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Research

Can we control marine invasive alien species by eating them? The case of *Callinectes sapidus*

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ABSTRACT. The management of invasive species is a current challenge for the conservation of biodiversity. One approach is their utilization as a food source. In this study, 2040 French people were interviewed to assess crustacean consumers' receptivity to this new species and its desirability as a food. The crab's appearance (shape and color) had no effect on consumers' opinions. Remarkably, 96% were willing to support culling blue crabs in French waters by purchasing and consuming them, mostly in restaurants and fish stores. They were ready to pay €15–€19 for a dish in restaurants and €8–€10/kg in fish stores, reflecting awareness of market prices for similar species. Importantly, the youngest French adults see eating blue crab as an act of environmental protection and civic engagement. The study showcases a comprehensive survey that could guide governments in managing this invasive species effectively.

Key Words: *commercial fishery; invasive species consumption; management plan; people perception; seafood*

INTRODUCTION

More than 60 years after the consequences of accidental species introductions were first officially recognized (Elton 2020), combating the negative effects of invasive alien species (particularly invasive alien fauna) remains a major conservation challenge (Carlton 1996, Bright 1999, Occhipinti-Ambrogi 2007). Biological invasions threaten the structure and function of aquatic ecosystems on a global scale, and continue to cause major losses in biodiversity and habitat functioning worldwide (Molnar et al. 2008). Dealing with the effects of invasions is particularly problematic in aquatic environments, as the rate at which invaders become established often far exceeds the resources available for their control (Mooney and Cleland 2001, Zenetos et al. 2017). Invasive alien species (IAS) management is now an international demand (i.e., global strategy on invasive alien species; International Union for Conservation of Nature [IUCN]) and is applied at international and national levels. In Europe, IAS management is governed by several international and national regulations aimed at preventing and minimizing the negative impacts of these species on local ecosystems. The European Union (EU) plays a key role in harmonizing these efforts through various legislative instruments. At the European level, Regulation (EU) No. 1143/2014 establishes a common framework for the prevention and management of invasive alien species in the EU. This regulation enumerates a list of species of concern, and member states are required to set up management plans for these species to limit their spread. In addition, prevention, early detection, and rapid response measures to control invasive species are encouraged. In France, regulations concerning invasive species are part of the transposition of European regulations. At the French national level, the need and demand for IAS management remain no less important, notably through the national strategy document on IAS produced by the French Ministry for the Environment, Energy and the Sea, including specific provisions for the prevention, control, and eradication of invasive alien species. French authorities are implementing national and local action plans to combat IAS in collaboration with local partners, non-governmental organizations, and other stakeholders. Implementing these regulations involves coordination between national, regional, and local authorities, as well as close collaboration with scientists, biodiversity management experts, and other stakeholders. Public awareness-raising efforts are also essential to encourage citizen participation in the monitoring and management of invasive species. It is, therefore, necessary to establish management strategies and plans adapted to the state of invasion of a non-native species in order to minimize its effects on the impacted ecosystem. The management of IAS in aquatic environments is, however, difficult to implement because of the challenges associated with confining them once established (Thresher and Kuris 2004).

In open marine environments, i.e., without the possibility of containment, the eradication of IAS is often impossible (Vander Zanden and Olden 2008, Havel et al. 2015), and considerable effort is required to keep certain populations under control (Simberloff 2021). The absence of predators and their biological, morphological, and ecological plasticity (high tolerance to temperature and salinity, for example; Azzurro et al. 2014, Karachle et al. 2022) mean that IAS have a wide range of competitive advantages over native species in invaded areas (Byers 2002, Bax et al. 2003). Currently, many species are overexploited in their native range but are invasive elsewhere; the American blue crab (*Callinectes sapidus*) and Mediterranean green crab (*Carcinus aestuarii*) are perfect examples. In the Mediterranean region, green crabs (genus *Carcinus*) are native to the region and are under serious threat from blue crabs, because of competition for resources and predation by blue crabs (Clavero et al. 2022). In the United States, on the other hand, the problem is reversed, as the Mediterranean green crab is introduced and invasive (Grosholz and Ruiz 1995). This has given rise to the idea of consuming these new invasive edible resources as a method of population control (Roman 2006, Nuñez et al. 2012, Lai 2013, Orth et al. 2020). The lionfish species *Pterois volitans* and *Pterois miles* are the main case studies on consumption of IAS as a measure to control populations, in particular in the United States

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(Huth et al. 2016, Noll and Davis 2020), through a campaign with the slogan "Eat the lionfish" (NOAA 2011, 2023a), and through the publication of cookbooks, such as *The Lionfish Cookbook: The Caribbean's New Delicacy* (Ferguson and Akins 2016), *The Invasive Species Cookbook: Conservation Through Gastronomy* (Francke 2006), and *Can't Beat 'Em, Eat 'Em!: 40 Invasive Species With Recipes* (Parola 2023). Another example of an IAS consumption initiative is the domestic consumption of the Asian carp in the United States and Canada (Varble and Secchi 2013). In the Mediterranean Sea, some local initiatives are observed, especially in Greece, with the program "Pick the Alien" consisting of the publication of a recipe book and public events to promote the consumption of IAS, such as the blue crab species *Callinectes sapidus* and *Portunus segnis* and the lionfish *Pterois miles*. Kampouris et al. (2021) is among the few studies that assessed the proximate composition (tail muscle) of another invasive decapod, *Penaeus aztecus*, and proposed the consumption of this prawn species not only as a control measure but also as an alternative to the threatened spiny lobster *Palinurus elephas*, because both species have similar nutritional value and other social and gastronomical similarities, as well. The consumption of new invasive species is a growing area of interest that will benefit in part from greater public awareness (Kleitou et al. 2019).

On a global scale, there are many local initiatives to promote the consumption of IAS, such as in Portugal for the consumption of weakfish *Cynoscion regalis* (Bloch and Schneider, 1801) through awareness-raising events (Cerveira et al. 2022). A recent review showed that chefs were at the heart of IAS consumer awareness, given their position at the junction of evolving cultural views on food, its origin, consumption, and environmental impact (Seaman et al. 2022). Many chefs around the world have adopted this approach to raising public awareness of IAS consumption. For example, chef Bun Lai of Miya's Sushi (Connecticut, USA) is campaigning to show that the European green crab *Carcinus maenas* (Linnaeus, 1758) is delicious (Lai 2013). In Portugal, chef Leonel Pereira indicated that Atlantic blue crab *C. sapidus* and weakfish were exceptional dishes (Cerveira et al. 2022). Recently in France (Corsica Island), the Chef Jean-Michel Querci (O Mà! Gourmandises, Corsica) has been working on raising public awareness of blue crab (*C. sapidus*) consumption through large gastronomic events (Marie Garrido, *personal communication*). In its native area, *C. sapidus* is heavily fished in the eastern and gulf states of the United States. It is very popular in much of the eastern U.S., where it is eaten in a variety of ways in upscale and casual seafood restaurants and in many households, and it supports at least two fisheries (hard and soft shell) (Kennedy and Cronin 2007, Bunnell et al. 2010).

Fishing as a means to control invasive species comes with several considerations for those involved. The primary goal of this approach should be to control the invasive species by managing and limiting their spread, and should not be to create a profitable fishery (Nuñez et al. 2012). Consequently, European laws prohibit the farming or intentional propagation of invasive species, regardless of any potential profitability. It is worth noting that fishing invasive species is expected to be particularly effective in countries, like France, where fish consumption rates are higher. According to the Food and Agriculture Organization of the United Nations (FAO) report, France ranks among the world's top 10 seafood-consuming countries in terms of quantity (FAO 2020). The French population consume shellfish, crustaceans, and fish as an integral part of their diet. According to available data, the French are among the second biggest consumers of seafood in Europe, with an average of ~35 kg/yr per capita consumption of fish (France Agri Mer 2020). Figures vary according to the type of seafood: on average, the French consume ~6 kg of crustaceans per year, including such varieties as shrimps, crabs, and lobster and ~29 kg of fish per year (FranceAgriMer 2020). Fresh fish is particularly popular in France, with salmon, cod, sole, and sea bream among the most consumed. These data testify to the importance of crustaceans and fish consumption in the French diet. The rich marine resources of the French coastline and the country's gastronomic culture contribute to this preference for seafood. The French tend to prefer fresh, high-quality foods, with crustaceans and fish occupying a special place in their balanced diet. All of these aspects point to the importance of seafood in the French diet, which could facilitate the introduction of a new crustacean like the blue crab *Callinectes sapidus* in the French food market. But our question is what if this new species is an invasive one?

The blue crab *C. sapidus* (Rathbun, 1896) is a species native to the western Atlantic Ocean of North and South America, from Canada to Brazil. It is one of the most recent invasive crustaceans in the Mediterranean Sea, where it ranges on the northern Mediterranean coast from Spain to Turkey and on the southern coast in Egypt, Lebanon, Tunisia, Algeria, and Morocco (Mancinelli et al. 2021). The recent expansion of the blue crab on the French Mediterranean coast is causing concern among professional fishermen and shellfish farmers (Kampouris et al. 2019, Labrune et al. 2019, Marchessaux et al. 2023). Indeed, the presence of *C. sapidus* in large numbers has a direct impact on fishing activities, not only by damaging nets with their claws or damaging the fish caught but also by competing with other local species (Kampouris et al. 2019, Marchessaux et al. 2023). This damage leads to additional costs and lower sales for professional fishermen (Nehring 2011, Perdikaris et al. 2016, Mancinelli et al. 2017b, Kampouris et al. 2019, Marchessaux et al. 2023), particularly in lagoons.

In its native range, blue crab fisheries are recognized for their commercial value and catch volume, making the blue crab fishery one of the most important fisheries on the eastern coast of the United States (NOAA 2023b). Blue crab is of major fishing interest and consumed in large quantities, mainly in the United States and Mexico (Churchill 1919, Van Engel 1958). Blue crabs are consumed both as hard and soft shell, and the two products differ widely in price (soft shell is much more expensive) and market. The soft-shell crabs offered in American and Asian markets can be priced 300%–400% higher than their hard-shelled counterparts (Ibarra et al. 2015, Cilenti et al. 2024). States in the Gulf of Mexico region, such as Louisiana, Texas, and Florida, are among the main producers of blue crab. The blue crab fisheries of the Chesapeake Bay in the United States produced an average of over 50,000 tons of crab each year over the last decade, for a total value of USD $300 million (Pelton and Goldsborough 2008). According to data from commercial and market sources, the average price of blue crab can fluctuate between USD $15 and

$30 per kg. In 2023, the average price of blue crab in the Chesapeake Bay area was approximately USD $25/kg (Maryland Seafood Market Bulletin - Blue Crab Program 2023) and USD $20/kg in Louisiana (Louisiana Department of Wildlife and Fisheries 2023). These figures underline the economic and dietary importance of *C. sapidus* blue crab for America's coastal regions. Blue crab fisheries provide jobs in the fishing industry, support local economies, and offer a valued food source for many coastal communities. The price per kilogram of *C. sapidus* blue crab in America can vary according to season, demand, availability, and region.

In some Mediterranean regions, *C. sapidus* has become a valuable fishing resource (e.g., Adriatic Sea, Egypt, Turkey, Tunisia, Spain; Glamuzina et al. 2021, Cannarozzi et al. 2023). Since 2008, the Tunisian Ministry of Agriculture has tried to turn the invasion into an economic opportunity. In 2018, Tunisia harvested approximately 3355 tons of blue crabs (4262 tons in 2019), worth 7 million euros (12 million euros in 2019; Ennouri et al. 2021), and 14,000 tons in 2022, 95% of which was exported to North and South America, Asia, and Oceania. Spain is the second country that has introduced control measures in 2020. To curb the blue crab's expansion, the government and the Consell de Mallorca (Spain) granted licenses for recreational fishing for personal consumption only. In addition, given its gastronomic value, in the Ebro Delta (Spain) the blue crab is being promoted in restaurants to reduce the negative effects on the professional fishing sector and create direct pressure on the blue crab population. In Spain, blue crab was also exported to China and South Korea, although its price has dropped from €12 to €0.70 per kg in just a few years. In Greece, the species is becoming rarer because of overfishing (Boschma 1972) and therefore has little commercial value (Mancinelli et al. 2017a). In Turkey, blue crab is sold by a small number of local fishermen, and a number of channels have been developed, although the most important trade concerns the other Portunidae species, *Portunus segnis* (4000 tons/yr). *Callinectes sapidus* can also be found on the market and sold for between €0.5 and €3.36 per kg, and in local restaurants where its price varies between €0.34 and €2.24 per kg (Öndes and Gökçe 2021). Some specimens are sold for export to China and the Netherlands at between €7 and €9 per kg, with more than 200,000 kg fished each year (Çelik et al. 2004). As for the other Mediterranean countries invaded by *C. sapidus*, only local initiatives for occasional sales are known, notably in France. On the French Mediterranean coast especially, the government and nature protection institutions are implementing the commercialization of blue crab as a means of population control. This marketing, or rather "use of the by-catch resource," would be a means of (1) compensating fishermen for the economic losses created by the blue crab invasion, and (2) controlling blue crab populations by fishing all blue crab life stages over a short period of time. However, apart from in regions where the species proliferates (e.g., French Mediterranean coast mainly; also, the Atlantic coast and English Channel), blue crabs are not well known to the French, who are very fond of seafood.

Thus, this study presents a large national public survey of more than 2000 people to assess (1) the potential of blue crab as a new fishing resource in France by evaluating crustacean consumers' receptivity to this new species, (2) in what form they plan to eat blue crab and at what price, and (3) French people's perception of and environmental commitment to blue crab consumption as a means of controlling the species. We used Bayesian networks to represent the relationships and conditional independences among the variables in the survey. The network's structure was determined by using a hill climbing algorithm, and the models were compared by using the Bayesian Information Criterion score.

METHODS

Survey strategies

A questionnaire-based online survey (Google Form format), named "BlueConso," was performed to identify the perception of French general public on the blue crab invasion and its consumption as a management measure (Appendix 1; University of Palermo ethical number: D.R. n. 3267). The questionnaire (response time: five to six min) was accessible for two months between 15 March and 15 May 2023. We used a "snowball" method to collect responses to the questionnaires, using previously identified networks as our first input, such as Facebook groups oriented toward citizen science and cooking topics, IUCN France network (National Center of Invasive Exotic Species), French nature managers, and university mailing lists. Through these different networks, we also asked respondents to share the questionnaire with their respective networks, so that we could reach a representative panel of respondents. This was also made possible by sharing the questionnaire online via press/television communication: two articles in French national newspapers (20 Minutes [3.3 million readers every day], France 3 [~400,000 readers every day]) and 2 National television channels (Brut Nature [250 million unique viewers per month] and BFM TV [~51,000 viewers per day]), which considerably increased the questionnaire's visibility in France.

The questionnaire was created on the basis of a review of the available literature on people's perceptions of invasive species (Varble and Secchi 2013, Huth et al. 2016, Cerveira et al. 2022) and was adapted on the basis of questions posed by the French Ministry of the Environment, Energy and the Sea on the challenges of blue crab consumption. The questionnaire was divided into five sections and the response time was approximately five to seven minutes to reach a maximum of people. To minimize response bias, respondents were asked to answer anonymously and on a voluntary basis. The first part of the survey dealt with anonymous information about the individual's gender, age, city of residence, and level of education. The second part focused on the respondent's knowledge of blue crab and their perception about the species appearance, color, and shape. The third part dealt with their personal consumption of crustaceans in general and their perception about the consumption of blue crab. The fourth part was focused on where people would like to buy blue crab (restaurants, fish stores, supermarkets) and at what price. The proposed price ranges were determined on the basis of crustacean prices in France, available in the reports of FranceAgriMer, a French national administrative public body for agricultural and sea products, whose mission is to apply, in France, certain measures provided for by the Common Agricultural Policy and to carry out certain national actions in favor of the various agricultural sectors. Finally, the last part of the questionnaire collected people's perceptions of issues surrounding the blue crab and their involvement in controlling it. The questionnaire consisted of questions to be ticked with one or more choices, including questions with an importance index from 0 to 4.

Data analysis

Socio-professional respondents' job categories were divided on the basis of criteria from the INSEE (French National Institute for Statistics and Economic Studies). Questions with importance indices (perception indices between 0 and 5, and prices categories) were plotted by violin plots (R package 'ggplot2,' Hintze and Nelson 1998), similar to boxplots but showing probability density of the data for different values (e.g., kernel density estimator), useful to identify the density of responses. The map was created by using QGIS 3.16.13 'Hannover' and the other plots by using the software Sigmaplot 12.5.

A Bayesian network (BN) was employed to represent the conditional independences among variables in the survey. BNs are graphical models that provide powerful and intuitive ways to reason about uncertain and complex systems. This class of models uses a directed acyclic graph (DAG) structure to represent conditional dependencies through directional links (Scutari and Denis 2021). The DAG consists of a mathematical object with nodes (representing the variables in our survey) and directional links (representing conditional independences), and is related to the model through a probabilistic property called factorization. Each node in the Bayesian network has an associated conditional probability table (CPT), specifying the conditional probabilities of the node given its parents' values, representing the probabilistic relationship between the node and its parents.

Generally, the DAG is unknown and inference for Bayesian networks consists of finding the best among a vast array of possibilities. This procedure is called structural learning and is one of the most essential characteristics of Bayesian networks. In other words, the DAG can be learned from data. Learning involves estimating the network structure's parameters (conditional probabilities) from observed data. There are various algorithms for learning Bayesian networks, including constraint-based, score-based, and hybrid structure learnings. In our study, we have considered the constraint-based hill-climbing algorithm, which is a search method that explores the space of the directed acyclic graphs by single-arc addition, removal and reversals with random restarts to avoid local optima. The comparison among models (i.e., the score) is the Bayesian Information Criterion that penalizes the likelihood by multiplying the degree of freedom (number of links in the DAG measuring its complexity) times the log of the number of observations. Finally, the selected DAG can be used as a tool for answering some queries through the use of a propagation method. Propagation in the context of a DAG typically refers to the process of updating or computing values for nodes in the graph based on the relationships defined by the edges. Statistical analyses were performed by using the software R studio and the package "bnlearn" (Scutari 2015).

RESULTS

A total of 2040 questionnaires (2018 in metropolitan France, and 22 outside metropolitan France and abroad) were completed between 15 March and 15 May 2023 (Fig. 1A). The spatial distribution of the statistical units of the survey covers all regions of mainland France (899 towns in total; Fig. 1A), with the number of responses ranging from 27 to 431, with a total of 890 responses only from the French Mediterranean coast, the area most affected by the invasion of *Callinectes sapidus*. The sample was composed of 57% male respondents, 41% female, and 2% unspecified gender. Respondents were between 18 and 94 years old, with a large contribution (59%) of those 40–69 years in age (Fig. 1B), and 64.2% were Bachelor or Master education level (Appendix 7). A total of 80% of people had already heard of the blue crab, mainly via newspapers and television (Fig. 2A), but only 24% had observed the blue crab in the wild (Fig. 2B). People were also well informed about the fact that *C. sapidus* was a non-native species in Europe and was invasive (85% and 81%, respectively) (Fig. 2D-E). When people were asked about the appearance, color, and shape of the blue crab, opinions were similar (Fig. 2E). Regarding the overall appearance of the specimen, 65% of people found it rather attractive or attractive (corresponding of the median). The same trends apply to the color (50%) and shape (86%) of the specimen.

Of those questioned, 92% said they ate crustaceans (Fig. 3A), and 39% and 34% said they ate them 1–2 times/month and 1–2 times/year, respectively. The shellfish eaten came mainly from France (66%), frozen (41%), and caught locally in season (16%; Fig. 3B).

Fig. 1. (A) Number of responses per French administrative regions and (B) age distribution of people (n = 2040). The respondents' socio-professional categories are presented in Appendix 2.

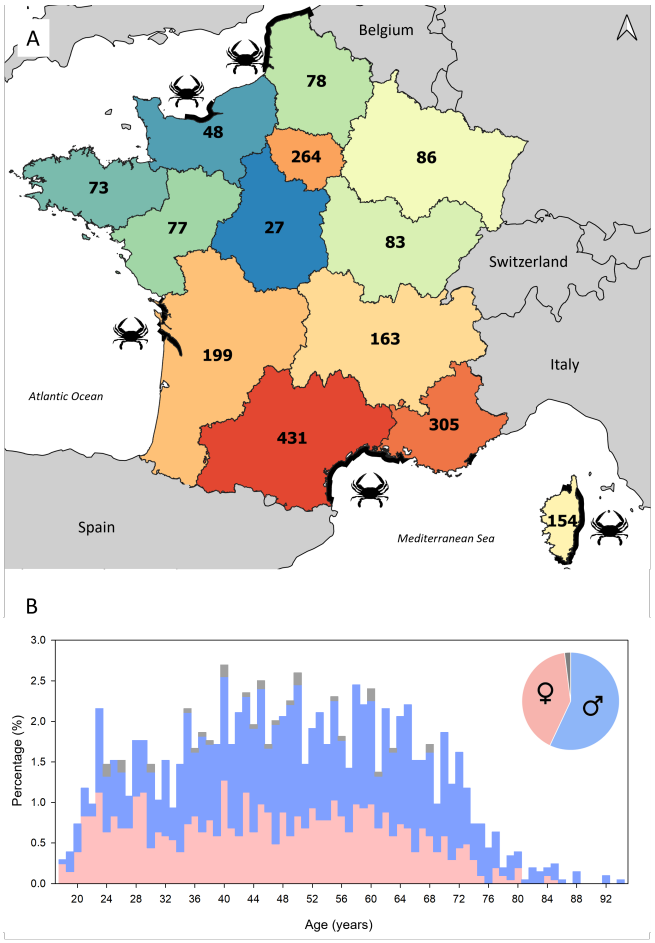
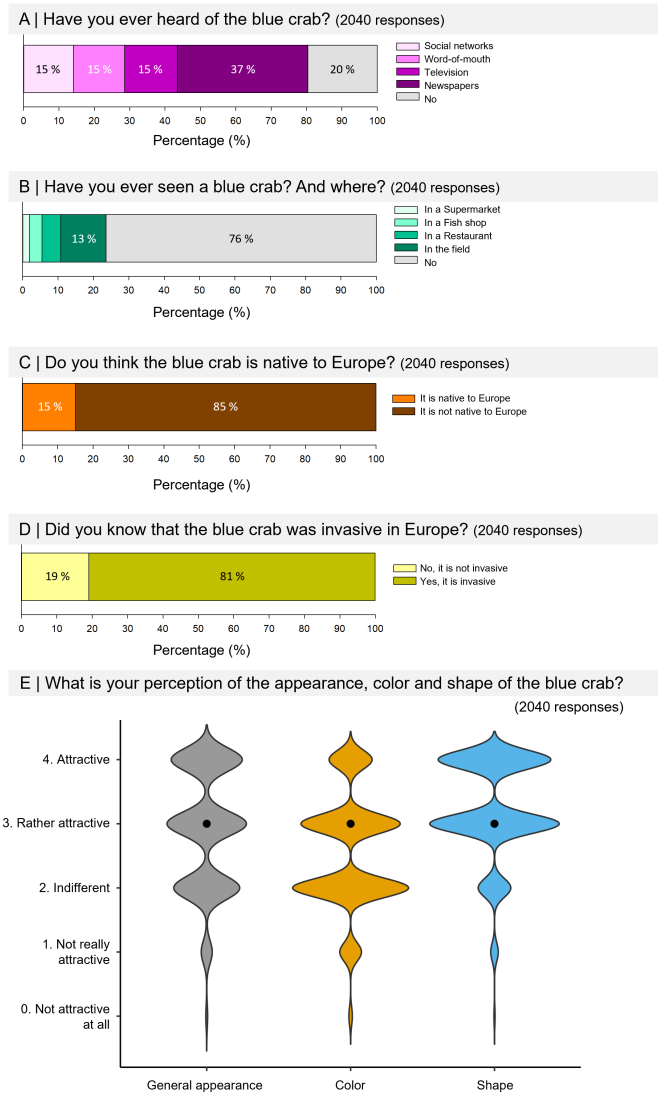


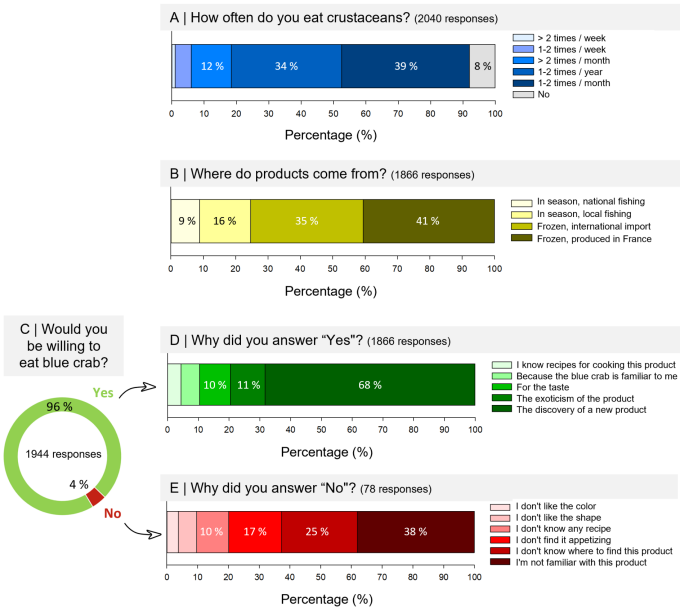
Fig. 2. People's perception and knowledge on the blue crab, *Callinectes sapidus*.



When French consumers were asked if they would eat blue crab, 96% responded positively (Fig. 3C). This choice was motivated by the "discovery of a new product" (68%), the "exoticism of the product" (11%) and for the "taste" (10%) (Fig. 3D). Of the 78 people who answered "no," the main reason was that they were unfamiliar with the product (38%) and did not know where to buy it (25%) (Fig. 3E).

People showed a strong interest in eating blue crab in restaurants, with over 78% of people indicating "probably yes" or "yes," and the greatest density of responses grouped between these two options (Fig. 4A). On the other hand, people were divided on the question of whether to buy blue crab from a fish store (raw product) or a supermarket (cooked or processed) (Fig. 4A). Most people answered "probably yes" for fish store (42%) and supermarket (36%). When it comes to willingness to pay, opinions were relatively divided (Fig. 4B): in restaurants, 43% and 36% of people, respectively, would be

Fig. 3. People's perception of crustacean consumption in general, and willingness to eat blue crabs.



prepared to pay €15–€19 and €10–€14 for a dish. In fish stores and supermarkets, responses were divided between €6–€10/kg (40% and 33%) and €10–€14/kg (27% for both). Once the price questions had been completed, respondents were told that blue crab was highly prized in the United States and was considered an exceptional delicacy (Appendix 2). Respondents were then asked to indicate whether they would keep the same price as before, or whether they would increase or decrease their price estimate (Appendix 8). For the restaurant, fish store, and supermarket, 67% of respondents indicated that they were willing to pay the same price, whereas only 17%, 16%, and 9%, respectively, were willing to pay more.

Raising awareness of blue crab consumption was the last point raised in the questionnaire. Over 90% of people agreed that the general public should be made aware of blue crab consumption (Fig. 5A), and that this should be done through social networks (28%), television (17%), the press (15%), and chefs (15%) (Fig. 5B). For the people questioned, eating invasive blue crab is a civic behavior ("probably yes": 41%; "yes": 49%; Appendix 3A), fishing and eating blue crab would help limit its impact on the environment ("probably yes": 37%; "yes": 54%; Appendix 3B), and eating blue crab instead of other crustaceans would also help ("probably yes": 46%; "yes": 30%; Appendix 3C). Finally, knowing that blue crab is invasive, fishing it to limit its impact on the environment is an additional motivation for 90% of people to buy and eat it (Appendix 3D).

The DAG in Figure 6 shows the Bayesian network based on respondents' opinions. The crab's appearance (shape, color, and overall appearance) had no effect on consumers' opinions; these three nodes were not connected with the others that implied conditional independence. Our DAG results show that people's opinions on willingness to pay (prices at restaurants, fish shops, and supermarkets) were influenced by their willingness to protect the environment. In other words, there is a correlation between

Fig. 4. People's perception of the place where they are able to buy blue crabs for consumption (on the top) and how much they are able to pay (on the bottom).

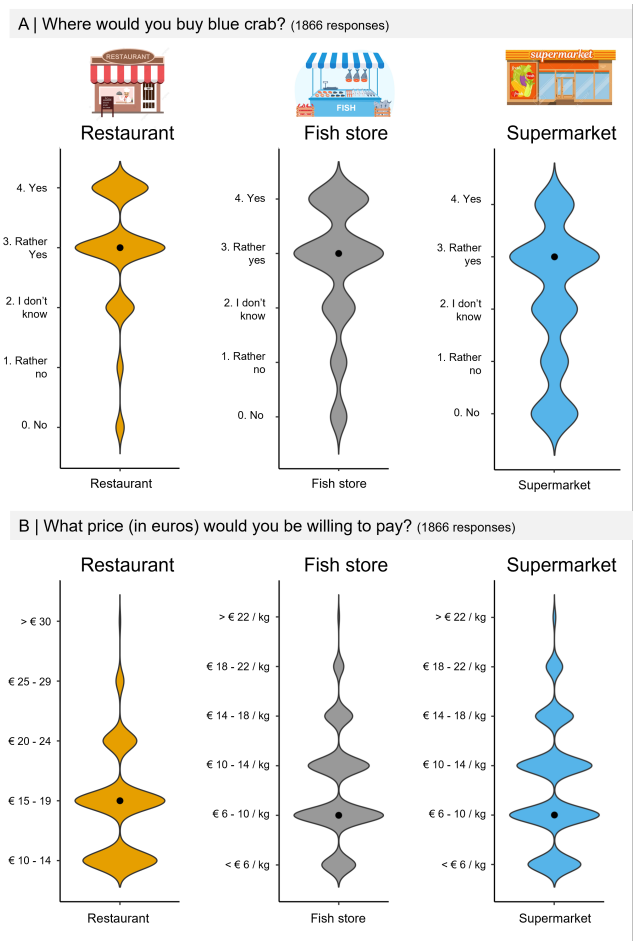
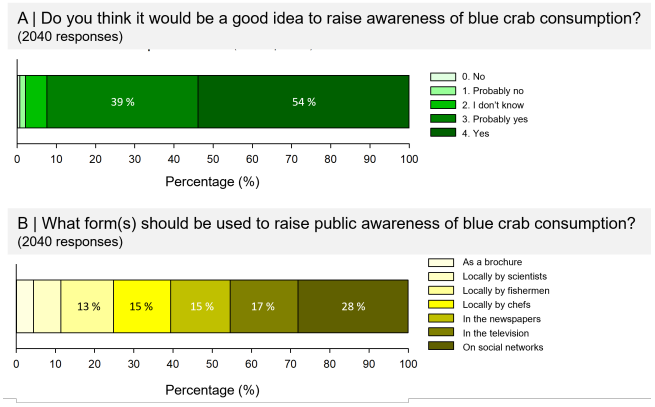


Fig. 5. (A) People's opinion on raising public awareness of blue crab consumption in France, and (B) people's opinion on the most suitable form for raising public awareness of blue crab consumption.

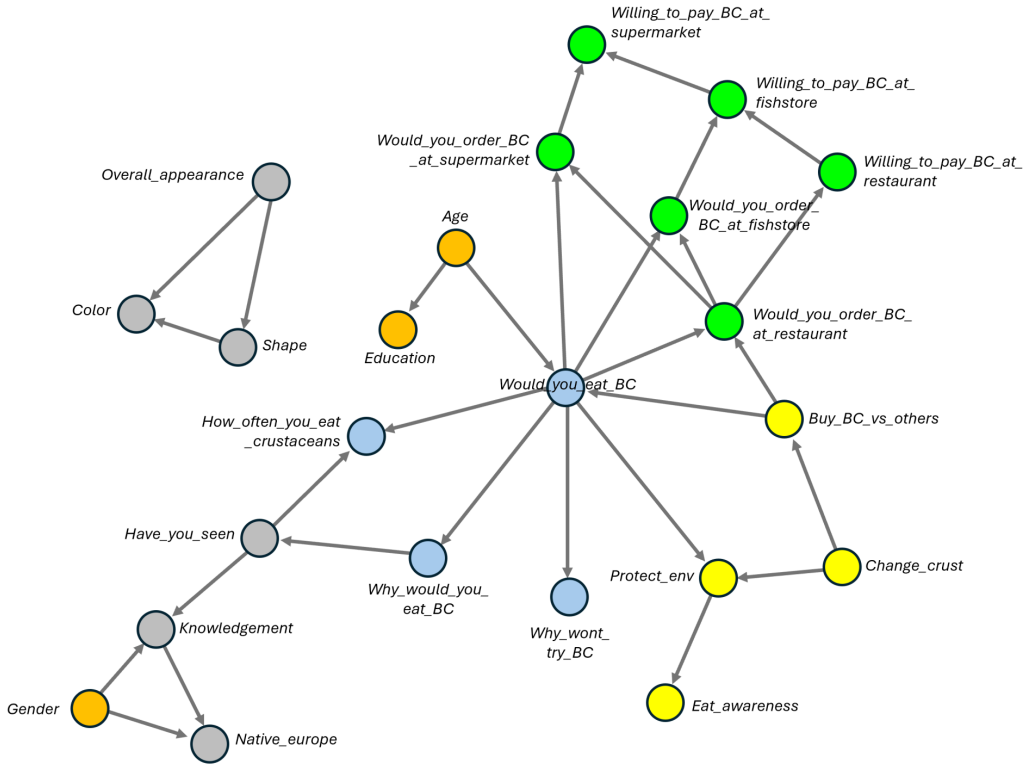


willingness to pay for blue crab, willingness to protect the environment, and the age of respondents (see Appendices 4–6). Indeed, the conditional probability table (CPT) revealed that young (< 30 years old) and middle (30–45 years old) adults with a willingness to contribute to environmental protection were more likely to spend more in restaurants to consume blue crabs (see Appendix 4). Willingness-to-pay CPTs in fish store and supermarket showed similar patterns (Appendices 5, 6).

DISCUSSION

The BlueConso public survey showed that the blue crab *Callinectes sapidus* has the potential to be accepted by French crustacean consumers and provided useful information on the acceptability of blue crab to French shellfish consumers. French crustacean consumers showed an interest in consuming the invasive blue crab *C. sapidus* as a means of species control. Overall, the specimen itself (appearance, color, shape) was perceived favorably by respondents, and most consumers surveyed would buy this species if it were available on the market even if the majority were able to buy blue crab in restaurant or in fish market. Respondents also indicated a purchase price for blue crab consistent with French market prices. Regarding the fish store (fresh crustaceans) and the supermarket (frozen and/or cooked crustaceans), the French were willing to pay between €6 and €15/kg, which was equivalent to the average price of lobsters (€9.5–€15.5/kg in 2017 [FranceAgriMer 2023]), grey shrimps and prawns (€12.4–€13.64/kg [FranceAgriMer 2023]), spider crabs (€10.50/kg [FranceAgriMer 2023]), and crayfish (€15/kg [FranceAgriMer 2023]). This confirms our original hypothesis that the average selling price of blue crab was accurately estimated by French crustacean consumers, who are well aware of market prices, although this preference may be linked to sociodemographic factors (such as age, education, income) (Myrland et al. 2000, Cardoso et al. 2016, Cerveira et al. 2022). Our panel of respondents, made up of a diverse socio-demographic group, showed that younger people are the most inclined to eat blue crab to protect the environment. Regarding consumption at restaurants, 43% of French people were willing to pay €15–19 per dish and 36% were willing to pay €10–€14 per dish. There is no scientific study or governmental survey on the official prices of crustaceans in restaurants, but we have extracted some prices from menus available in the Michelin guide: €17 per dish for half a lobster (Restaurant *Le Gallion*, Grau du Roi, South France) to €11 per 100 g of blue lobster and €21 per dish for shrimp (Restaurant *Le Bocal*, Reims, North France). In Corsica, the price of blue crab soup is €16.5 for 570 g (*O' ma Gourmandise*). French restaurants saw crustaceans making up 96% of the dishes consumed (FranceAgriMer 2018) in 2017 in France, and crustaceans accounted for 9240 tons valued at €157 million (FranceAgriMer 2018). Raw shrimp and prawns represented the most consumed species, accounting for 49.3% of the volume and 41.4% of the total value of these purchases. Lobster followed next (22% of the volume), followed by raw langoustines (16.6%) and other raw crustaceans (12.1%). The overall positive opinion on the characteristics of blue crab and their estimated price, consistent with the French crustacean market, suggest that blue crab could easily become part of the French culinary habits. Also,

Fig. 6. Directed Acyclic Graph (DAG) of the Bayesian network selected by hill climbing with BIC and 300 perturbation and 50 restarts. Descriptive statistics and name correspondences with questions are available in the Appendix 7. The colors represent the nodes.



because in our study more than 50% of people said they eat locally and seasonal seafood, it suggests that the French "eat local" habit would facilitate the inclusion of locally caught blue crab.

The BlueConso survey showed that French shellfish consumers were ready to include invasive blue crabs on their plates, indicating that eating blue crab was for them a civic gesture and a way of protecting the environment, mainly for young people. But the blue crab is still not widely known. That is why awareness-raising events will draw the media's attention to the ecology of invasive species (Nuñez et al. 2012), describe their impacts and promote their use as new delicacies to reduce their impact on native species, and increase the income of local fishermen. It is through social networks, television, the press, and chefs that awareness can be raised to the French people. The media's interest in invasive species is particularly strong and could therefore help to raise awareness of the blue crab and increase its consumption, as has been done with weakfish *Cynoscion regalis* in Portugal, for example (Cerveira et al. 2022). What is more, a recent study showed that chefs were at the heart of the adoption of invasive species as food, given their position at the juncture of changing cultural views on food, its origin, consumption, and environmental impact (Nuñez et al. 2012, Seaman et al. 2022). Local chefs and food groups have been instrumental in raising awareness of edible invasive species, but only after they have learned about the use of invasive species through harvesting programs (Linh 2022).

Eradication of aquatic invasive species has proven difficult when invasive species are not confined to small enclosed areas (Simberloff 2014) but effective in enclosed areas. Fishing is known to be one of the most effective means of controlling and reducing commercially valuable aquatic invasive species (Weidel et al. 2007, Wittmann et al. 2012, Holbrook et al. 2016, Závorka et al. 2018, Talbot et al. 2019). In Sparkling Lake in the United States, intensive fishing for the invasive rusty crayfish *Orconectes rusticus* (Girard, 1852) caused a 99% reduction in population size in eight years (2001–2008), and the population never increased after such a fishing effort (Hansen et al. 2013). This was also the case for Asian carp in the Mississippi and Ohio basins, where commercial fishing reduced the population size in only three years, which remained low in subsequent years (Love et al. 2018). However, in some cases, populations can recover from overfishing once removal rates decline, as has been predicted for invasive populations of the common lionfish *Pterois miles* (Bennett, 1828; Barbour et al. 2011). For this reason, the implementation of continuous, non-targeted fishing (fishing of all life stages) is advocated, and this method could be effective in semi-enclosed lagoons for the blue crab in France.

Eradication of the blue crab could be less practicable given its wide distribution in the Mediterranean across various habitats (e.g., lagoons, estuaries, saltmarshes, etc.). Consequently, if numerical eradication is unfeasible, functional reduction (i.e., reducing population size below levels that cause deleterious ecological effects in high-priority locations; Green and Grosholz 2021) seems to be the ideal approach. To make an invasive species population reduction effective, it is necessary to (1) acquire fundamental scientific knowledge of the species' biological traits and ecology, so as to be able to estimate at a later stage the trait performance at varying level of environmental factors (e.g., temperature, salinity, etc.), and biotic interactions in order to estimate how many individuals need to be

removed from an ecosystem to maintain ecosystem health and ecological integrity (Green and Grosholz 2021); (2) establish a dialogue with natural resource managers and practitioners and with conservation experts while gathering scientific data; (3) engage with fishermen, restaurateurs, and the general public to raise awareness of invasive species, with an emphasis on edible species; (4) maintain investment in a participatory science program to ensure constant, ongoing monitoring of species population density across invaded habitats; and (5) compile and integrate all collected and available biological, ecological, social, cultural, and economic data through complete, free, and open access data science platforms to increase our ability to holistically manage IAS invasive trajectories at larger than local scales by implementing tailored-dynamic management and conservation measures (Sarà et al. 2018, Mangano et al. 2020).

Nevertheless, there are various risks involved in adopting any program to control populations. It can be difficult to remove enough individuals to reduce population density, and there is a risk of harming native species by accidentally capturing non-target individuals (Pasko and Goldberg 2014). In the United States, efforts to completely remove adult invasive European green crabs *Carcinus maenas* were counterproductive because they released predation pressure on juveniles, pointing out just how difficult eradication can be (Grosholz and Ruiz 1995, 1996). Species control programs can also lead to unexpected ecological consequences, such as changes in the structure of the food web. For example, this may promote biological overcompensation or create new ecological niches for other species (Zavaleta et al. 2001, Zipkin et al. 2009). Therefore, it is essential to investigate first the biological trait's performances and the ecological features of the invasive species in native versus invaded habitats and the interaction with native species in the potential recipients before implementing a plan to control IAS populations. Among others, to concentrate scientific efforts in investigating the environmental tolerance of IAS with and without local interactive species can make more complete the ecological frame to design invasion's measures as well as determine which life stages of the species are most likely to be affected by harvesting (Cerveira et al. 2022, Seaman et al. 2022).

Eradication, then, is certainly one way to control local populations, but there is another side of the coin in that the creation of a profitable fishery may deter the eradication of the target species (Nuñez et al. 2012). This is particularly true if the costs associated with fishing the target invasive species become excessive compared to the native species, which can lead to the protection of the target invasive species to the detriment of native species (Lambertucci and Speziale 2011), as observed, for example, with the introduced giant river prawn *Macrobrachium rosenbergii* in Brazil (Marques et al. 2016, de Oliveira et al. 2023). Thus, an essential prerequisite is increasing stakeholder's awareness of: (1) the negative effects of invasive species, (2) the legal prohibition on introducing non-native species and the breeding of invasive species, and (3) how economic benefits generated by invasive species are secondary to reducing long-term costs associated with controlling the population of the invasive species and mitigating its impacts on native species and ecosystems (Lambertucci and Speziale 2011, Varble and Secchi 2013). In other words, the objective of an action plan to fight against invasive species would not be to perpetuate a viable fishery, but rather to significantly reduce the population of the invasive species (Nuñez et al. 2012), and given the open and connected nature of marine environment such a strategy should be contextually implemented by all countries adjacent to the same sea, such as in the Mediterranean where EU and not-EU countries share the same halieutic resources. Another point to assess is that *C. sapidus* is known to accumulate heavy metals (Sastre et al. 1999, Çoğun et al. 2017, Annabi et al. 2018) and further studies on this aspect are therefore needed to avoid adverse effects on human health.

CONCLUSION

Our large survey of the general public showed that the French people were keen to include blue crab in their diet. Moreover, this study was eagerly awaited by the French government and decision makers to find out what people think of blue crab consumption. The French government wants to set up a blue crab resource utilization action plan as a population control measure and as a means of compensating fishermen for economic losses. The worrying increase in *C. sapidus* populations on the French coast since 2020 has led the French government to create a French Mediterranean working group, managed by the Corsican Environment Agency (OEC) and the Corsican DREAL (Regional Department for the Environment, Planning and Housing, Ministry decentralized state service in the regions), involving stakeholders from different institutions (Ministry of Ecological Transition, government departments, universities, public establishments, fishermen, etc.) to define a strategy to deal with the expansion of this species to (1) preserve coastal ecosystems and the traditional trades associated with them, (2) prioritize the means/studies to be undertaken in the short and medium term, and (3) to validate an action plan to combat *C. sapidus* in line with the results of the various studies carried out on this species.

Removing the species from the environment through targeted fishing seemed to be the most favorable action. This pressure exerted by strategic fishing needs to be further improved in terms of the choice of periods and the individuals preferentially targeted (e.g., large male individuals during the spring period and gravid females at the end of summer and beginning of autumn). Strategic fisheries will be subject to consultation with managers and owners of natural sites. These fisheries will essentially be carried out by professional fishermen and will be subject to scientific monitoring. The use of the resource has been envisaged by setting up a short circuit (fishermen/restaurants) and on a regional scale only. The results obtained in our study will therefore be used to help French policy-makers implement the marketing of invasive blue crabs as a means of controlling the species. In particular, our study showed that younger people were willing to buy and consume blue crabs as a means of protecting the environment, and we therefore suggest that decision makers raise awareness of invasive blue crab consumption among this age group. Finally, our study conducted on a very large panel of respondents represents an example in the collection of public perceptions on consumer spending. So the French are ready to welcome the invasive blue crab onto their plates. This study could be carried out in other European countries and could contribute to political decisions on blue crab management.

Author Contributions:

Conceptualization, G.M.; methodology, G.M. and A.A; software, G.M. and A.A; validation, G.M., B.S., M.G., A.A. and G.S.; formal analysis, G.M., B.S., M.G., A.A. and G.S.; investigation, G.M., B.S., M.G., A.A. and G.S.; resources, G.M.; data curation, G.M., B.S. and A.A; writing—original draft preparation, G.M.; writing—review and editing, G.M., B.S., M.G., A.A. and G.S.; visualization, G.M. and A.A; supervision, G.S.; project administration, G.M., G.S.; funding acquisition, G.S. All authors have read and agreed to the published version of the manuscript.

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Data Availability:

The data and code that support the findings of this study are available on request from the corresponding author, G.M. Ethical approval for this research study was granted by University of Palermo ethical number: D.R. n. 3267.

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Appendix 1. Survey questionnaire performed to collect the people's perceptions on blue crab consumption in France.

People perception on blue crab consumption

Section 1 : Your individual information

1. **To begin, we need some information about you** *(The data collected are anonymous and did not allow you to be identified.)*

- **Your gender** *(select one response)*:
  - Female
  - Male
  - I do not wish to specify
- **Your age** : _____ years old
- **Your city of residence** : _____
- **Your level of education** *(select one response)*:
  - Middle-school
  - High school
  - University - Bachelor
  - University - Master
  - University - PhD
- **Your curent job** : _____

Section 2 : Your blue crab knowledge

Here are a few photos of the blue crab Callinectes sapidus :

2.1 **Have you ever heard of the blue crab?** *(select one or more response(s))*

- Yes, via the press (newspapers)
- Yes, via television
- Yes, via social networks (Facebook, Twitter, Instagram, etc.)
- Yes, by word-of-mouth
- No

2.2 Have you ever seen the blue crab? *(select one or more response(s))*

- Yes, in France
- Yes, abroad
- No

If you answered "Yes", where exactly did you see it ? *(select one or more response(s))*

- In a restaurant
- In a fish store
- In a supermarket
- In nature
- I answered "No" to the previous question

Section 3 : Your blue crab personal consumption

3.1 Do you eat crustaceans (all species)? *(select one response)*

- Yes
- No

If "Yes", how often do you eat crustaceans? *(select one response)*

- 1-2 times a week
- More than 2 times a week
- 1-2 times a month
- More than 2 times a month
- 1-2 times a year
- I answered "No"

3.2 Do you prefer crustaceans... *(select one or more response(s))*

- In season, caught locally (within 50 km of your home)
- In season, imported or caught nationally (Mediterranean, Atlantic, Channel)
- Frozen, produced in France
- Frozen, imported (international origin)
- I answered "NO", I don't eat/purchase crustaceans.

3.3 Would you eat blue crab? *(select one response)*

- Yes
- No

For what reason(s) did you answer "Yes" ? *(select one or more response(s))*

- For the taste (if you have already tried it)
- For the discovery of a new product
- For the exoticism (new species)
- Because I am already familiar with blue crab
- I know recipes for cooking blue crab
- I answered "No" to the previous question

For what reason(s) did you answer "No" ? *(select one or more response(s))*

- I don't find it appetizing/attractive
- I don't like the shape
- I don't like the color
- I'm not familiar with the blue crab
- I don't know recipes for cooking blue crab
- I don't know where to find this product
- Because I don't eat crustaceans
- I answered "Yes" to the previous question

Section 4 : Where would you like to buy blue crab and at what price?

4.1. If blue crab was on a RESTAURANT menu, would you order it? *(select one response)*

- 0. Not at all
- 1. Probably no
- 2. I don't know
- 3. Probably yes
- 4. Definitively yes

... and how much would you be willing to pay for the dish? *(select one response)*

- 10-14 euros
- 15-19 euros
- 20-24 euros
- 25-29 euros
- More than 30 euros

2.3 In your opinion, is the blue crab native to Europe ? *(select one response)*

- Yes, it is **native** to Europe
- No, it is **not native** to Europe

2.4 **Let's talk aesthetics...** *Take a close look at the blue crabs photos below.*

How do you like the overall appearance of the blue crab? *(select one response)*

- 0. Not at all attractive
- 1. Probably not attractive
- 2. Indifferent
- 3. Probably attractive
- 4. Attractive

Concerning the shape of the blue crab... *(select one response)*

- 0. Not at all attractive
- 1. Probably not attractive
- 2. Indifferent
- 3. Probably attractive
- 4. Attractive

Concerning the color of the blue crab... *(select one response)*

- 0. Not at all attractive
- 1. Probably not attractive
- 2. Indifferent
- 3. Probably attractive
- 4. Attractive

- I answered "Not at all" to the previous question

4.2. If blue crab was available in a FISH STORE, would you be willing to buy and cook it? *(select one response)*

- 0. Not at all
- 1. Probably no
- 2. I don't know
- 3. Probably yes
- 4. Definitively yes

... and how much would you be willing to pay for 1 kg of blue crab? *(select one response)*

- Less than 6 euros / kg
- 6-9 euros / kg
- 10-13 euros / kg
- 14-17 euros / kg
- 18-21 euros / kg
- More than 22 euros / kg
- I answered "Not at all" to the previous question

4.3. If blue crab was available in a SUPERMARKET already cooked or processed, would you buy it? (*select one response)*

- 0. Not at all
- 1. Probably no
- 2. I don't know
- 3. Probably yes
- 4. Definitively yes

... and how much would you be willing to pay for 1 kg of blue crab? *(select one response)*

- Less than 6 euros / kg
- 6-9 euros / kg
- 10-13 euros / kg
- 14-17 euros / kg
- 18-21 euros / kg
- More than 22 euros / kg
- I answered "Not at all" to the previous question

Did you know? Blue crab is highly prized in the United States. The quality and delicacy of its meat has been estimated to be somewhere between that of edible crab and spider crab - in other words, a quality delicacy.

4.4. Knowing this, would you change your price for :

- **Blue crab at RESTAURANT** *(select one reponse)*
  - I'd pay more than what I've already indicated
  - I'd keep the same price as before
  - I would pay less than what I previously indicated
  - I don't know
- **Blue crab at FISH STORE** *(select one reponse)*
  - I'd pay more than what I've already indicated
  - I'd keep the same price as before
  - I would pay less than what I previously indicated
  - I don't know
- **Blue crab at SUPERMARKET (cooked or processed)** *(select one reponse)*
  - I'd pay more than what I've already indicated
  - I'd keep the same price as before
  - I would pay less than what I previously indicated
  - I don't know

Section 5 : Your perception of blue crab problems and you engagement

5.1. Are you aware that blue crab is an invasive species in Europe? *(select one response)*

- Yes
- No

5.2. The blue crab is currently very abundant and invasive on French coasts and lagoons.

Do you think that eating blue crab rather than other, more endangered crustaceans (lobster, edible crab, lobster, etc.) would be a good thing to do? *(select one response)*

- 0. Not at all
- 1. Probably no
- 2. I don't know
- 3. Probably yes
- 4. Definitively yes

5.3. Would you buy blue crab instead of other shellfish you usually buy? *(select one response)*

- 0. Not at all
- 1. Probably no
- 2. I don't know
- 3. Probably yes
- 4. Definitively yes

5.4. Do you agree with the following statement: "The blue crab fishery would help limit the impact of blue crab on the environment"? *(select one response)*

- 0. Not at all
- 1. Probably no
- 2. I don't know
- 3. Probably yes
- 4. Definitively yes

If you answered "YES", do you think this is an added incentive to buy and eat blue crab? *(select one response)*

- Not at all
- 1. Probably no
- 2. I don't know
- 3. Probably yes
- 4. Definitively yes
- I answered "No" to the previous question

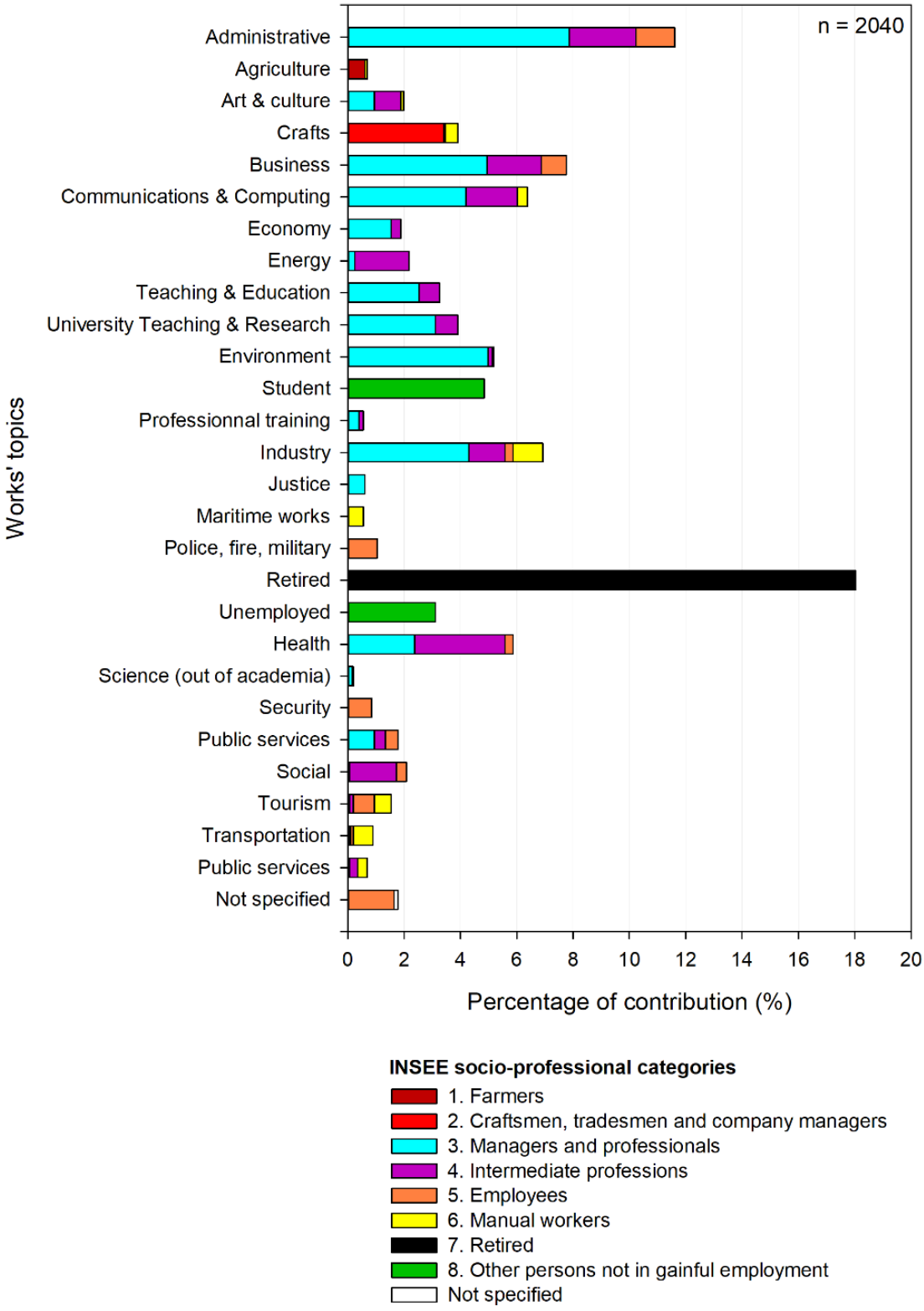
5.6 From the perspective of protecting biodiversity, do you think it would be appropriate to raise awareness about eating blue crab? *(select one response)*

- 0. Not at all
- 1. Probably no
- 2. I don't know
- 3. Probably yes
- 4. Definitively yes

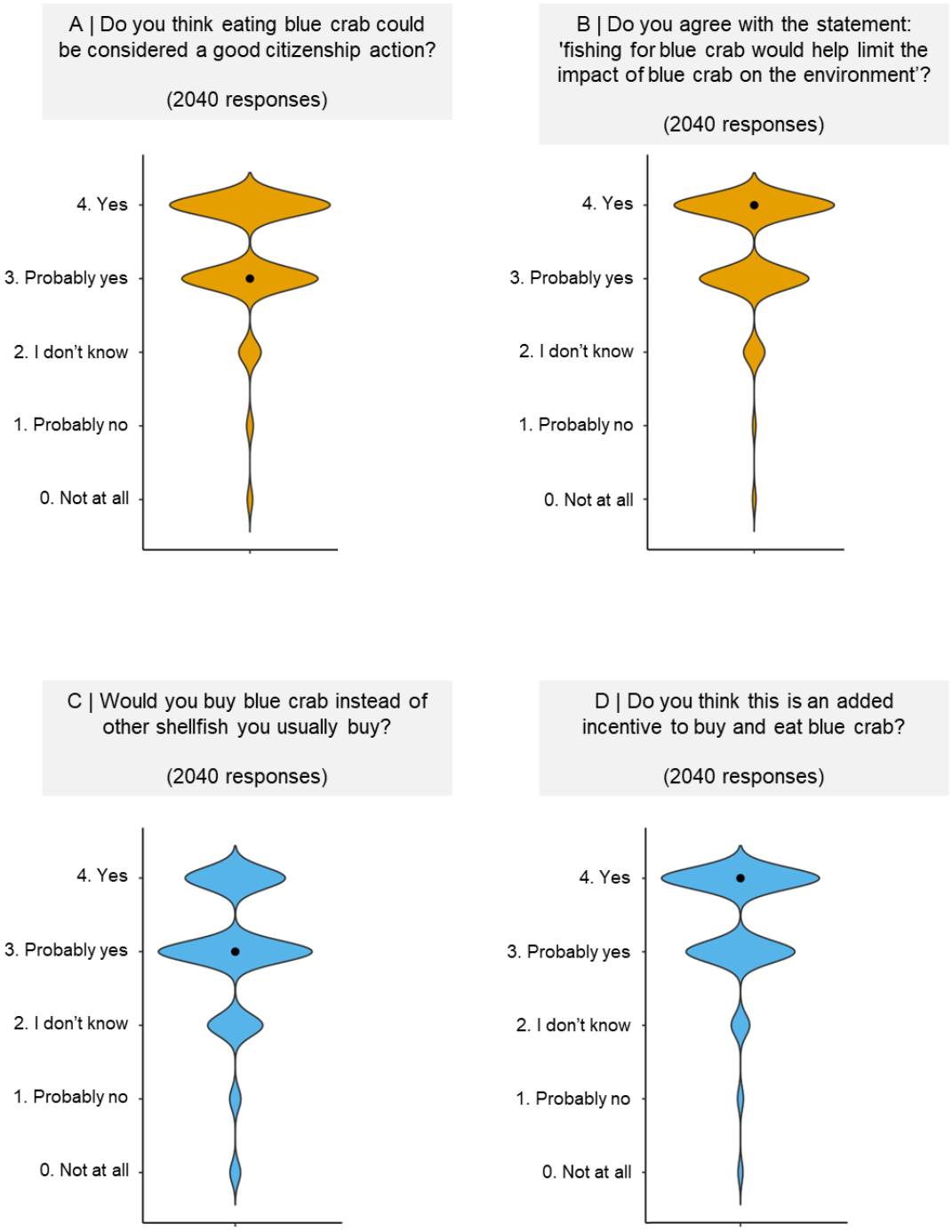
5.7. In what form(s) should the general public be made aware of blue crab consumption? *(select one or more response(s))*

- On social networks (Facebook, Twitter, Instagram, etc.)
- In newspapers
- On television
- In brochure form
- Locally by fishermen
- Locally by scientists
- Locally by chefs of restaurants
- I answered "No" to the previous question

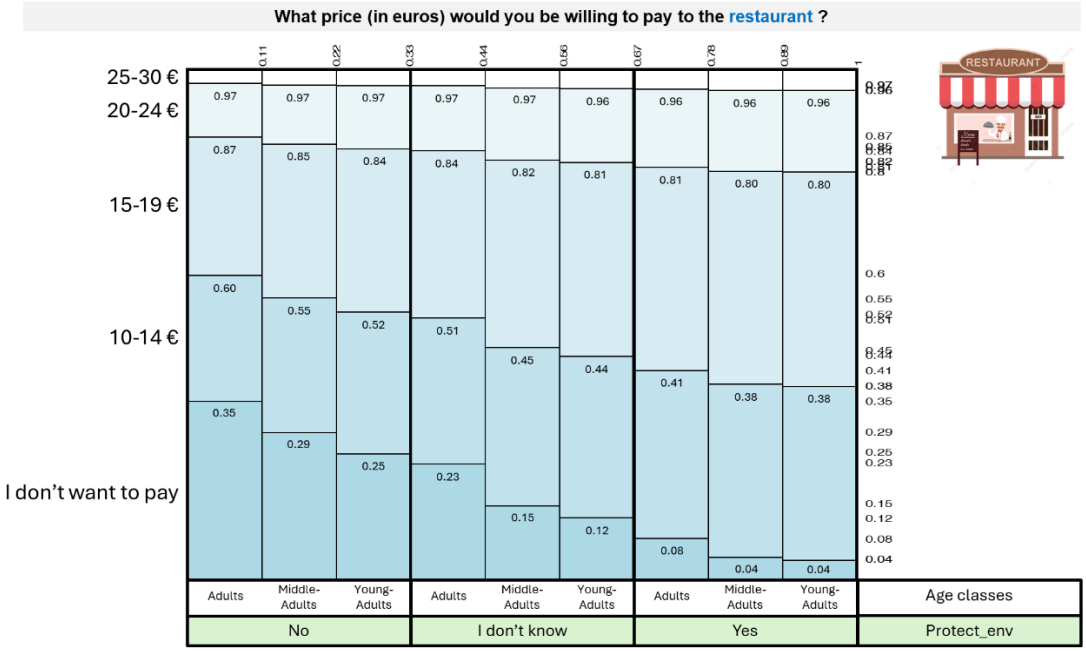
Appendix 2. Respondents' socio-professional categories based on their job position and determined based on the official national criteria from the INSEE (French National Institute for Statistics and Economic Studies).



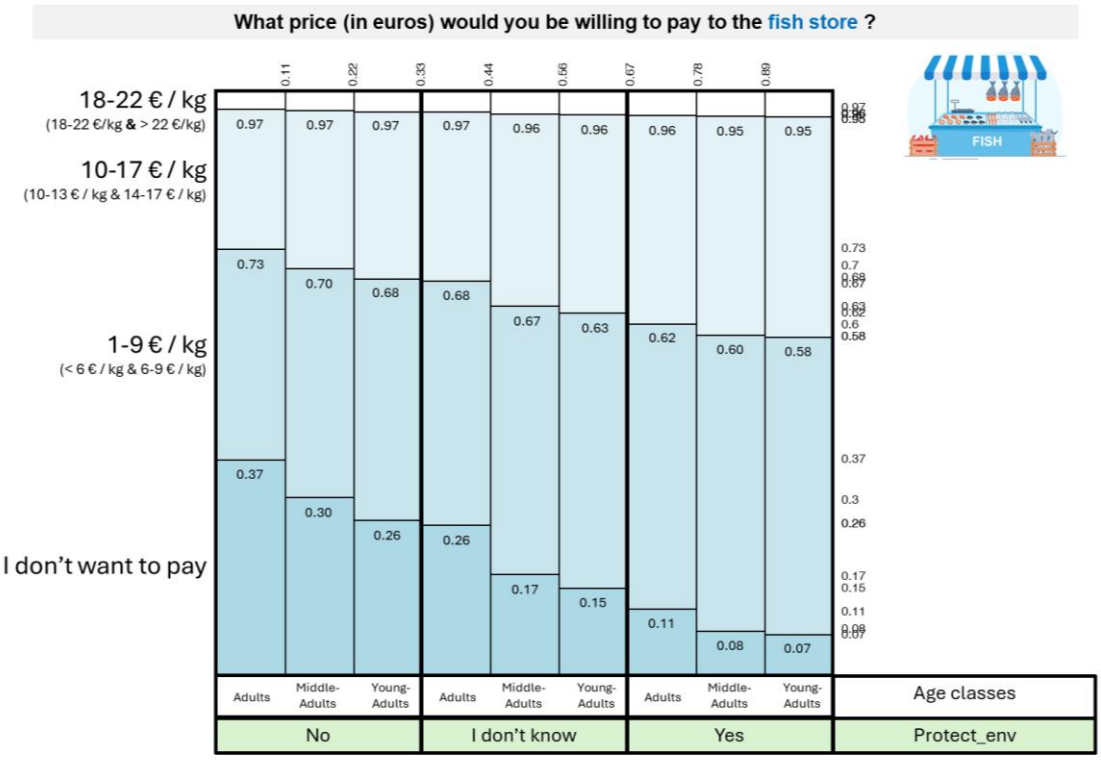
Appendix 3. People's perceptions on the blue crab consumption as citizen and ecological actions.



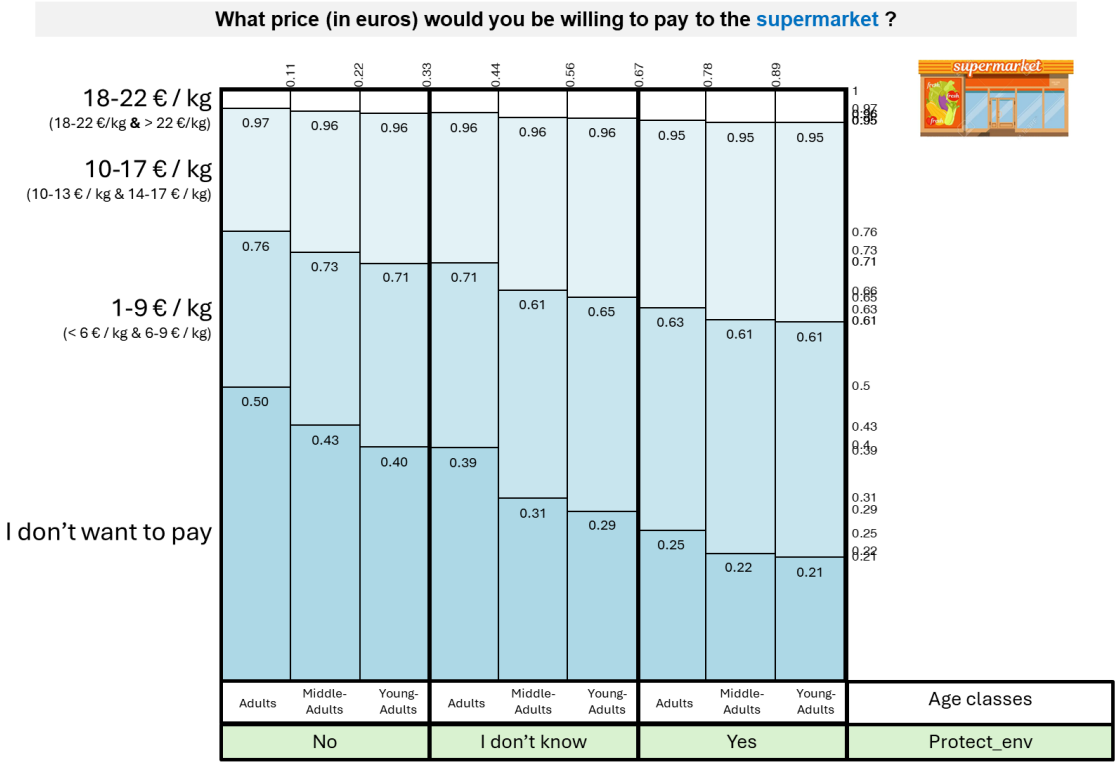
Appendix 4. Conditional probability of "*Willing to pay blue crabs at the restaurant"* (Question 4.1 of the questionnaire) with *Age* and *Protect_env* (Question 5.4 of the questionnaire : "*Do you agree with the following statement: "The blue crab fishery would help limit the impact of blue crab on the environment ?"*). In the graph, "*No*" includes the replies "*0. Not at all*" and "*1. Probably no*", and "*Yes*" includes the replies "*3. Probably yes"* and "*4. Definitively yes".* Ages classes correspond to Adults : > 45 years-old; Middles-Adults : 30-45 years-old; Young-Adults : < 30 years-old.



Appendix 5. Conditional probability table of *Willing_to_pay_BC_at_fisherstore* (Question 4.2. of the questionnaire: "*If blue crab was available in a FISH STORE, would you be willing to buy and cook it*?") with *Age* and *Protect_env* (Question 5.4 of the questionnaire: "*Do you agree with the following statement: "The blue crab fishery would help limit the impact of blue crab on the environment ?"*). In the graph, "*No*" includes the replies "*0. Not at all*" and "*1. Probably no*", and "*Yes*" includes the replies "*3. Probably yes"* and "*4. Definitively yes".* Ages classes correspond to Adults : Ages classes correspond to Adults : > 45 years-old; Middles-Adults : 30-45 years-old; Young-Adults : < 30 years-old.



Appendix 6. Conditional probability table of *Willing_to_pay_BC_at_supermarket* (Question 4.3. of the questionnaire: "*If blue crab was available in a SUPERMARKET already cooked or processed, would you buy it?"*) with *Age* and *Protect_env* (Question 5.4 of the questionnaire : "*Do you agree with the following statement: "The blue crab fishery would help limit the impact of blue crab on the environment ?"*). In the graph, "*No*" includes the replies "*0. Not at all*" and "*1. Probably no*", and "*Yes*" includes the replies "*3. Probably yes"* and "*4. Definitively yes".* Ages classes correspond to Adults : > 45 years-old; Middles-Adults : 30-45 years-old; Young-Adults : < 30 years-old.



Appendix 7. Descriptive statistics used for the Bayesian Network analysis, only on crustaceans consumers. Note that the variable "Age" has been categorize into three categories (Adults : > 45 years-old; Middles-Adults : 30-45 years-old; Young-Adults : < 30 years-old), and some item category has been aggregated. The former operation allows to use Bayesian network for discrete variable, while the second one reduces the curse of high dimensionality making our inferential results more reliable.

label	variable	value
Gender	Female	41.81 %
	Male	58.19 %
Age	Adults	14.65 %
	Middle-Adults	26.36 %
	Young-Adults	59.00 %
Education	Middle-school	5.32 %
	High school	19.51%
	Bachelor	30.71 %
	Master	34.06 %
	PhD	10.39 %
"Knowledgement" : Question 2.1. Have you ever heard of the blue crab?	No	24.99 %
	Yes	75.01 %
"Seen" Question 2.2. Have you ever seen the blue crab?	No	79.37 %
	Yes	20.63 %
"Native_Europe" Question 2.3. In your opinion, is the blue crab native to Europe ?	No	84.64 %
	Yes	15.36 %
"Overall_Appearance" Question 2.4. How do you like the overall appearance of the blue crab?	No	5.52 %
	Don't know	28.89 %
	Yes	65.59 %
"Shape" Question 2.4. Concerning the shape of the blue crab…	No	8.92 %
	Don't know	41.05 %
	Yes	50.03 %
"Color" Question 2.4. Concerning the color of the blue crab…	No	2.99 %
	Don't know	11.66 %
	Yes	85.35 %
"How_often_you_eat_crustaceans" Question 3.1. Do you eat crustaceans (all species)?	Never	8.41 %
	Rarely	33.50 %
	Monthly	52.10 %
	Weekly	5.98 %
"Would_you_eat_BC" Question 3.3 Would you eat blue crab?	Yes	92.09 %
	No	7.91 %
"Why_would_you_Eat_BC" Question 3.1. For what reason(s) did you answer "Yes" ?	Because I am already familiar with blue crab	1.12 %
	For the discovery of a new product	76.48 %
	For the exoticism	0.56 %
	For the taste	12.72 %
	I know recipes for cooking blue crab	1.12 %
	No	8.01 %
"Why_wont_try_BC" Question 3.1. For what reason(s) did you answer "No" ?	Because I don't eat crustaceans	2.48 %
	I answered I would	90.83 %
	I don't find it appetizing/attractive	1.82 %
	I don't know recipes for cooking blue crab	0.41 %
	I don't know where to find this product	1.52 %
	I don't like the color	0.05 %
	I don't like the shape	0.10 %
	I'm not familiar with the blue crab	2.79 %
Would_you_order_BC_at_restaurant Question 4.1.If blue crab was on a RESTAURANT menu, would you order it?	No	7.91 %
	Don' t know	14.39 %
	Yes	77.70 %

label	variable	value
Willing_to_pay_BC_at_restaurant Question 4.1. … and how much would you be willing to pay for the dish?	0	5.78 %
	10-14 euros	33.55 %
	15-19 euros	41.05 %
	20-24 euros	15.66 %
	25-30 euros	3.95 %
Would_you_buy_BC_at_fisherstor Question 4.2. If blue crab was available in a FISH STORE, would you be willing to buy and cook it?	No	15.15 %
	Don' t know	15.00 %
	Yes	69.84 %
Willingness_to_pay_BC_at_fishertore Question 4.2. … and how much would you be willing to pay for the blue crab?	0	9.02 %
	1-9 euros/kg	50.03 %
	10-17 euro/kg	36.54 %
	18-22 euro/kg	4.41 %
Would_you_buy_BC_at_supermarket Question 4.3. 4.3. If blue crab was available in a SUPERMARKET already cooked or processed, would you buy it?	No	30.71 %
	Don' t know	17.28 %
	Yes	52.00 %
Willingness_to_pay_BC_at_supermar ket Question 4.3. … and how much would you be willing to pay for the blue crab?	0	22.96 %
	1-9 euros/kg	39.03 %
	10-17 euro/kg	32.89 %
	18-22 euro/kg	5.12 %
Change_crust Question 4.4. Knowing this, would you change your price for Restaurant, Fish store, Supermarket	No	3.70 %
	Don' t know	6.54 %
	Yes	89.76 %
Buy_BC_vs_others Question 5.3. Would you buy blue crab instead of other shellfish you usually buy?	No	6.64 %
	Don' t know	16.52 %
	Yes	76.84 %
Protect_env Question 5.4. Do you agree with the following statement: "The blue crab fishery would help limit the impact of blue crab on the environment"?	No	2.33 %
	Don' t know	6.89 %
	Yes	90.78 %
Eat_awareness Question 5.6. From the perspective of protecting biodiversity, do you think it would be appropriate to raise awareness about eating blue crab?	No	2.08 %
	Don' t know	5.42 %
	Yes	92.50 %

Appendix 8. People perception on the modification of the price of the crab indicated knowing that blue crab was indicated as a prized dish in USA.

	I'm keeping the same price as indicated above	I don’t know	I would pay less than I indicated previously	I would pay more than I indicated previously
Restaurant	**68 %**	14 %	1 %	17 %
Fish store	**68 %**	15 %	1 %	16 %
Supermarket	**64 %**	23 %	3 %	10 %