They represent a change in the probability of belonging to one of the three modalities of our dependent variable according to our different explanatory variables.

2.3.2 Description of the variables

In our ordered probit model, the dependent variable y is categorical with three possible outcomes. We denominate as “regular consumers” those who eat FAPs at least once a week

Table 3. Variables included in the ordered probit model.

Variable name	Block of the survey	Signification	Mean	SD
Sociodemographic characteristics of consumers				
Age	6	Age of consumer	44.11	0.39
Female	6	Consumer is a female	0.47	0.01
Children	6	Household has one or more children	0.39	0.01
Coastal dep.	6	Consumer lives in a coastal region	0.39	0.01
Low.income (ref)	6	Monthly household < 1,799 € per month	0.24	0.01
Mid.income	6	Monthly household income of between 1,799 € and 2,799 € per month	0.30	0.01
High. income	6	Monthly household income >2,800 € per month	0.45	0.01
Knowledge	4	Measures objective knowledge of the consumer	5.72	0.06
Price attention	4	Measures the attention the consumer pays to price during FAP purchases	6.4	0.06
Consumers preferences				
Fresh	3	Consumer prefers fresh FAP (whole or cuts) to canned, processed or frozen FAP	6.86	0.05
Env.wild	3	Consumer takes environmental issues into account when buying wild products	6.26	0.06
Env.farmed	3	Consumer takes environmental issues into account when buying farmed products	6.15	0.06
France	3	Consumer is interested in the French origin of the FAP	6.78	0.05
Health Hazards	3	Consumer takes health risks into account when buying FAP	6.23	0.06
Artisanal	3	Consumer prefers artisanal FAP compared to industrial FAP	3.24	0.04
Wild	3	Consumer prefers wild products compared to farmed products	5.08	0.04
Product attributes				
Health	3	Consumer perceives FAP as beneficial to health	0.24	0.01
Tasty	3	Consumer perceives FAP as having excellent taste qualities	0.16	0.01
Difficulty in cooking	3	Consumer does not perceive FAP as difficult to cook	0.15	0.01
Expensive	3	Consumer perceives FAP as expensive	0.15	0.01

($k=1$), as “medium consumers” consumers who eat FAPs at least once a month ($k=2$) and as “occasional consumers” consumers who eat FAPs less than once a month, excluding those who never eat FAP at home ($k=3$).

Five explanatory variables helped to characterize consumers: age (continuous variable), gender (1 = female, 0 = male), presence of children in the household (1 = children under 18 present in the household, 0 = otherwise), and place of residence (1 = coastal region, 0 = otherwise). The place of residence was determined from the postcode specified by the respondents of the survey. The last variable relates to household income, which was divided into three categories. The first category includes individuals with a household income of less than 1,799 € per month, which is our reference category in the model. The second category includes individuals with a household income between 1,800 € and 2,800 € per month, and the last category individuals with a household income higher than 2,800 € per month.

To test the relationship between knowledge and FAP consumption, we included a variable related to the objective knowledge of consumers. This variable is a score derived from a series of eleven “Yes/No” questions. Each correct answer increases the score of this variable by 1. Table A2 lists all statements and their correct answer. These statements made it possible to measure consumer awareness of the biological, environmental, economic and logistic aspects of the FAP sector, which cannot be perceived without some knowledge. Prior to the survey, these questions were tested with experts

and non-experts in the FAP sector in order to measure their ability to discriminate between the levels of knowledge of the responding consumers.

To test the influence of price on consumption frequency, we included a variable measuring the attention consumers pay to price when buying FAPs. We asked our consumers to position themselves on a scale from 0 (strongly disagree) to 10 (strongly agree) for the following question: “*Would you say that price is your first choice when buying FAPs for consumption AT HOME?*”

We also included seven different statements related to consumer preferences regarding FAPs. The first five statements related to the intrinsic quality of FAPs. Consumers were asked to rate themselves on a scale from 0 (not at all important) to 10 (very important). Table A3 presents these statements. The last two preferences relate to the production process. Consumers were asking to answer the following question: “*Whenever I can, I try to eat FAPs from...*”. For these two statements, consumers had to position themselves on a scale ranging from 0 to 7, with 4 indicating a null preference. For the question relative to production methods, 0 was associated with “artisanal production” and 7 with “industrial production”. Similarly, for the question relative to the production methods, 0 was associated with “aquaculture” and 7 with “wild fishing”.

We also included variables related to two main drivers of FAP consumption: FAP health perception and taste. To measure their importance, we asked our consumers to answer the following questions: “*In your opinion, regardless of how they are packaged, are FAPs good for your health?*” and

Table 4. FAP consumption frequency by location.

Frequency (%)	Home	Restaurant	Canteen	Overall
Consumer eats FAP at least once a week	40.8	8.1	10.6	46.1
Consumer eats FAP at least once a month	34.8	28.7	14.2	35.8
Consumer eats FAP less than once a month	24.4	49.6	20.9	18.1
Consumer never eats FAP	X	13.7	54.4	X

Note: Consumers included in the survey were required, at least to consume FAPs at home. “X” is thus equivalent to “No value”.

“In your opinion, regardless of how they are packaged, do FAPs have excellent taste qualities?”. Finally, we wanted to test the effect of two barriers to FAP consumption: price and difficulty in cooking. We, therefore, asked our consumers to answer the following questions: “In your opinion, regardless of how they are packaged, are FAPs expensive?” and “In your opinion, whatever form they come in, are FAPs difficult to cook?”. For these four questions, consumers were asked to rate their opinion on a scale from 1 (strongly disagree) to 4 (strongly agree). Table 3 summarizes the explanatory variables included in our model.

2.3.3 Statistical comparisons

We also wanted to test the difference in perception between wild and farmed products from the French consumers’ point of view. To do so, we used questions from the survey in which consumers had to position themselves on a scale from 1 (strongly disagree) to 4 (totally agree) regarding five attributes (taste, health benefits, health risks, expensive, difficult to cook). Consumers were asked to position themselves once for fishery products and once for aquaculture products. We also allowed our consumers to choose an “opt-out” option. Table A4 presents the attributes tested in the survey.

We then compared the mean score values for each attribute between wild and aquaculture products using Welch’s *t*-test as variance comparison tests (*F*-test) revealed significant differences in variance. Welch’s *t* statistic is defined as:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2}}} \quad (4)$$

with \bar{X}_n the mean score of group *n*, s_n its standard error and N_n the sample size.

3 Results

3.1 Frequency of FAP consumption in France

Only 40.8% of FAPs consumers responding to our survey eat FAPs at home at least once a week, 34.8% eat FAPs at least once a month, and 24.4% eat FAPs less than once a month (Tab. 4). Considering other places of FAP consumption, we found that the consumption of FAPs in restaurants is occasional for most French consumers (less than 40% of our consumers declared they eat FAPs in restaurants once a month or more) and quite rare in canteens; 54.4% of respondents declared they never eat FAPs in canteens. Combining the different places of consumption, only 46.1%

of consumers eat FAPs at least once a week, 35.8% at least once a month and 18.1% less than once a month (Tab. 4). The analysis of survey data at the individual level provided a spatial picture of FAP consumption in France. Despite the absence of a coastal effect (see below for model results), French FAP consumption was not completely uniformly distributed across the country (Fig. 1).

3.2 Determinants of FAP consumption in France

The ordered probit model revealed that with increasing age the probability of being a regular consumer increased (+0.3 percentage point (pp)), while the probability of being an occasional or medium consumer decreased (−0.2 and −0.1 pp, respectively) (Tab. 5). We also found an effect of household income. Belonging to the “middle-income household” class increased the probability of being a regular consumer by 8.7 pp and reduced the probability of belonging to the medium (−2.5 pp) or occasional (−6.2 pp) consumer categories. This effect was even more pronounced for the “high-income household” category, with a +12.5 pp increase for being a regular consumers, a −3.2 pp decrease for being a medium consumer and a −9.3 pp decrease for being an occasional consumer. Consumers with objective knowledge of the sector were also more likely to be in the regular consumer category (+1.5 pp). In contrast, they were less likely to be medium (−0.4 pp) or occasional consumers (−1.1 pp). Being a price-conscious consumer increased the probability of belonging to the occasional (+0.6 pp) or medium (+0.2 pp) consumer categories and reduced the probability of belonging to the regular category (−0.8 pp). We did not find any effects of gender, region of residence or presence of children in the household.

In terms of consumer preferences, we found a positive relationship between interest in the freshness of FAP (+1.0 pp), preference for artisanal productions (+2.1 pp) and weekly consumption of FAP. Further, it reduced the probability of being a medium consumer (by −0.2 pp and −0.5 pp, respectively) or an “occasional consumer” (by −0.7 pp and −1.5 pp, respectively). The other preferences tested (Env.wild; Env.farmed; France; Health Hazards; Wild) had no significant effect on reported consumption (see Tab. 3 for variable names).

Regarding product attributes, we found a positive relationship between consumers who believe that FAPs are beneficial to health and regular consumers (+5.2 pp) and a negative relationship with the medium (−1.5 pp) and occasional consumer (−3.8 pp) categories. The frequency of consumption was also influenced by the difficulty of cooking. Consumers who stated that FAP are not difficult to cook were

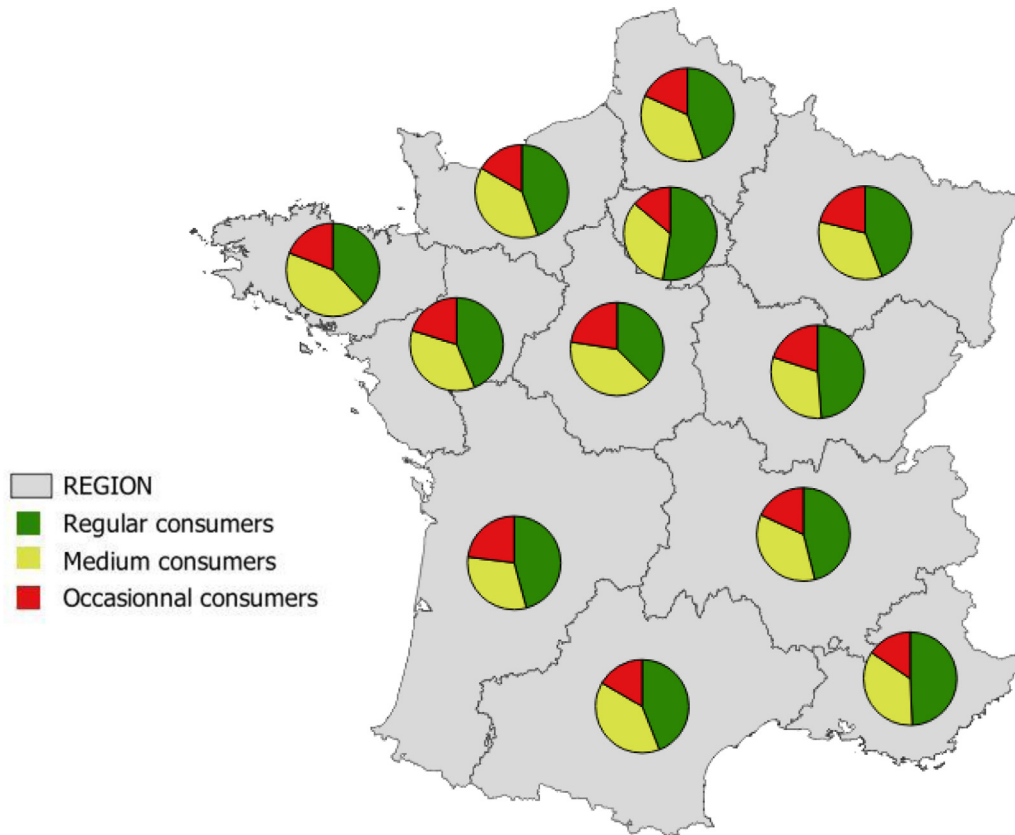


Fig. 1. French FAP consumption by region – 2023.

more likely to be regular FAP consumers (+10.4 pp), and less likely to be medium (−3.3 pp) or occasional (−7.1 pp) consumers. Finally, consumers who perceived FAP as expensive were not among the regular consumers (−8.7 pp) and were most present in the medium (+1.7 pp) and occasional (+7.0 pp) consumer categories. The perception that FAP are tasty did not influence the frequency of consumption.

3.3 A differentiated perception between wild and farmed products

Wild fisheries and aquaculture have an important and complementary role to play in achieving a healthy and sustainable diet. French consumers' perception of these two production methods differed across the five attributes tested (Fig. 2).

As expected, FAP were perceived as expensive by consumers (mean score=3.1). Further, French consumers perceived wild products as more expensive (3.3) than farmed ones (2.9). Consumers also associated FAP with tasty products (3.2). Again, consumers considered wild species to be tastier (3.5) than aquaculture species (2.9). French consumers did not necessarily perceive FAP as difficult to cook (2.1), with no differences seen between the two production methods. Overall, the perception that FAP present certain health hazards was moderate (2.4). However, farmed FAP were more associated with health risks (2.5) than wild species (2.3). Similarly, although French consumers perceived FAPs as healthy (3.3),

wild FAPs were more strongly associated with this attribute (3.6) than farmed ones (3.1).

4 Discussion

The aim of this study was to gain a deeper understanding of current FAP consumption behaviors on the French market. While FAP offer undeniable opportunities to meet tomorrow's health and environmental dietary challenges, consumption patterns in developed countries such as France need to be adapted, to align consumption patterns with the desired objectives.

4.1 The current French situation

According to our results, at least 53.9% of French consumers do not follow the French dietary recommendations to consume FAP twice a week². This result confirmed that overall dietary recommendations remain poorly followed in France and that the objectives of a healthy diet remain far from being achieved. Our findings indicated that the primary location for FAP consumption in the French market is at home. Focusing on this place of consumption, 40.8% of the respondents consumed FAP on a weekly basis, underlying

² It should be noted that the consumer survey used in this article only covers FAP consumers, which may lead to an overestimation of the percentage presented here.

Table 5. Ordered probit model results.

Variable	Occasional consumers (24.4%)		Medium consumers (34.8%)		Regular consumers (40.8%)	
	Coef	Std. Err	Coef	Std. Err	Coef	Std. Err
Socio-demographic						
Age	−0.002***	0.001	−0.001***	0.000	0.003***	0.001
Male (ref)						
Female	0.005	0.017	0.002	0.005	−0.007	0.021
Children	0.001	0.018	0.000	0.005	−0.001	0.023
Coastal dep.	−0.005	0.017	−0.001	0.005	0.006	0.022
Low.income (ref)						
Mid.income	−0.063***	0.022	−0.019***	0.007	0.082***	0.029
High. income	−0.091***	0.021	−0.028***	0.007	0.119***	0.027
Knowledge	−0.011***	0.003	−0.003***	0.001	0.014***	0.004
Price attention	0.006*	0.003	0.002*	0.001	−0.007*	0.004
Consumers Preference						
Fresh	−0.007*	0.004	−0.002*	0.001	0.009*	0.005
Env.wild	−0.007	0.005	−0.002	0.002	0.009	0.007
Env.farmed	−0.006	0.005	−0.002	0.002	0.007	0.007
France	−0.001	0.004	−0.000	0.002	0.002	0.006
Health Hazards	−0.003	0.004	−0.001	0.001	0.004	0.005
Artisanal	−0.015***	0.006	−0.005**	0.002	0.020***	0.007
Wild	−0.002	0.006	−0.001	0.002	0.002	0.008
Products attribute						
Health	−0.038*	0.023	−0.012*	0.007	0.049*	0.029
Tasty	−0.035	0.026	−0.011	0.008	0.046	0.034
Not difficult to cook	−0.075***	0.023	−0.023***	0.007	0.098***	0.030
Expensive	0.064***	0.023	0.020***	0.007	−0.084***	0.031

Note: Significance thresholds: *** 0.01; ** 0.05; * 0.1.

that French FAP consumption is driven by a limited proportion of the population. According to our model, the typical French regular FAP consumer tends to be older, knowledgeable about the sector, lives in a high-income household, and expresses a preference for fresh and artisanal FAP. Furthermore, he/she perceives FAP as healthy and not difficult to cook. Globally, these results are consistent with others obtained at the EU level in terms of age and income (European Commission, 2021b), while providing additional information for the French market.

Conversely, 24.4% of the individuals in our study consumed FAPs at home less than once a month. This segment of the French population thus does not follow the dietary recommendations of ANSES. The typical “occasional consumer” tends to be young, has a low household income, limited knowledge of the sector, no preference for fresh and artisanal products, and tends to perceive FAP as difficult to cook and expensive. If the French government aims to pursue its objectives of a healthy diet, without compromising the environmental sustainability of the resources, it seems necessary to better balance FAP consumption between these different groups of the population. Furthermore, given the variations in consumption patterns across French regions³ (Fig. 1), it might be useful to incorporate regional considerations into public food policies.

³ Regional specificities were identified using Chi2 statistical tests, notably for the “Ile-de-France” region.

4.2 Educating and informing consumers

Globally, there is a need to increase citizens’ knowledge of the FAP sector to promote new consumption behaviors (Pieniak et al., 2013, Almeida et al., 2015). Knowledge is an important predictor of food consumption behavior (Olsen, 2008) and an essential step to trigger behavioral change (Teixeira and Silva, 2024). Our results showed that objective knowledge was associated with regular FAP consumption. Therefore, information and education are essential to encourage consumers to consume in a more sustainable way. It should help to guide regular French consumers towards more sustainable behaviors and encourage occasional French consumers to consume sustainably produced FAP.

4.2.1 Promoting domestic “under-utilized” species

As mentioned, French FAP consumption is today focused on a few species, often imported, and associated with environmental and safety issues. It is thus imperative to curtail the reliance of French consumers on these species, particularly the “regular consumers”. The diversification of consumption has been identified as a promising lever to achieve more sustainable consumption of FAP (Koehn et al., 2022; Teixeira and Silva, 2024), notably by promoting the consumption of “under-utilized” species (Koehn et al., 2020; Farmery et al., 2020), ensuring that these species are well managed. Interestingly, French fishers land more than 300 species, notably from Small-Scale Fisheries (SSF)

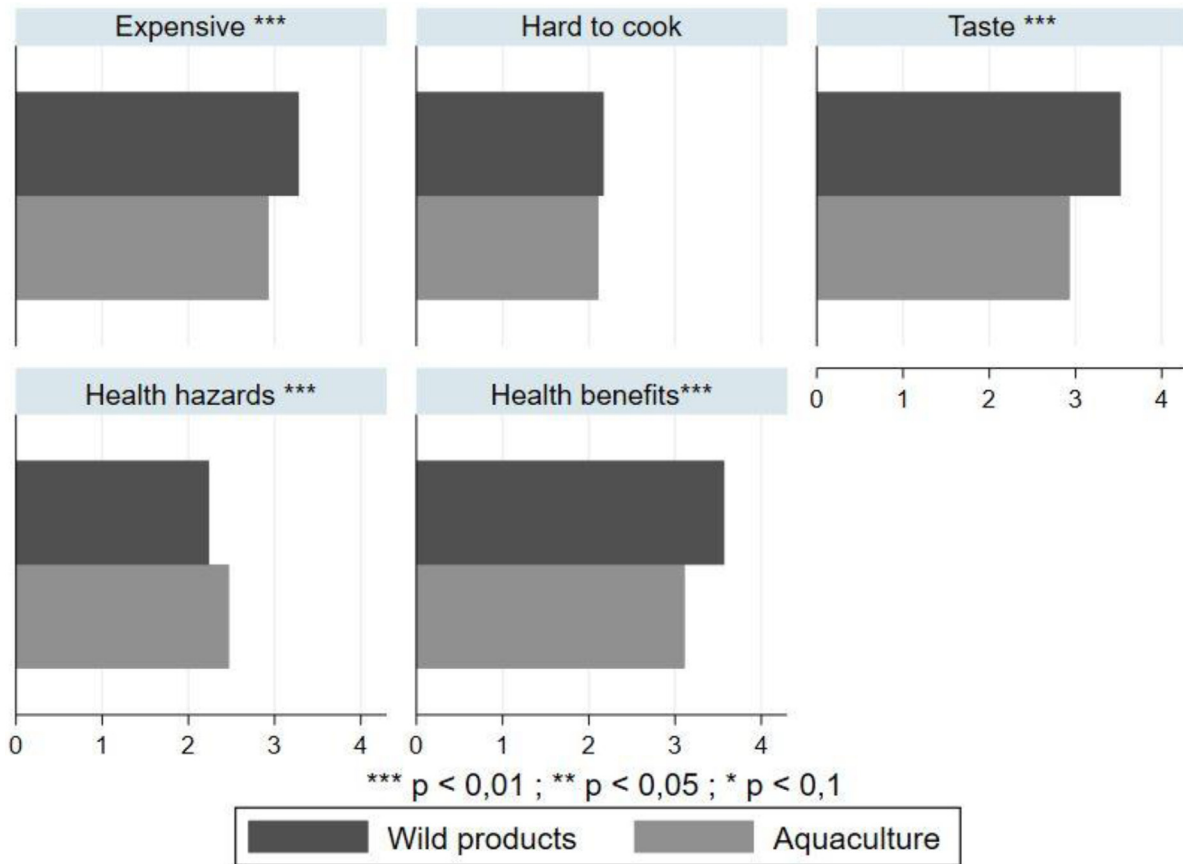


Fig. 2. Perception of wild and aquaculture products (scale 1 to 4).

(IFREMER, 2024), but consumer demand for these species remains fairly limited. Informing and educating French consumers about these domestic “under-utilized” species is thus a lever to achieve more sustainable consumption patterns.

Indeed, this species diversity offers undeniable potential to provide French consumers with sustainable and healthy products, as each product’s nutritional and environmental attributes are different (Golden et al., 2021; Gephart et al., 2021; Koehn et al., 2022; Crona et al., 2023). More than that, promoting these domestic products has the potential to open new markets for French producers, to reduce the market’s dependence on unsustainable imports, limit greenhouse gas emissions associated with transport, reduce pressure on certain exploited stocks, etc., Small pelagic species such as sprat, sardine, mackerel or herring, which are landed by the French fleets, are often presented as “green and nutritious” species (Hallström et al., 2019; Gephart et al., 2021; Koehn et al., 2022). In addition, most of these “under-utilized” species are landed fresh. Promoting the consumption of these species could therefore, help to reverse the current trend towards the consumption of delicatessen products, which are highly criticized for their impact on health (Ahern et al., 2021).

4.2.2 Adapting nutritional recommendations

When they choose FAP, consumers tend to arbitrate between their own health and environmental health (Clonan et al., 2012). To limit this trade-off situation, the message

provided by the public authorities must be holistic and consistent with a healthy and sustainable diet (Jacobs et al., 2018). One possibility could be to integrate environmental considerations into French nutritional recommendations (Tigchelaar et al., 2022). This is also the position of several French institutional actors working on food issues (RéseauActionClimat, 2024). Taking up this idea, the latest Nordic nutritional recommendations have integrated environmental impacts into their nutritional recommendations (Blomhoff et al., 2023). A list of sustainably managed species to consume according to seasonality could provide French consumers with interesting additional information, notably for the “regular consumers”.

To guide French consumers towards more sustainable consumption pattern, following the nutritional recommendations provided by Willett et al. (2019) could also be interesting. According to Springmann (2020), these recommendations are compatible with the objectives of a healthy and sustainable diet. They recommend a FAP consumption of 28 g per day to achieve a healthy and green FAP consumption, i.e. a weekly consumption of approximately 200 g per capita. Although French dietary recommendations fall within this range, several European countries still recommend excessive consumption, underlining that some nutritional recommendations regarding FAP at the EU scale are incompatible with protecting marine resources, as stated by Reynolds et al. (2014). Following this recommendation would result in an average per capita consumption of 20.4 kg

of FAP per year⁴, which is considerably below current average French consumption levels, leading to a decreasing global French FAP demand. This result underlines that a redistributive trend from “regular consumers” toward the segment of lower consumption is necessary to achieve fair and sustainable consumption of FAP products in France.

4.2.3 More holistic information campaigns

Information campaigns are another interesting tool to improve consumer awareness of the sector and related issues. Such campaigns have the potential to reach a large part of the population, notably if the mass media support them, despite the long time needed to change consumption behavior (Teixeira and Silva, 2024). As discussed by Jacquet and Pauly (2007), the rise of media campaigns between the 1990s and 2000s helped to increase consumer awareness regarding marine environment degradation. Nevertheless, between 2007 and 2015, 685 promotional campaigns were carried out in Europe to increase the consumption of FAP, including 99 campaigns in France (EUMOFA, 2017). These French campaigns focused on the consumption of local species, the health and nutritional attributes of FAP, and the promotion of Protected Geographical Indication (PGI) (EUMOFA, 2017). While these are essential levers for more sustainable consumption, the “environmental dimension” was not clearly identified. It is necessary to integrate this particular dimension more specifically in future campaigns. For instance, these campaigns could promote domestic “under-utilized” species (as discussed above) that are managed sustainably. The latest IFREMER report (IFREMER, 2024) on the state of stocks exploited by the French fleets can provide interesting species to promote. Finally, other information tools are being developed to help consumers make informed decisions about the health and environmental impact of their purchases (Marquès et al., 2021). An interesting example is the FishChoice software (www.fishchoice.eu). It provides consumers with information on the health and sustainability of the FAP they consume. However, communication tools like this are often not visible to consumers. In order to improve their effectiveness, it is thus necessary to increase their visibility and use.

4.2.4 “Out-of-home” consumption, a key area for developing sustainable practice

Our results showed that out-of-home consumption was important in France. These consumption places can be used to inform and educate consumers, notably “occasional consumers”. For example, school and university canteens could provide a valuable network to promote healthy and sustainable FAP consumption among the young population. The consumption of domestic and under-utilized species can easily be promoted. Although “Food Education” is a key component of the objectives outlined in the French “Programme National pour l’Alimentation (PNA)” for the period 2019–2023, the place of FAP is not clearly discussed. There is, therefore, a need to better integrate FAP into this policy. Classroom teaching can also be an

interesting way to educate and inform young people (Teixeira and Silva, 2024). Restaurant chefs are also presented as a viable alternative to incite sustainable consumption behavior (Teixeira and Silva, 2024). If we look at the French scale, an initiative like “Ethic Ocean” uses a network of restaurateurs to promote more sustainable consumption of FAP.

4.2.5 The potential of labelling policies

Although there are various ways of informing consumers (information campaigns, education in schools, etc.), food labels have emerged as an essential tool for achieving the EU’s strategy for reforming food systems. These labels are now numerous in the FAP sector (Lucas et al., 2021; Sonntag et al., 2023), and they cover a wide range of FAP attributes. While the increase of labels in the FAP market may point to a global improvement in the sector, this perception should be nuanced (Grunert et al., 2014). Sonntag et al. (2023) speak about the “jungle” of labels in the FAP sector. This is highly problematic, as consumers may not have the expertise to distinguish between labels and make informed choices (Janßen and Langen, 2017). Label overlap, global confusion and trade-off situations result in growing consumer mistrust towards these labels (Grunert et al., 2014; Sonntag et al., 2023). Several papers have discussed the existing limitations of such initiatives, particularly with regard to consumer behavior (Grunert, 2011; Grunert et al., 2014; Annunziata et al., 2019). Our results suggested that production methods (wild vs farmed) and the preference for artisanal productions influence consumer behaviors. A better understanding of the link between label valuation and these preferences could also be a promising lever for implementing more efficient policies.

4.3 Synergy of production methods

The method of production is also a factor to be taken into account to encourage consumers to consume FAP in a more sustainable way. Despite their synergy in achieving public health and resource conservation objectives (FAO, 2022), the issues behind farm production and wild catches differ, particularly from an environmental and health perspective (Gephart et al., 2021; Golden et al., 2021). Our results indicated that a difference in consumer perception existed between the two product types. Wild products are perceived as being of higher quality, while aquaculture products are perceived as less healthy. Interestingly, these conflicting perceptions influence consumer expectations of the sustainability of these two production processes. According to Zander and Feucht (2018a), French consumers associate sustainable fisheries mainly with environmental issues, while they associate sustainable aquaculture with more health and safety issues (use of hormones and drugs). This dichotomy is in line with Verbeke et al. (2007a), who showed that consumer refusal to consume wild products was mainly related to sustainability and ethical concerns. In contrast, the reasons for not eating aquaculture products were more related to health issues. In order to promote more sustainable FAP food systems and at the same time reassure French consumers about their specific concerns, it is therefore of paramount importance to inform them about the products that come from less impactful wild fishing methods (in terms of endangered species and habitats) and those that result from production processes that employ fewer hormones and drugs in aquaculture practices.

⁴28 (Willett et al., 2019) daily intake of FAP (including fish and shellfish) recommendations in g) * 7 (number of days in a week) * 52 (number of weeks in a year) * 2 (average conversion rate for equivalent live weight).

4.4 The price barrier

According to our results, promoting the consumption of sustainable FAPs could face a significant barrier: the price of FAP. This barrier may limit the effectiveness of promotion policies, especially among the low-income population, as also discussed by Koehn et al. (2020). However, in reality, this perception of FAP requires nuancing. As with the meat sector, the price of FAP varies greatly depending on the species consumed. The FranceAgriMer report (FranceAgriMer, 2011) showed that on average FAP are not always more expensive than meat (average FAP price in 2021 was 12.2 € per kilo, FranceAgriMer (2023a)), compared to 11.6 € per kilo for meat in 2021 (FranceAgriMer, 2021). The French market currently favors expensive species such as cod and salmon, but as discussed, there is a diversity of “under-utilized” species, leading to a range of prices similar to the meat sector. Considering the average price of fresh cod and salmon in 2022 (20 € per kilo), other species, such as fresh sardines (priced at 6.2 € per kilo), mackerel (priced at 8.2 € per kilo) were more affordable. Therefore, encouraging more diversified consumption and possibly of “under-utilized” species with no identified market can also result in more diversified prices for consumers.

The question of price can also be approached through the prism of its distribution along the value chain. There is a significant difference between the prices upstream in the value chain (landings, imports) and the final price for consumers on the French market, even for products that are not or hardly processed. According to FranceAgriMer, the average price of fish landings (mostly fresh) is 3.9 € per kilo in 2022, and the average FAP import price is 6 € per kilo (7.3 € per kilo for fresh products and 6.3 € per kilo for frozen ones) (FranceAgriMer, 2023a). Thereafter, the final price for at-home consumption is 12.9 € per kilo for fresh products, 11.4 € per kilo for frozen products, 15.1 € per kilo for delicatessen products and 10 € per kilo for canned products (FranceAgriMer, 2023a). Efforts on the margins made by manufacturers could make certain FAPs more accessible to consumers. Moreover, reducing the consumption of delicatessen species can also be interesting for the consumer wallet. Nevertheless, as discussed for the diversification part, this value reallocation must consider the economic sustainability of fishing enterprises, notably producers (Koehn et al., 2020).

5 Conclusion

The aim of this study was to gain a deeper insight into the prevailing consumer behavior on the French FAP market, with a view to guiding consumers towards a more sustainable and healthier consumption of these products. Overall, our results indicated that French consumption patterns were inequitable and not in line with global environmental and public health objectives. Based on our findings, this article proposed a number of levers to guide consumers towards sustainable consumption of FAP. Increasing consumer knowledge and awareness of FAP is an essential step in guiding them towards more sustainable behavior. Several levers to better inform consumers were discussed (promoting more diversified consumption, integrating environmental considerations into existing policies and developing active communication

towards the young generation). The complementary role of wild and aquaculture production methods and the price barrier need also to be better considered by policy makers.

Acknowledgment

We gratefully acknowledge the support of the FORESEA 2050 research program funded by Ifremer. This research was further supported by the Brittany region and Quimper Bretagne Occidentale as part of a doctoral contract.

Data availability statement

Authors do not have permission to share data publicly.

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Appendix: A

Table A1. Test of multicollinearity 1.

Variables	Variance Inflation Factor
Socio-demographic	
Age	1.41
Female	1.06
Children	1.21
Coastal dep.	1.01
Mid.income	1.62
High. income	1.75
Knowledge	1.20
Price attention	1.07
Consumers Preference	
Fresh	1.26
Env.wild	2.93
Env.farmed	2.94
France	1.68
Health Hazards	1.72
Artisanal	1.19
Wild	1.18
Products attribute	
Health	1.33
Tasty	1.31
Not difficult to cook	1.09
Expensive	1.08

Note: The mean VIF is $1.47 < 2.5$, which means that there is no multicollinearity between our variables.

Table A2. Questions used for measuring consumer's objective knowledge of the sector.

Statement	Answers
The production method (wild or farmed) is mandatory information on seafood products sold fresh	True
The quantity of OMEGA 3 present in fish does not depend on the species	False
Cod and “Morue” are the same species	True
Haddock and hake are the same species	False
Saithe is a freshwater species	False
Oil and meal from wild fish are used as feed for farmed fish	True
As with fruit and vegetables, there are seasons for FAPs	True
Anchovies, mackerel and sardines belong to the family of small pelagic fish.	True
Monkfish can be described as an invasive species	False
The colour of a salmon fillet cannot be changed by its diet	False
In the wild, cod generally travel in shoals	True

Table A3. Questions used for measuring consumer preferences for FAP.

Questions
I buy fresh FAPs (whole or cut up) rather than canned, processed or frozen
I take environmental issues into account when I buy WILD seafood
I take environmental issues into account when I buy FARMED seafood
It's important for me to know that my FAP come from France
I take health risks into account when I buy FAP

Table A4. Question used to measure consumer perception of wild and farmed products.

Question	Attributes
In your opinion, whatever the form of packaging, wild seafood products...	... have high taste qualities ... are beneficial to health ... present health risks ... are expensive products ... are difficult to cook
In your opinion, whatever the form of packaging, farmed seafood products...	... have high taste qualities ... are beneficial to health ... present health risks ... are expensive products ... are difficult to cook