



Assessing Consumer Attitude Towards Marine Non-Indigenous Fish Species: A Case Study From Greece (Eastern Mediterranean Sea)

Vasileios Minasidis^{1,2} · Nikolaos Doumpas² · Ioannis Giovos^{1,2,3} · Periklis Kleitou^{2,3} · Alexandros Kaminas^{2,4} · Dimitrios K. Moutopoulos¹

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Abstract

Non-indigenous fish species (NIFS) are spreading in the Mediterranean Sea, altering species assemblages and reshaping the marine ecosystems. Market-based approach has been promoted as a measure to limit the spread and damages by the NIFS and provide economic revenues to fishers. Understanding drivers of NIFS consumption and documenting consumers' habits are pivotal in guiding a market strategy. A custom-made online questionnaire was developed and distributed to Greek consumers through Social Media networks. The majority of consumers: (a) supported that NIFS are causing adverse effects to the marine environment (54%), (b) would consume NIFS products if they encountered them on a restaurant menu (62%), (c) would buy and consume NIFS provided they protect the marine environment and indigenous species (76%), and (d) hanker for the implementation of a quality control certificate on NIFS products (79%). Multivariate models revealed that the most important criteria for the consumers except for taste were the freshness of the products, whether the fish is poisonous, and the hygienic conditions of the fish market and its staff. The results reflected the positive attitude of the Greek consumers towards the consumption of NIFS and highlighted the importance of further promoting a market that could improve fisheries sustainability and challenge non-indigenous species (NIS) proliferation.

Keywords Fish market · Consumer preferences · Social norms · Fisheries

Introduction

Mediterranean Sea has faced the invasion of non-indigenous species (NIS) in its waters, recording over 800 species (Zenetos et al. 2017); with about a third of them inhabiting the Greek Seas (Zenetos et al. 2020). Not all NIS (also known as 'invasive species') are able to cause negative effects. Those that cause negative effects on marine ecosystems and the local economy or human are characterized as invasive alien species (IAS), and

often they can disrupt ecological niches, destabilise the community structure and cause ecosystem shifts (Korsu et al. 2012; Arndt and Schembri 2015; Corrales et al. 2020). Some IAS might be venomous or poisonous and threaten human health; with notable examples being the common lionfish (*Pterois miles*) and species of the pufferfish family (Tetraodontidae) silver-cheeked toadfish (*Lagocephalus sceleratus*) (Galil 2018; Savva et al. 2020). To deal with NIS, the European Union has considered NIS in their Directives (EU Water Framework Directive; Marine Strategy Framework Directive), strategies (EU 2030 Biodiversity Strategy) (European Commission 2020) and legislations (Regulation no.1143/2014; 2016/1141, 2017/1263 and 2019/1262) (EU 2014, 2016, 2017, 2019, respectively).

An oriented market-based approach towards NIS has been suggested as a possible way to reduce the ecological footprint of NIS, reduce pressure to native species, and provide additional income to local communities (Kleitou et al. 2019, 2021a, b). These suggestions are in line with the recent reform of the Common Fisheries Policy (EU REG 1380/2013) which seeks to: (a) improve the organization of the fish markets, (b) inform consumers about the value of fish consumption and the

✉ Vasileios Minasidis
vasileios.minasidis@upatras.gr

¹ Department of Fisheries and Aquaculture, University of Patras, 30200 Mesolongi, Greece

² iSea, Environmental Organization for the Preservation of the Aquatic Ecosystems, 54645 Thessaloniki, Greece

³ Marine and Environmental Research (MER) Lab, 4533 Limassol, Cyprus

⁴ Faculté des Sciences, Université de Montpellier, Place Eugène Bataillon, 34095 Montpellier, France

presence of a wide variety of fishery products that are available and (c) raise the awareness of the consumers on health and safety issues of the fish products. Such a challenge facilitates the transition of supply chains toward more sustainable seafood production and consumption (Schmidt et al. 2012). In this context, consumers constitute an important link between supply and demand and their preferences contribute catalytically to the improvement of the conditions for the sale of wild-caught fish but to the promotion of new fishery products in the Greek market (Batzios et al. 2005).

The number of studies focusing on consumers' perceptions and attitudes toward seafood products is growing. The perceived health benefits are indeed one main driver of fish and seafood consumption (Carlucci et al. 2015). Consumption of underutilized species can be increased by disseminating media messages and campaigns that educate the public about the existence of undervalued fish species and raise public awareness of sustainability (Farmery et al. 2020). As a result, sustainability certification (ecolabels) could be added to fish products to promote sustainable exploitation practices (Menozzi et al. 2020). Traceability allows seafood to be traced from “boat to throat” (Ashton Morgan et al. 2018). New initiatives to improve and promote the consumption of species that are presently discarded may also emerge. Discards are harvested while targeting other species and are a missed opportunity, because they could replace or supplement the consumption of well-known species.

Consumer choices are influenced by the food environment, which ensures food availability and access (Castellani et al. 2017; Milford et al. 2019). According to the behavioral sciences, a choice architecture should be designed to promote healthy and sustainable food preferences in order to achieve a meaningful dietary shift (Dwivedi et al. 2020). To achieve its goals, the present study used an online survey to examine the willingness of consumers to support the purchase and consumption of edible non-indigenous fish species (NIFS) in Greek markets, and identify interrelated motivational factors that might explain consumer behaviour such as the availability of fish, social norms, and moral obligations. The present study utilized a modern technique, with a survey that was administered online. Social media surveys are increasingly used for communication studies targeting a large global audience, with both limited effort and budget, as compared to conventional methods such as personal interviews, telephone surveys or online paid survey platforms (Dwivedi et al. 2020; Giovos et al. 2021). Web surveys also provide a number of advantages; i.e. they are inexpensive survey tools, easy to approach large audiences, and facilitate an easy and fast electronic data collection (Giovos et al. 2021). This is the first study on the consumer preferences towards NIFS in the Mediterranean Sea, the most invaded sea worldwide, where the need for fisheries sustainability is of primary importance (Öztürk 2021).

Materials and Methods

Survey Design

In line with the market-based approach, the "Pick the Alien" campaign (<https://isea.com.gr/pick-the-alien-2/?lang=en>) was conducted between 2019 and 2021 in various islands of Greece aimed in challenging social norms and motivate consumers towards the consumption of marine NIS. The data collection for the consumer preferences was performed via an online questionnaire (Google Forms) (Appendix Table A1). The language of the questionnaire was Greek and the survey was limited to Greek people. The recruitment process was through Social Media platforms and specifically through the Facebook and Instagram. In these platforms, a direct hyperlink of the questionnaire was provided, in which participants were transferred to the questionnaire page where they could complete the questionnaire anonymously and submit their responses. The promotion of the questionnaire took place over a period of four months (August–November 2020).

The questionnaire was created online using Google forms, and was not pre-tested. The questionnaire with scaling and dichotomous (coded as “no”=0 and “yes”=1) questions consisted of three sections. Section A included the demographic characteristics of the participants such as gender, age, marital status, and level of education; section B addressed questions about the consumption of fish such as frequency, quantity, and marketplace; and section C focused on questions related to perceptions on the purchase and consumption of edible marine non-indigenous fish species in Greece, whether the consumer is aware of what NIFS are (referring to them as ‘alien fish species’), whether they have a negative impact on human health and the marine environment, and whether they believe that the consumption of NIFS may pose a risk to their health. Scaling questions were related with "quality and marketing" aspects on purchasing NIFS, and "sensitivity on media influence". In the former, consumers declared their preferences on eight factors related to specific characteristics of the purchased NIFS without evaluating for taste (i.e., fish size, freshness, hygienic conditions of the fish shop and its staff, fish packaging, price, origin of the fish, poisonous animal, and familiar species) based on three-level Likert scale questions (non-significant=0, significant=1, and very significant=2). In the second multi-thematic question, consumers declared whether they were influenced by the media announcements regarding the health and safety of fish consumption based on a three-level Likert scale response (none=0, few=1, and very much=2). Dichotomous or trichotomous scales (3-point scale) performed well compared to the current 5-point scale (Jeong and Lee 2016). A 3-Likert level gives the respondents a middle ground as negative, neutral or positive cases in order to use binomial tests such the binary logistic regression, which has been used in the present study.

Data Analysis

Data analysis was conducted using simple univariate or multivariate techniques. Univariate tests (Likelihood-ratio χ^2 -test) were performed to determine the relationship of demographic factors with the answers referring to both the general consumption of fish and the potential consumption of marine NIFS.

Binary logistic models were used to identify the potential drivers of the perceptions on the purchase and consumption of edible marine NIFS in Greece. Binary logistic models overcome many of the restrictive assumptions of linear regressions. For instance, linearity, normality and equal variances are not assumed, nor is it assumed that the error term variance is normally distributed. The major assumptions that there should be no outliers in the data and no high multicollinearity among the predictors were satisfied (Wilson and Lorenz 2015). Models were developed to predict the probability of the respondent's knowledge about NIFS purchase for consumption (YES/NO) based on more than one of independent variables (i.e., demographic features, educational level, frequency and person from the family that purchase fish). Furthermore, a categorical regression with optimal scaling was developed to predict the attitudes of the consumers towards C11 "How important is each of the following factors to you if you were to buy alien species", and one regarding the C14 "How much do you affect by the press reports or media announcements on the hygiene of fish?" (Appendix Table A1), based on the above-mentioned independent variables. This technique quantifies data of categorical variables by attributing numerical values to the categories, resulting to an optimal linear regression equation for the transformed variables (Kooij and Meulman 1997; Batzios et al. 2005). The effect of each of the classification variables on the dependent variable is described with the corresponding regression coefficient. For testing the collinearity into the model, the Pratt's measures of relative importance and tolerance were used. All analyses were carried out using the statistical package IBM SPSS Statistics 25.0 (SPSS 2017).

Results

Demographic Characteristics and Fish Consumption Habits

A total of 218 citizens participated in the survey, correctly and completely filling out the corresponding questionnaire. Gender ratio was 1:1, and the majority of the participants (48%) belonged to the 18–25 age group, followed by the age groups 26–45 (36%) and to a lesser extent by 46–65 (16%). More than 1/3 of the participants (37%) were university students or a third of them pertained a university alumnus (33%), whereas 23% held a MSc or PhD degree (23%). The

majority of participants stated that they buy and consume fish every week (68%), from a traditional fish shop (52%), a quantity of 1.5–2 kg (53%), mostly gutted fish (53%).

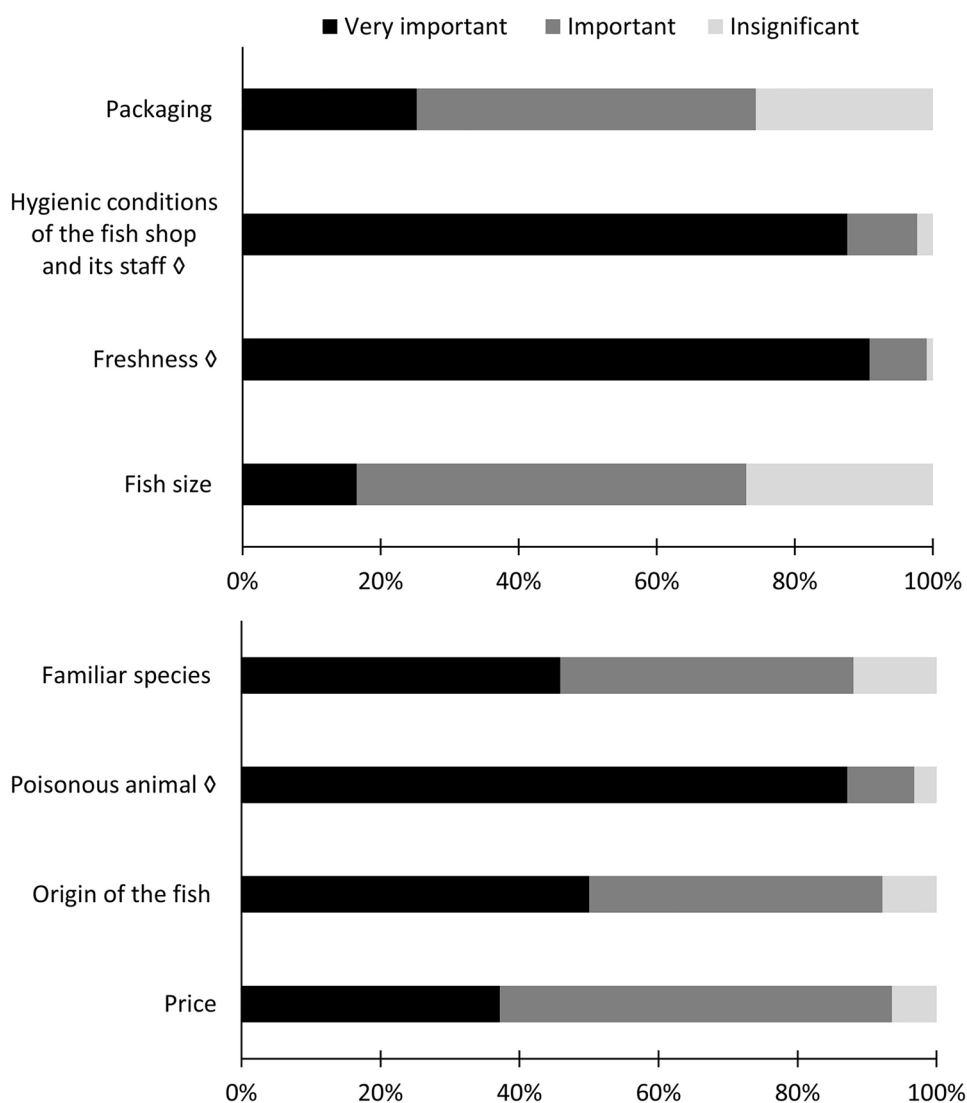
The frequency of purchase and market quantity was independent of socio-demographic characteristics (Appendix Table A2). The act of fish-gutting by the consumer themselves was significantly (χ^2 -test; $P > 0.05$) independent of age, marital status and educational level. In contrast, this behavior was significantly dependent on gender (χ^2 -test; $P > 0.05$); with more males than females preferring to gut the fish themselves (Appendix Table A2). The preferred fish marketplace was not significantly (χ^2 -test; $P < 0.05$) affected by socio-demographic characteristics (Appendix Table A3). Almost 2/3 of the participants (64%) purchased fish from the same "fisher/fishmonger", mostly based on personal trust (76%), whereas the rest of participants (36%) did not purchase fish from the same trader every time.

Perceptions on Purchase and Consumption of Non-indigenous Fish Species (NIFS)

The majority of participants (67.0%) were aware of what is a NIFS, while more than half reported that NIFS do not have a negative impact on human health (53.0%) and that NIFS have a negative impact on the marine environment (54.0%). More than 2/3 of the participants believed that consuming fish products prepared from NIFS does not pose a risk to their health. More than half (57.0%) of respondents would be triggered to buy and/or consume seafood products if they were aware that NIFS were used as an ingredient in a cooking show. The majority of the participants would consume a product prepared from NIFS if it appeared on the menu of a restaurant (62%) or if they knew that this action would help protect the marine environment and native species (76.0%).

The vast majority of participants ranked the "freshness", the "hygienic conditions of the fish shop and its staff" and whether the fish is "poisonous" as "very important" criteria for purchasing a NIFS (Fig. 1). About half of the participants stated that the "origin of the fish" and the "familiarity with the species" were also "very important" (50.0% and 45.9%, respectively). More than half of the respondents (56.4%) answered that "fish size" and "price" were "important" factors for the purchase of NIFS. Almost half of the participants (49.1%) considered the "fish packaging" as "important" for the purchase of a NIFS product (Fig. 1). More than 2/3 of the participants (79.0%) noted that they would wish for NIFS products to be labelled with a quality control certificate or a distinct quality mark, while 17.0% stated that they would not care for such a label. Half of the participants (50.0%) would buy processed NIFS products from local organizations. More than a third of the participants were less or

Fig. 1 Frequency of selection of participants based on the importance of each factor related to the purchase of non-indigenous fish species (NIFS). The symbol (◇) indicates the most important factors



greatly affected by press releases or media announcements about fish hygiene (37.0% and 36.0%, respectively). The vast majority of the participants had never had a health problem caused by the consumption of fish (95.0%).

The analysis of consumers' perceptions and preferences for NIFS in relation to socio-demographic characteristics revealed that, when asked about the knowledge of NIFS (referring to them as 'alien species'), postgraduate/doctoral consumers or those at the age group of 18–25 stated positively and negatively, respectively, in significantly (χ^2 -test; $P < 0.05$) higher frequency than others (Fig. 2, Appendix Table A2). Regarding the question on "knowing of any negative effects on human health brought about by the consumption of alien species", married people responded positively to a significantly higher frequency (χ^2 -test; $P < 0.05$), whereas for students or participants in the 18–25 age group responded negatively to significantly higher frequency (χ^2 -test; $P < 0.05$) (Fig. 2, Appendix

Table A4). The replies to this question between students in the age group 18–25 or other participants of the same age group without the student status, did not differ significantly (χ^2 -test; $P > 0.05$).

The eldest consumers stated positively with significantly (χ^2 -test; $P < 0.05$) higher frequency to the "knowledge or lack of any negative effects of alien species in the marine environment" (Fig. 2, Appendix Table A4). Men or unmarried consumers responded negatively with significantly (χ^2 -test; $P < 0.05$) higher frequency to the question "Do you think that the consumption of alien-species goods can be a risk to your health?" (Appendix Table A4). Males responded positively with significantly (χ^2 -test; $P < 0.05$) higher frequencies to the questions "If your preferred marketplace sold alien species products at a lower price than their traditional items, would you buy them?" and "If your fishmonger suggested an alien species, would you buy it?" than females (Appendix Table A4).

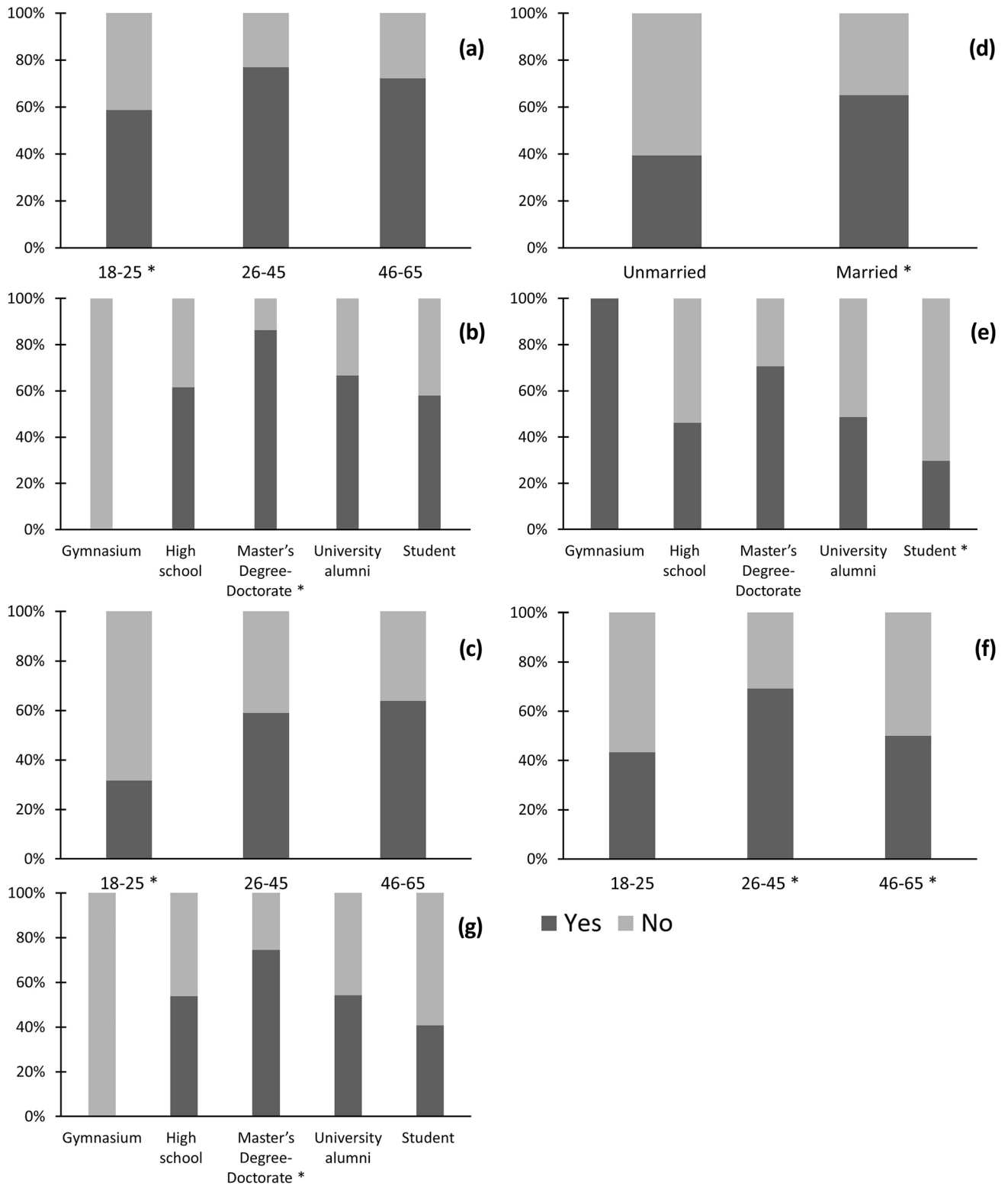


Fig. 2 Knowledge of non-indigenous species (NIS) by **a** age, and **b** education levels; having any adverse effects on health by **c** age, **d** marital status, and **e** educational level; and having adverse effects on

the marine environment by **f** age, and **g** educational level. Statistically significant values are highlighted by (*)

Married consumers depicted significantly (χ^2 -test; $P < 0.05$) higher importance of the freshness of the NIS product when choosing fish as a food for their families (Fig. 3, Appendix Table A5). Females also exhibited significantly (χ^2 -test; $P < 0.05$) higher importance to the origin of the NIFS compared to male consumers (Fig. 3, Appendix Table A5). Married consumers or those at 46–65 age group considered the likelihood that their choices would be influenced by media announcements on the health of fish as significantly (χ^2 -test; $P < 0.05$) higher (Appendix Table A6).

Modelling approach

The binary logistic models applied to evaluate the knowledge of the consumers about non-indigenous fish species impact on human and ecosystem health were statistically significant (χ^2 value(13) = 43.65, $P < 0.05$; and χ^2 value(13) = 38.90, $P < 0.05$, respectively), explaining 24.3% and 21.9%, respectively, of the initial variance (Table 1). Both major assumptions of the two binary models tested have been satisfied as there were no outliers in the data (Omnibus test of model coefficients; $df = 13$, chi-square: > 38.90 , $P < 0.001$) and no high multicollinearity existed among the predictors (pairwise correlation coefficients among the predicted variables were lower than 0.30). Table 1 shows the levels of the independent variables that were significantly added in the final model (Table 1; Wald test and sign values), and the contribution of these levels to each of the above-mentioned dependent variables. For instance, the participation of consumers that always purchase their fish meal increased the likelihood of knowledge (Knowledge; YES) by 15% and almost 20% for the knowledge of the consumers about NIFS impact on human and ecosystem health, respectively (Table 1; Exp(B) values). In contrast, the participation of consumers belonging in age-class 46–65 decreased the likelihood of knowledge by 3 times.

The application of a categorical regression model on the themes of the question C11 “How important is each of the following factors to you if you were to buy alien species” with the demographic features showed that only “Fish origin” exhibited an acceptable and significant model ($F = 1.584$; $df: \nu_1 = 18, \nu_2 = 198$; $P < 0.05$) with a relatively moderate value of multiple R (0.363) (Table 2). Consumers’ age, education level, marital status, and place of fish purchase were the significant (ANOVA-test; $P < 0.05$) independent variables with the largest importance to the predictability of the applied model. The tolerance values of the regression model were very high indicating lack of multicollinearity (Table 2). All independent variables have positive impact to the above-mentioned questions. Non-educated or high educated Consumers that often-purchasing fish by

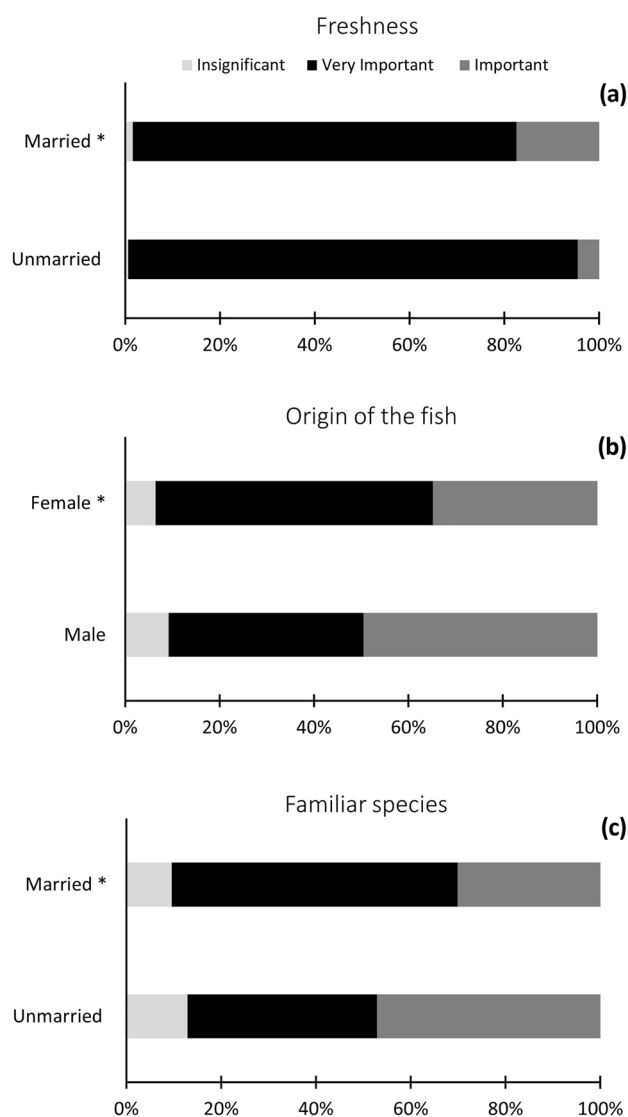


Fig. 3 Importance: **a** of product freshness by marital status; associated to the origin of the non-indigenous species (NIS) regarding the purchase by **b** gender; of familiarity with species by **c** marital status. Statistically significant values are highlighted by (*)

themselves in action markets and street fishmongers consider as important factor the fish origin (Fig. 4).

A categorical regression model was also applied to the multi-thematic question C14 “How much do you affect by the press reports or media announcements on the hygiene of fish?”. The applied model was acceptable and statistically significant ($F = 2.077$; $df: \nu_1 = 18, \nu_2 = 198$; $P < 0.05$) and resulted in relatively moderate value of multiple R (0.415) (Table 2). Married consumers older than 26 years old with moderate education level were very much influenced by media (Fig. 5).

Table 1 Partial binary logistic regression coefficients for the independent variables applied to the knowledge of the consumers about non-indigenous fish species (NIFS) impact on human and ecosystem health. Exp(B) values indicated the contribution of the model varia-

tion to the dependent variable when controlling the other variables. Nagelkerke R² indicated the values of pseudo R² explaining the percentage contribution of the initial variation explained by the model

| Dependent: Knowledge of non-indigenous fish species (NIFS) impact on human health | | | | | | |
|---|--------|-------|--------|----|-------|--------|
| Factors | B | S.E | Wald | df | Sig | Exp(B) |
| Self-purchase of the fish meal | -1.622 | 0.467 | 12.073 | 1 | 0.001 | 0.197 |
| Constant | -0.138 | 0.136 | 1.035 | 1 | 0.031 | 0.871 |
| Nagelkerke R ² : 24.3% | | | | | | |
| Dependent: Knowledge of non-indigenous fish species (NIFS) impact on ecosystem health | | | | | | |
| Factors | B | S.E | Wald | df | Sig | Exp(B) |
| Age (45–65 yr) | 1.135 | 0.555 | 4.188 | 1 | 0.041 | 3.111 |
| Self-purchase of the fish meal | -1.851 | 0.488 | 14.366 | 1 | 0.000 | 0.157 |
| Constant | -0.138 | 0.136 | 1.035 | 1 | 0.031 | 0.871 |
| Nagelkerke R ² : 21.9% | | | | | | |

Discussion

This study shed light about the consumers’ preferences towards non-indigenous fish species (NIFS), their willingness to purchase and consume these species, and their demographic characteristics that would introduce and expand NIFS in the Greek seafood markets. The use of social media for the recruitment process is cost-effective for communicating studies to a large global audience, despite some limitations that must be considered for the interpretation of results (Giovos et al. 2019; Al Mabruk et al. 2021; Izquierdo-Gómez 2022). Shortcoming of the present study is the fact that the sample being analyzed is not truly representative of Greek consumers in their entirety. This is partially due to the use of the online survey format and social media platforms. There is evidence that internet users tend to be younger and better educated compared with surveys performed

using face-to-face surveys (López de la Lama et al. 2018; Giovos et al. 2021). In this study, the majority of participants were aged between 18 and 45 years (84%) with university education (70%). In contrast, based on the 2011 Greek population census survey, the age distribution of the corresponding demographic group in Greece was 39% (HELSTAT (Hellenic Statistical Authority) 2014). However, similar aged and educational level proportions to the corresponding results of this study were recorded in other online surveys (Curtin et al. 2000; Giovos et al. 2019, 2021). In general, online surveys have two serious methodological limitations; the population to which they are distributed cannot be described, and respondents with biases may select themselves into the sample. The bottom line is that despite these weaknesses, this study provides some clear indication about consumer preferences on NIFS consumption and important insights on the factors that affect their choices.

Table 2 Categorical regression models of the two questions towards "originality issues" and "sensitivity on media influence" in relation to independent variables

| Independent variable: Fish origin | Standardized coefficients | | <i>F values</i> | <i>Importance</i> | <i>Tolerance</i> |
|--|---------------------------|------------|-----------------|-------------------|------------------|
| | <i>Beta</i> | <i>S.E</i> | | | |
| | Education level | 0.178 | | | |
| Person of fish purchase | 0.142 | 0.070 | 4.138 | 0.175 | 0.884 |
| Place of fish purchase | 0.196 | 0.067 | 8.677 | 0.323 | 0.961 |
| R ² | | | 0.137 | | |
| Independent variable: Sensitivity on media influence | | | | | |
| Age | 0.304 | 0.151 | 4.042 | 0.473 | 0.434 |
| Education level | 0.244 | 0.084 | 8.326 | 0.047 | 0.697 |
| Marital status | 0.219 | 0.103 | 4.516 | 0.370 | 0.562 |
| R ² | | | 0.172 | | |

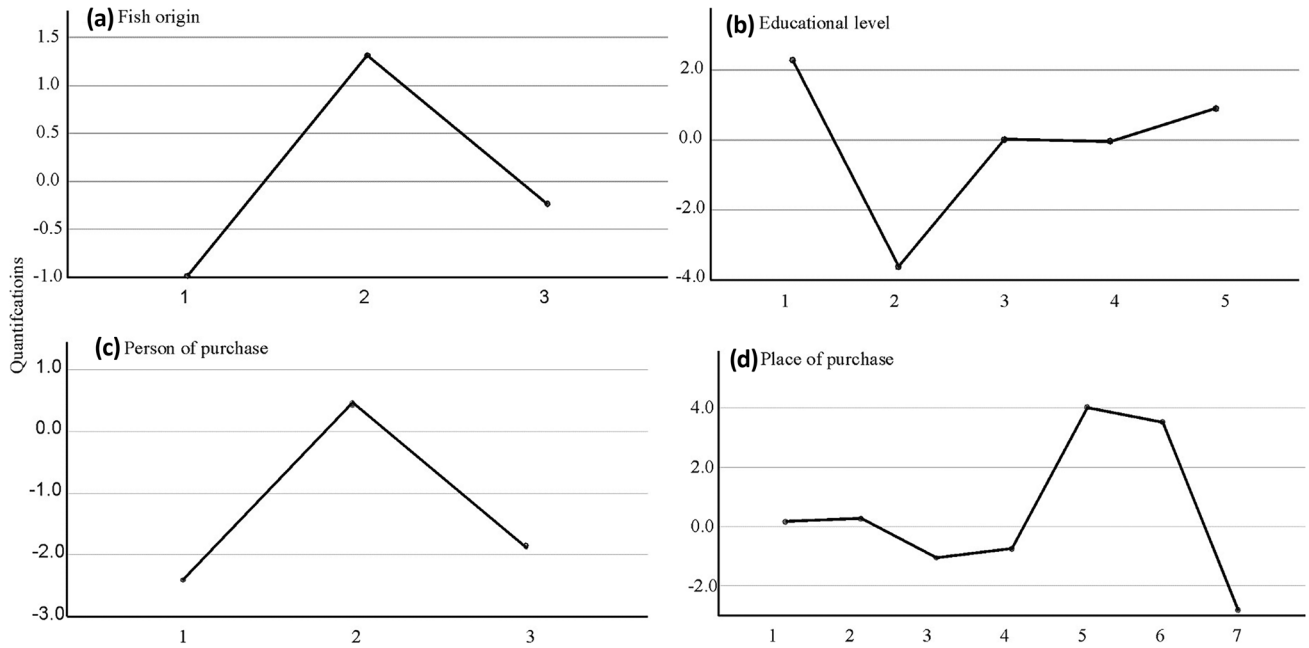


Fig. 4 Categorical regression quantification plots of the question on fish origin issues: **a** quantification plot (axis x; 1=Insignificant, 2=Important, 3=Very important), **b** education level (axis x: 1=Gymnasium, 2=High school, 3=Master's Degree-Doctorate, 4=University alumni, 5=Student), **c** purchase from the interviewed

person (axis x: 1=always, 2=often and 3=rarely) and **d** place of purchase fish (axis x: 1=Traditional fish shop, 2=Public market, 3=Central fish market, 4=Super market, 5=Action market, 6=Street fishmongers, 7=Other)

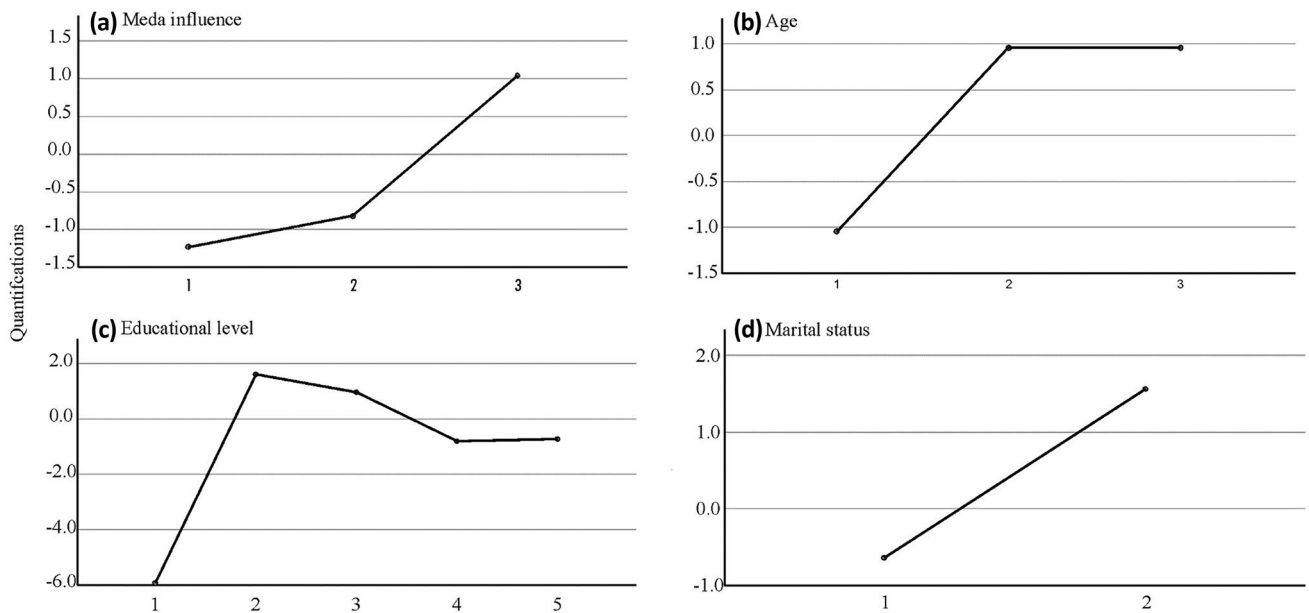


Fig. 5 Categorical regression quantification plots of the question "sensitivity on media influence": **a** quantification plot (axis x: 1=Insignificant, 2=Important, 3=Very important), **b** age (axis x: 1=18–25, 2=26–45, 3=46–65), **c** education level (axis x: 1=Gym-

nasium, 2=High school, 3=Master's Degree-Doctorate, 4=University alumni, 5=Student), **d** marital status (axis x: 1=Unmarried, 2=Married)

Nowadays, the spatial expansion of NIFS and their presence in the fisheries catches, has led to calls for alteration of both the fishing practices of professional fishers and the consumption patterns towards those invaders (Gücü et al. 2021; Kleitou et al. 2021a, b). Judging from the result that more than half of the participants purchase 1.5–2.0 kg of fish for the family (frequently three to four persons) meal, this behavior is independent of gender and educational level, while the amount of fish consumption is significantly affected by the specific demographic characteristics (Batzios et al. 2002, 2005). Most of the participants (68%) purchased fish on a weekly basis, which this is contradicting with a recent survey on a European consumer habits regarding seafood products, in which most of the Greek consumers (71%) purchase and consume seafood at least once a month (European Union 2021). However, there is an agreement between the above-mentioned studies in terms of the most frequent place of seafood purchase with most of the Greek consumers prefer local supermarkets (52.0 vs 56.0%, respectively). However, this trend has been altered in the Greek seafood market compared to two decades ago, when traditionally Greek consumers purchase mostly their seafood directly from the fish shop (Batzios et al. 2002, 2005; Arvanitoyannis et al. 2004).

A high part of the respondents (64%) purchased fish from the same "fisher/fishmonger", mostly based on mainly trust, because they considered fish origin as an important factor, as outcomes of the logistic regression were revealed. Trust was necessary, because it was linked to a sense of security and it is required to ensure that risk does not become a source of concern or anxiety (Guillou et al. 2019). The importance of attitudes toward food safety it is advisable to bridge the gap among producers, traders, and consumers by promoting the vertical integration of the supply chain (Tran et al. 2013). Given the fragmented supply chain of the Greek seafood market, which includes thousands of small producers, traders, and retailers, public oversight of control measures has proven difficult, and private initiatives aimed at assuring consumers of the product's sustainability may require attention and promotion (Moutopoulos et al. 2021).

The resulting models portray consumers' conceptualization underlying their food choices. Logistic regression models exhibited that the knowledge of the consumers about NIFS impact on human and ecosystem health is mostly dependent on the person who purchased the fish together with the age of the consumers. In this survey, consumers were well-informed about NIFS presence (67.0%) and their potentially negative effects on the marine environment (54.0%). More specifically, logistic regression depicted that young consumers (<45 years old) exhibited a three times higher likelihood of

knowledge on NIFS. The inclusion of these species in restaurant menus triggers consumers to purchase them (62.0%), indicating a possible domestic demand for these species in the region, while their promotion from cooking shows would positively contribute to this direction (Kleitou et al. 2021a, b). This is in line with the establishment of "ethnic food" in European countries in order to boost local economies by leading to new ways of food gastronomy, improve the food marketing and attracts many customers (Guiné et al. 2021), especially in a high touristic destination such as Greece.

The catalytic effect that the media and the press have on consumers could potentially be of use as a tool for informing the consumer about the quality of NIS products, as well their quality control criteria and freshness. Multiple regression models exhibited that media influence on the hygiene of fish was very much high on married consumers. This is because fish choice decisions is subject to fluctuation over the life course, depending upon the consumers' changing life roles, such as marital status and level of independence (Furst et al. 1996). The importance of socio-demographic variables usually governs over an individual's consumer tendencies and the documented social phenomena may inhibit the successful promotion of NIFS as food products, like food neophobia (Varble and Secchi 2013; Cerveira et al. 2022). The lack of credible information and knowledge on issues related to NIFS, as frequently disseminated by local and international media reports, and especially regarding any possible toxic effects on human health (Fig. 2) might create feelings of fear, suspicion, and caution within the Greek consumer for non-indigenous species, even concerning edible species. As evidenced by the interviews, less educated individuals are particularly susceptible to showing aversion and distrust regarding the safety of NIS products (Fig. 2). Trust of new food products and consumers' lack of knowledge about it might evoke expressions of 'disgust,' 'unnaturalness,' or 'fear' and might lead to negative evaluations (Verbeke et al. 2015). In this context, celebrity involvement may boost awareness and acceptability of an otherwise unattractive or easily dismissed species, as invasive species that were featured on popular shows or were endorsed as premium food items have gained unprecedented attention from consumers (Cerveira et al. 2022).

The preferences of consumers also highlight further the need to adopt specialized marketing practices, with integrated strategies for promoting and distributing fish products. According to this study, the most important criteria for the consumer regarding the possibility of purchase of NIFS were freshness, whether the fish is poisonous and the hygienic conditions of the fish market and its staff. Similar results were observed in a relevant

study of offshore fish (Batzios et al. 2005), where freshness (92.0% of the participants) and to a lesser extent, the hygienic conditions of the fish shop (69.8%) as well as the origin of fish (59.8%), were the main criteria governing the selection of fish by the consumers. Certification of quality for the fish product as well as other issues of product quality seem to constitute an important indicator and a useful marketing tool when trying to address structural problems in the production and distribution of fishery products. This is also supported by a pan-European survey (Pieniak et al. 2007) revealed that consumers are most interested in information on safety guarantees and quality marks.

A ratio of three out of four consumers would consume NIFS knowing their actions may help protect the marine ecosystems and native species. Logistic regression models exhibited that the participation of consumers that always purchase their fish meal increased the likelihood of knowledge on NIFS impact on human and ecosystem health. This indicates the importance of promoting the sustainability of the supply chain. The positive relations found between care about the environment and the frequency of consumption suggest that consumers have a positive judgment on the fish supply chain, perceived as a sustainable and environmental friendly one. Consumers support seafood sustainability and are very concerned about environmental sustainability (Olson et al. 2014; McClenachan et al. 2016). This might be a good signal that emphasizes a new era of consumption patterns (Santeramo et al. 2017) and it is particularly

important in the economy of the fisheries dependent areas of the European Union relating to the conservation of exhaustible natural resources. In this context, the spread of consumption of more fish species might expand the process of standardization of fish consumption practices within other European countries (Aranda et al. 2019), which in fact will reduce the overall environmental impact, such as reduced energy consumption or habitat destruction.

In conclusion, initiatives such as the present study aiming to familiarize consumers with new seafood products, highlight the advantages of promoting invasive species as a food (Nuñez et al. 2012; Varble and Secchi 2013). The results of this study revealed avenues for further research, such as a more devoted analysis not only to food safety, but also to environmental issues. The positive attitude of the sampled group towards the consumption of NIFS emphasizing the high sense of responsibility towards the protection of marine habitats. This might indicate a signal that the concept of "sustainability" is becoming a key driver in consumers' choices (Santeramo et al. 2017). Labelling the non-indigenous products could facilitate their consumption. Market promotion campaigns are vital for increasing the familiarity of citizens with alien species products, and further increase demand and consumption. The outcomes of the present study are useful for policymakers and fish product vendors in their efforts to expand and support the introduction of new fish species, based on consumers' willingness to pay for these species as food items.

Appendix

A. Socio-demographic

A1. Gender:

| | |
|-----------------------------------|-------------------------------------|
| Male [1] <input type="checkbox"/> | Female [2] <input type="checkbox"/> |
|-----------------------------------|-------------------------------------|

A2. Age:

| | | |
|------------------------------------|------------------------------------|------------------------------------|
| 18-25 [1] <input type="checkbox"/> | 26-45 [2] <input type="checkbox"/> | 46-65 [3] <input type="checkbox"/> |
|------------------------------------|------------------------------------|------------------------------------|

A3. What is your educational level?

| | |
|---|--|
| I've not finished primary school [1] <input type="checkbox"/> | University alumni [5] <input type="checkbox"/> |
| Gymnasium [2] <input type="checkbox"/> | Student [6] <input type="checkbox"/> |
| High school [3] <input type="checkbox"/> | |
| Master's Degree-Doctorate [4] <input type="checkbox"/> | |

A4. What is your family status?

| | |
|--|--------------------------------------|
| Unmarried [1] <input type="checkbox"/> | Married [2] <input type="checkbox"/> |
|--|--------------------------------------|

B. General fish consumption

B1. In what of the following frequencies are you purchase and consume fish for the family meal?

| | | |
|-------------------------|--------------------------|---|
| Every day | <input type="checkbox"/> | 1 |
| Every week | <input type="checkbox"/> | 2 |
| Once a month | <input type="checkbox"/> | 3 |
| Once every three months | <input type="checkbox"/> | 4 |
| In exceptional cases | <input type="checkbox"/> | 5 |

B2. Do you purchase the fish for your family by yourself?

| | | |
|--------|--------------------------|---|
| Always | <input type="checkbox"/> | 1 |
| Often | <input type="checkbox"/> | 2 |
| Rarely | <input type="checkbox"/> | 3 |

B3. From which of the following fish marketplaces are usually purchase fish for your household?

| | | |
|-----------------------|--------------------------|---|
| Traditional fish shop | <input type="checkbox"/> | 1 |
| Public market | <input type="checkbox"/> | 2 |
| Central fish market | <input type="checkbox"/> | 3 |
| Supermarket | <input type="checkbox"/> | 4 |
| Action market | <input type="checkbox"/> | 5 |
| Street fishmongers | <input type="checkbox"/> | 6 |
| Other | <input type="checkbox"/> | 7 |

B4. What is the quantity of fish that you, usually, purchase and consume for one meal of your family?

| | | |
|------------------|--------------------------|---|
| 1 kg | <input type="checkbox"/> | 1 |
| 1.5 – 2 kg | <input type="checkbox"/> | 2 |
| 2.5 kg and above | <input type="checkbox"/> | 3 |

B5. You prefer to purchase fish from the same "fisher/fishmonger" every time?

| | | |
|-----|--------------------------|---|
| Yes | <input type="checkbox"/> | 1 |
| No | <input type="checkbox"/> | 2 |

B6. If YES, what's the reason?

| | | |
|--------------|--------------------------|---|
| Trust | <input type="checkbox"/> | 1 |
| Good service | <input type="checkbox"/> | 2 |
| Other | <input type="checkbox"/> | 3 |

B7. Do you gut the fish by yourself?

| | | |
|-----|--------------------------|---|
| Yes | <input type="checkbox"/> | 1 |
| No | <input type="checkbox"/> | 2 |

| |
|-----------------------------------|
| C. Alien fish species consumption |
|-----------------------------------|

C1. Do you know what alien fish are?

| | | |
|-----|--|---|
| Yes | | 1 |
| No | | 2 |

C2. Do you know if alien species have a negative impact on human health?

| | | |
|-----|--|---|
| Yes | | 1 |
| No | | 2 |

C3. Do you know if alien species have a negative impact on the marine environment?

| | | |
|-----|--|---|
| Yes | | 1 |
| No | | 2 |

C4. Do you think that the consumption of alien-species goods can be a risk to your health?

| | | |
|-----|--|---|
| Yes | | 1 |
| No | | 2 |

C5. If you were told that some of the alien species are fine food in other countries, would you try?

| | | |
|-----|--|---|
| Yes | | 1 |
| No | | 2 |

C6. If your preferred marketplace sold alien species products at a lower price than their traditional items, would you buy them?

| | | |
|-----|--|---|
| Yes | | 1 |
| No | | 2 |

C7. If your fishmonger suggested an alien species, would you buy it?

| | | |
|-----|--|---|
| Yes | | 1 |
| No | | 2 |

C8. If you saw an alien species cooking on a cooking show, would you be encouraged to buy/consume an alien species on your own?

| | | |
|-----|--|---|
| Yes | | 1 |
| No | | 2 |

C9. If an alien species item appeared in a restaurant menu, would you try it?

| | | |
|-----|--|---|
| Yes | | 1 |
| No | | 2 |

C10. Would you consume alien species if you were told that this action protects the marine environment and native species?

| | | |
|-----|--|---|
| Yes | | 1 |
| No | | 2 |

C11. How important is each of the following factors to you if you were to buy alien species (Note an X for each factor)?

| Factor | Very important | Important | Insignificant |
|--|----------------|-----------|---------------|
| Fish size | | | |
| Freshness | | | |
| Hygienic conditions of the fish shop and its staff | | | |
| Fish packaging | | | |
| Price | | | |
| Origin of the fish | | | |
| Poisonous animal | | | |
| Familiar species | | | |

C12. Would you like to have a quality control certificate or a quality badge if you buy alien fish products?

| | | |
|--------------------|--|---|
| Yes | | 1 |
| No | | 2 |
| It doesn't concern | | 3 |

C13. Would you buy processed alien species products from local cooperatives?

| | | |
|-----|--|---|
| Yes | | 1 |
| No | | 2 |

C14. How much do you affect by the press reports or media announcements on the hygiene of fish?

| | | |
|-------------------|--|---|
| Very much | | 1 |
| Greatly | | 2 |
| A little | | 3 |
| Not affect at all | | 4 |

C15. Have you ever had a health problem from fish consumption?

| | | |
|-----|--|---|
| Yes | | 1 |
| No | | 2 |

We warmly thank you for your participation in the survey

Table A2 Consumer preferences for fish, compared to various socio-demographic characteristics (%)

| Variable | Groups | Frequency of purchase | | | | | χ^2 -test | Market quantity | | | | Fish-gutting | | χ^2 -test |
|----------------|--------|-----------------------|------------|--------------|-------------------------|----------------------|----------------|-----------------|----------|----------------|-------|--------------|------|----------------|
| | | Every day | Every week | Once a month | Once every three months | In exceptional cases | | Up to 1 kg | 1.5–2 kg | 2.5 kg & above | Yes | No | | |
| Gender | 1 | 0.0 | 67.0 | 26.6 | 0.9 | 5.5 | 2.56 | 39.4 | 55.0 | 5.5 | 1.66 | 54.1 | 45.9 | 4.14 |
| | 2 | 0.0 | 69.7 | 22.9 | 3.7 | 3.7 | NS | 45.9 | 51.4 | 2.8 | NS | 40.4 | 59.6 | |
| Marital status | 1 | 0.0 | 63.9 | 27.7 | 2.6 | 5.8 | 5.42 | 40.6 | 53.5 | 5.8 | 4.18 | 47.1 | 52.9 | 0.00 |
| | 2 | 0.0 | 79.4 | 17.5 | 1.6 | 1.6 | NS | 47.6 | 52.4 | 0.0 | NS | 47.6 | 52.4 | NS |
| Education | 1 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | 18.91 | 0.0 | 100.0 | 0.0 | 12.18 | 100.0 | 0.0 | 1.42 |
| | 2 | 0.0 | 61.5 | 15.4 | 15.4 | 7.7 | NS | 53.8 | 46.2 | 0.0 | NS | 53.8 | 46.2 | NS |
| | 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| | 4 | 0.0 | 76.5 | 17.6 | 2.0 | 3.9 | | 58.8 | 39.2 | 2.0 | | 47.1 | 52.9 | |
| | 5 | 0.0 | 66.7 | 31.9 | 0.0 | 1.4 | | 36.1 | 61.1 | 2.8 | | 47.2 | 52.8 | |
| | 6 | 0.0 | 65.4 | 24.7 | 2.5 | 7.4 | | 37.0 | 55.6 | 7.4 | | 45.7 | 54.3 | |
| Age | 1 | 0.0 | 71.2 | 21.2 | 1.9 | 5.8 | 8.02 | 34.6 | 59.6 | 5.8 | 7.11 | 47.1 | 52.9 | 0.00 |
| | 2 | 0.0 | 59.0 | 34.6 | 2.6 | 3.8 | NS | 51.3 | 44.9 | 3.8 | NS | 47.4 | 52.6 | NS |
| | 3 | 0.0 | 80.6 | 13.9 | 2.8 | 2.8 | | 47.2 | 52.8 | 0.0 | | 47.2 | 52.8 | |

χ^2 -test = the values correspond to the Likelihood-ratio χ^2 , *S* Significant ($P \leq 0.05$), *NS* Non-Significant ($P > 0.05$)

Gender: 1 = Male, 2 = Female. **Marital status:** 1 = Unmarried, 2 = Married. **Education:** 1 = Gymnasium, 2 = High school, 3 = I've not finished primary school, 4 = Master's Degree-Doctorate, 5 = University alumni, 6 = Student. **Age:** 1 = 18–25, 2 = 26–45, 3 = 46–65

Table A3 Consumer preferences for the preferred fish marketplace, compared to various socio-demographic characteristics (%)

| Variable | Groups | Fish marketplace | | | | | | | χ^2 -test |
|----------------|--------|-----------------------|---------------|---------------------|-------------|---------------|--------------------|-------|----------------|
| | | Traditional fish shop | Public market | Central fish market | Supermarket | Action market | Street fishmongers | Other | |
| Gender | 1 | 56.9 | 11.9 | 2.8 | 18.3 | 2.8 | 3.7 | 3.7 | 7.22 |
| | 2 | 46.8 | 18.8 | 2.8 | 27.5 | 1.8 | 0.9 | 1.8 | NS |
| Marital status | 1 | 50.3 | 14.8 | 1.9 | 24.5 | 2.6 | 2.6 | 3.2 | 2.97 |
| | 2 | 55.6 | 15.9 | 4.8 | 19.0 | 1.6 | 1.6 | 1.6 | NS |
| Education | 1 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 24.78 |
| | 2 | 38.5 | 0.0 | 7.7 | 46.2 | 0.0 | 7.7 | 0.0 | NS |
| | 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| | 4 | 43.1 | 21.6 | 3.9 | 23.5 | 5.9 | 0.0 | 2.0 | |
| | 5 | 51.4 | 16.7 | 2.8 | 25.0 | 1.4 | 0.0 | 2.8 | |
| | 6 | 59.3 | 12.3 | 1.2 | 17.3 | 1.2 | 4.9 | 3.7 | |
| Age | 1 | 53.8 | 14.4 | 1.9 | 20.2 | 2.9 | 3.8 | 2.9 | 11.53 |
| | 2 | 48.7 | 16.7 | 1.3 | 26.6 | 2.6 | 0.0 | 3.8 | NS |
| | 3 | 52.8 | 13.9 | 8.3 | 22.2 | 0.0 | 2.8 | 0.0 | |

χ^2 -test = the values correspond to the Likelihood-ratio χ^2 , *S* Significant ($P \leq 0.05$), *NS* Non-Significant ($P > 0.05$)

Gender: 1 = Male, 2 = Female. **Marital status:** 1 = Unmarried, 2 = Married. **Education:** 1 = Gymnasium, 2 = High school, 3 = I've not finished primary school, 4 = Master's Degree-Doctorate, 5 = University alumni, 6 = Student. **Age:** 1 = 18–25, 2 = 26–45, 3 = 46–65

Table A4 Consumer perceptions and preferences for the non-indigenous fish species (NIFS), compared to the socio-demographic characteristics (%)

| Variable | Groups | Q. A | | | Q. B | | | Q. C | | | Q. D | | |
|----------------|--------|------|-------|-----------------|-------|------|-----------------|------|-------|-----------------|------|-------|-----------------|
| | | Yes | No | χ^2 - test | Yes | No | χ^2 - test | Yes | No | χ^2 - test | Yes | No | χ^2 - test |
| Gender | 1 | 69.7 | 30.3 | 0.52 | 48.6 | 51.4 | 0.29 | 58.7 | 41.3 | 2.23 | 31.2 | 68.8 | 4.38 |
| | 2 | 65.1 | 34.9 | NS | 45.0 | 55.0 | NS | 48.6 | 51.4 | NS | 45.0 | 55.0 | S |
| Marital status | 1 | 64.5 | 35.5 | 2.08 | 39.4 | 60.6 | 11.91 | 51.0 | 49.0 | 1.57 | 33.5 | 66.5 | 4.66 |
| | 2 | 74.6 | 25.4 | NS | 65.1 | 34.9 | S | 60.3 | 39.7 | NS | 49.2 | 50.8 | S |
| Education | 1 | 0.0 | 100.0 | 13.80 | 100.0 | 0.0 | 22.42 | 0.0 | 100.0 | 15.52 | 0.0 | 100.0 | 3.35 |
| | 2 | 61.5 | 38.5 | S | 46.2 | 53.8 | S | 53.8 | 46.2 | S | 38.5 | 61.5 | NS |
| | 3 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| | 4 | 86.3 | 13.7 | | 70.6 | 29.4 | | 74.5 | 25.5 | | 43.1 | 56.9 | |
| | 5 | 66.7 | 33.3 | | 48.6 | 51.4 | | 54.2 | 45.8 | | 41.7 | 58.3 | |
| | 6 | 58.0 | 42.0 | | 29.6 | 70.4 | | 40.7 | 59.3 | | 30.9 | 69.1 | |
| Age | 1 | 58.7 | 41.3 | 7.22 | 31.7 | 68.3 | 18.35 | 43.3 | 56.7 | 12.32 | 32.7 | 67.3 | 2.49 |
| | 2 | 76.9 | 23.1 | S | 59.0 | 41.0 | S | 69.2 | 30.8 | S | 42.3 | 57.7 | NS |
| | 3 | 72.2 | 27.8 | | 63.9 | 36.1 | | 50.0 | 50.0 | | 44.4 | 55.6 | |

χ^2 -test = the values correspond to the Likelihood-ratio χ^2 , *S* Significant ($P \leq 0.05$), *NS* Non-Significant ($P > 0.05$)

Gender: 1 = Male, 2 = Female. **Marital status:** 1 = Unmarried, 2 = Married. **Education:** 1 = Gymnasium, 2 = High school, 3 = I've not finished primary school, 4 = Master's Degree-Doctorate, 5 = University alumni, 6 = Student. **Age:** 1 = 18–25, 2 = 26–45, 3 = 46–65. **Q.A:** Do you know what alien fish are? **Q.B:** Do you know if alien species have a negative impact on human health? **Q.C:** Do you know if alien species have a negative impact on the marine environment? **Q.D:** Do you think that the consumption of alien-species goods can be a risk to your health?

Table A4 concluded

| Variable | Groups | Q. E | | | Q. F | | | Q. G | | | Q. H | | |
|----------------|--------|-------|------|-----------------|------|-------|-----------------|------|-------|-----------------|-------|------|-----------------|
| | | Yes | No | χ^2 - test | Yes | No | χ^2 - test | Yes | No | χ^2 - test | Yes | No | χ^2 - test |
| Gender | 1 | 74.3 | 25.7 | 2.17 | 61.5 | 38.5 | 16.55 | 73.4 | 26.6 | 7.25 | 60.6 | 39.4 | 1.20 |
| | 2 | 65.1 | 34.9 | NS | 33.9 | 66.1 | S | 56.0 | 44.0 | S | 53.2 | 46.8 | NS |
| Marital status | 1 | 69.7 | 30.3 | 0.06 | 47.7 | 52.3 | 0.00 | 64.5 | 35.5 | 0.01 | 56.8 | 43.2 | 0.00 |
| | 2 | 69.8 | 30.2 | NS | 47.6 | 52.4 | NS | 65.1 | 34.9 | NS | 57.1 | 42.9 | NS |
| Education | 1 | 100.0 | 0.0 | 0.95 | 0.0 | 100.0 | 3.48 | 0.0 | 100.0 | 4.01 | 100.0 | 0.0 | 4.88 |
| | 2 | 76.9 | 23.1 | NS | 53.8 | 46.2 | NS | 69.2 | 30.8 | NS | 69.2 | 30.8 | NS |
| | 3 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| | 4 | 68.6 | 31.4 | | 56.9 | 43.1 | | 66.7 | 33.3 | | 54.9 | 45.1 | |
| | 5 | 70.8 | 29.2 | | 44.4 | 55.6 | | 58.3 | 41.7 | | 48.6 | 51.4 | |
| | 6 | 67.9 | 32.1 | | 44.4 | 55.6 | | 69.1 | 30.9 | | 63.0 | 37.0 | |
| Age | 1 | 68.3 | 31.7 | 0.68 | 44.2 | 55.8 | 5.56 | 66.3 | 33.7 | 0.78 | 60.6 | 39.4 | 1.12 |
| | 2 | 73.1 | 26.9 | NS | 57.7 | 42.3 | NS | 65.4 | 34.6 | NS | 53.8 | 46.2 | NS |
| | 3 | 66.7 | 33.3 | | 36.1 | 63.9 | | 58.3 | 41.7 | | 52.8 | 47.2 | |

Table A4 concluded

| Variable | Groups | Q. I: If an alien species item appeared in a restaurant menu, would you try it? | | | Q. J: Would you consume alien species if you were told that this action protects the marine environment and native species? | | |
|----------------|--------|---|-------|-----------------|---|-------|-----------------|
| | | Yes | No | χ^2 - test | Yes | No | χ^2 - test |
| Gender | 1 | 67.9 | 32.1 | 2.81 | 78.9 | 21.1 | 0.91 |
| | 2 | 56.9 | 43.1 | NS | 73.4 | 26.6 | NS |
| Marital status | 1 | 61.9 | 38.1 | 0.05 | 76.8 | 23.2 | 0.12 |
| | 2 | 63.5 | 36.5 | NS | 74.6 | 25.4 | NS |
| Education | 1 | 0.0 | 100.0 | 6.63 | 0.0 | 100.0 | 5.65 |
| | 2 | 76.9 | 23.1 | NS | 69.2 | 30.8 | NS |
| | 3 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| | 4 | 72.5 | 27.5 | | 84.3 | 15.7 | |
| | 5 | 55.6 | 44.4 | | 75.0 | 25.0 | |
| | 6 | 60.5 | 39.5 | | 74.1 | 25.9 | |
| Age | 1 | 60.6 | 39.4 | 1.01 | 73.1 | 26.9 | 3.78 |
| | 2 | 66.7 | 33.3 | NS | 83.3 | 16.7 | NS |
| | 3 | 58.3 | 41.7 | | 69.4 | 30.6 | |

χ^2 -test=the values correspond to the Likelihood-ratio χ^2 , *S* Significant ($P \leq 0.05$), *NS* Non-Significant ($P > 0.05$)

Gender: 1 = Male, 2 = Female. **Marital status:** 1 = Unmarried, 2 = Married. **Education:** 1 = Gymnasium, 2 = High school, 3 = I've not finished primary school, 4 = Master's Degree-Doctorate, 5 = University alumni, 6 = Student. **Age:** 1 = 18–25, 2 = 26–45, 3 = 46–65. **Q.E:** If you were told that some of the alien species are fine food in other countries, would you try? **Q.F:** If your preferred marketplace sold alien species products at a lower price than their traditional items, would you buy them? **Q.G:** If your fishmonger suggested an alien species, would you buy it? **Q.H:** If you saw an alien species cooking on a cooking show, would you be encouraged to buy/consume an alien species on your own?

Table A5 Consumer preferences depending on the importance, for each of the 8 factors for buying non-indigenous fish species (NIFS) (%)

| Variable | Groups | Fish size | | | | Freshness | | | | Hygienic conditions of the fish shop and its staff | | | | Fish packaging | | | |
|----------------|--------|--------------------|-------------------|-----------|--------------------|--------------------|-------------------------|-----------------|----------------|--|-------------------------|-----------------|----------------|--------------------|-------------------------|-----------------|----------------|
| | | Insignifi- cant | Very Important | Important | χ^2 - test | Insig- nificant | Very Import- tant | Import- tant | χ^2 -test | Insig- nificant | Very Import- tant | Import- tant | χ^2 -test | Insig- nificant | Very Import- tant | Import- tant | χ^2 -test |
| Gender | 1 | 29.4 | 15.6 | 55.0 | 0.61 | 0.9 | 89.0 | 10.1 | 0.97 | 1.8 | 84.4 | 13.8 | 3.37 | 28.4 | 21.1 | 50.5 | 2.20 |
| | 2 | 24.8 | 17.4 | 57.8 | NS | 0.9 | 92.7 | 6.4 | NS | 2.8 | 90.8 | 6.4 | NS | 22.9 | 29.4 | 47.7 | NS |
| Marital status | 1 | 23.9 | 16.8 | 59.4 | 2.86 | 0.6 | 94.8 | 4.5 | 10.47 | 1.3 | 88.4 | 10.3 | 2.42 | 25.8 | 23.2 | 51.0 | 1.24 |
| | 2 | 34.9 | 15.9 | 49.2 | NS | 1.6 | 81.0 | 17.5 | S | 4.8 | 85.7 | 9.5 | NS | 25.4 | 30.2 | 44.4 | NS |
| Education | 1 | 0.0 | 0.0 | 100.0 | 1.94 | 0.0 | 100.0 | 0.0 | 2.50 | 0.0 | 100.0 | 0.0 | 7.37 | 0.0 | 100.0 | 0.0 | 8.25 |
| | 2 | 30.8 | 15.4 | 53.8 | NS | 0.0 | 84.6 | 15.4 | NS | 7.7 | 69.2 | 23.1 | NS | 46.2 | 7.7 | 46.2 | NS |
| | 3 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | |
| | 4 | 23.5 | 19.6 | 56.9 | | 0.0 | 92.2 | 7.8 | | 2.0 | 94.1 | 3.9 | | 25.5 | 29.4 | 45.1 | |
| | 5 | 30.6 | 15.3 | 54.2 | | 1.4 | 88.9 | 9.7 | | 1.4 | 86.1 | 12.5 | | 26.4 | 26.4 | 47.2 | |
| | 6 | 25.9 | 16.0 | 58.0 | | 1.2 | 92.6 | 6.2 | | 2.5 | 87.7 | 9.9 | | 22.2 | 23.5 | 54.3 | |
| Age | 1 | 26.9 | 16.3 | 56.7 | 3.08 | 1.0 | 93.3 | 5.8 | 4.58 | 1.9 | 87.5 | 10.6 | 2.23 | 24.0 | 25.0 | 51.0 | 2.10 |
| | 2 | 23.1 | 15.4 | 61.5 | NS | 0.0 | 91.0 | 9.0 | NS | 1.3 | 88.5 | 10.3 | NS | 28.2 | 21.8 | 50.0 | NS |
| | 3 | 36.1 | 19.4 | 44.4 | | 2.8 | 83.3 | 13.9 | | 5.6 | 86.1 | 8.3 | | 25.0 | 33.3 | 41.7 | |

Table A5 to be concluded

| Variable | Groups | Price | | | | Origin of the fish | | | | Poisonous animal | | | | Familiar species | | | |
|----------------|--------|----------------|-----------------|------------|----------------|--------------------|-----------------|------------|----------------|------------------|-----------------|------------|----------------|------------------|-----------------|------------|----------------|
| | | Insig-nificant | Very Impor-tant | Impor-tant | χ^2 -test | Insig-nificant | Very Impor-tant | Impor-tant | χ^2 -test | Insig-nificant | Very Impor-tant | Impor-tant | χ^2 -test | Insig-nificant | Very Impor-tant | Impor-tant | χ^2 -test |
| Gender | 1 | 7.3 | 37.6 | 55.0 | 0.37 | 9.2 | 41.3 | 49.5 | 6.62 | 4.6 | 81.7 | 13.8 | 5.90 | 15.6 | 38.5 | 45.9 | 5.72 |
| | 2 | 5.5 | 36.7 | 57.8 | NS | 6.4 | 58.7 | 34.9 | S | 1.8 | 92.7 | 5.5 | NS | 8.3 | 53.2 | 38.5 | NS |
| Marital status | 1 | 5.8 | 34.2 | 60.0 | 2.80 | 9.0 | 45.8 | 45.2 | 4.05 | 3.9 | 84.5 | 11.6 | 3.34 | 12.9 | 40.0 | 47.1 | 7.51 |
| | 2 | 7.9 | 44.4 | 47.6 | NS | 4.8 | 60.3 | 34.9 | NS | 1.6 | 93.7 | 4.8 | NS | 9.5 | 60.3 | 30.2 | S |
| Education | 1 | 0.0 | 100.0 | 0.0 | 2.78 | 0.0 | 100.0 | 0.0 | 12.18 | 0.0 | 100.0 | 0.0 | 6.32 | 0.0 | 100.0 | 0.0 | 6.77 |
| | 2 | 7.7 | 38.5 | 53.8 | NS | 15.4 | 23.1 | 61.5 | NS | 7.7 | 92.3 | 0.0 | NS | 7.7 | 38.5 | 53.8 | NS |
| | 3 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | |
| | 4 | 3.9 | 35.3 | 60.8 | | 2.0 | 54.9 | 43.1 | | 5.9 | 80.4 | 13.7 | | 15.7 | 51.0 | 33.3 | |
| | 5 | 6.9 | 38.9 | 54.2 | | 11.1 | 56.9 | 31.9 | | 1.4 | 91.7 | 6.9 | | 9.7 | 51.4 | 38.9 | |
| | 6 | 7.4 | 35.8 | 56.8 | | 7.4 | 44.4 | 48.1 | | 2.5 | 86.4 | 11.1 | | 12.3 | 38.3 | 49.4 | |
| Age | 1 | 5.8 | 33.7 | 60.6 | 2.05 | 7.7 | 48.3 | 44.2 | 1.39 | 1.9 | 86.5 | 11.5 | 6.91 | 12.5 | 40.4 | 47.1 | 4.75 |
| | 2 | 6.4 | 38.5 | 55.1 | NS | 9.0 | 48.7 | 42.3 | NS | 6.4 | 83.3 | 10.3 | NS | 12.8 | 46.2 | 41.0 | NS |
| | 3 | 8.3 | 44.4 | 47.2 | | 5.6 | 58.3 | 36.1 | | 0.0 | 97.2 | 2.8 | | 8.3 | 61.1 | 30.6 | |

χ^2 -test = the values correspond to the Likelihood-ratio χ^2 , *S* Significant ($P \leq 0.05$), *NS* Non-Significant ($P > 0.05$)

Gender: 1 = Male, 2 = Female. **Marital status:** 1 = Unmarried, 2 = Married. **Education:** 1 = Gymnasium, 2 = High school, 3 = I've not finished primary school, 4 = Master's Degree-Doctorate, 5 = University alumni, 6 = Student. **Age:** 1 = 18–25, 2 = 26–45, 3 = 46–65

Table A6 Consumer preferences for the purchase of alien species and the influence of consumers by the media on the hygiene of fish in relation to socio-demographic characteristics (%)

| Variable | Groups | Quality control certificate | | | | Q. K | | | Q. L | | | | χ^2 -test |
|----------------|--------|-----------------------------|-----|-----------------------|----------------|------|-------|----------------|-----------|---------|----------|-------------------|----------------|
| | | Yes | No | It doesn't concern me | χ^2 -test | Yes | No | χ^2 -test | Very much | Greatly | A little | Not effect at all | |
| Gender | 1 | 74.3 | 4.6 | 21.1 | 3.39 | 56.0 | 44.0 | 3.60 | 11.9 | 33.9 | 35.8 | 18.3 | 1.31 |
| | 2 | 84.4 | 2.8 | 12.8 | NS | 43.1 | 56.9 | NS | 11.9 | 37.6 | 37.6 | 12.8 | NS |
| Marital status | 1 | 78.7 | 3.9 | 17.4 | 0.15 | 47.1 | 52.9 | 1.28 | 9.0 | 29.7 | 41.9 | 19.4 | 18.22 |
| | 2 | 81.0 | 3.2 | 15.9 | NS | 55.6 | 44.4 | NS | 19.0 | 50.8 | 23.8 | 6.3 | S |
| Education | 1 | 100.0 | 0.0 | 0.0 | 13.88 | 0.0 | 100.0 | 8.56 | 0.0 | 0.0 | 100.0 | 0.0 | 16.01 |
| | 2 | 69.2 | 0.0 | 30.8 | NS | 61.5 | 38.5 | NS | 30.8 | 53.8 | 15.4 | 0.0 | NS |
| | 3 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | |
| | 4 | 78.4 | 2.0 | 19.6 | | 62.7 | 37.3 | | 13.7 | 39.2 | 29.4 | 17.6 | |
| | 5 | 76.4 | 9.7 | 13.9 | | 38.9 | 61.1 | | 9.7 | 36.1 | 43.1 | 11.1 | |
| | 6 | 84.0 | 0.0 | 16.0 | | 49.4 | 50.6 | | 9.9 | 30.9 | 38.3 | 21.0 | |
| Age | 1 | 84.6 | 1.0 | 14.4 | 6.62 | 44.2 | 55.8 | 5.65 | 7.7 | 26.0 | 45.2 | 21.2 | 18.25 |
| | 2 | 71.8 | 6.4 | 21.8 | NS | 60.3 | 39.7 | NS | 14.1 | 42.3 | 30.8 | 12.8 | S |
| | 3 | 80.6 | 5.6 | 13.9 | | 41.7 | 58.3 | | 19.4 | 50.0 | 25.0 | 5.6 | |

χ^2 -test = the values correspond to the Likelihood-ratio χ^2 , *S* Significant ($P \leq 0.05$), *NS* Non-Significant ($P > 0.05$).

Gender: 1 = Male, 2 = Female. **Marital status:** 1 = Unmarried, 2 = Married. **Education:** 1 = Gymnasium, 2 = High school, 3 = I've not finished primary school, 4 = Master's Degree-Doctorate, 5 = University alumni, 6 = Student. **Age:** 1 = 18–25, 2 = 26–45, 3 = 46–65. **Q.K:** Would you buy processed alien species products from local cooperatives? **Q.L:** How much do you affect by the press reports or media announcements on the hygiene of fish?

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Declarations

Conflict of Interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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