Ocean and Coastal Management 214 (2021) 105915

Contents lists available at ScienceDirect

Ocean and Coastal Management

journal homepage: www.elsevier.com/locate/ocecoaman

Reducing Mediterranean Seafood Footprints: The role of consumer attitudes

Selen Altiok [a], Adeline Murthy [a], Katsunori Iha [a], Alessandro Galli [b,*]

[a] *Global Footprint Network, 1528 Webster Street, Suite 11, Oakland, CA, 94612, USA*
[b] *Global Footprint Network, Avenue Louis-Casaï, 18, 1209, Geneva, Switzerland*

ARTICLE INFO

Keywords:
Food consumption survey
Dietary habits
Consumer preferences
Seafood consumption
Sustainable consumption

ABSTRACT

Seafood is central to the diet of Mediterranean inhabitants. However, there is high consumer demand for certain species whose populations are rapidly declining in the Mediterranean Sea. Diversifying regional seafood preferences has the potential to reduce pressure on marine ecosystems while supporting local fishing economies. Here, we explored this opportunity through case studies in three Mediterranean countries: Croatia, Italy, and Turkey. First, we conducted an Ecological Footprint Analysis (EFA) to quantify the environmental impact of each country's food consumption choices. Then, we distributed a seafood consumer survey to understand each country's dietary preferences and residents' overall willingness to change their diets, with a specific focus on products from Small-Scale Fisheries (SSF). We found food consumption to be the primary Ecological Footprint driver in all three countries, with a contribution from the consumption of fish and seafood ranging from 6% (Turkey) to 11% (Italy) of each country's food Footprint. Results from the consumer survey showed that dietary preferences were unique to each culture. For example, consumers in Italy and Turkey were more willing to modify their diets than residents surveyed in Croatia. Across all three countries, consumers who are more aware of product labels, origin, and freshness of seafood products were more willing to purchase diverse seafood products. To diversify seafood consumption choices, particularly away from high trophic level species, consumer awareness campaigns should be tailored to meet the preferences of each unique culture in the Mediterranean. A broader Pan-Mediterranean study of culturally-unique consumer attitudes is warranted to accelerate progress towards sustainable seafood consumption in the region that benefits both biodiversity and local fishing economies.

1. Introduction

1.1. A changing mediterranean

The Mediterranean Sea is one of the most important sources of food security, livelihood, and culture for the approximately 500 million people who inhabit the region. Located at the intersection of Europe, Asia and Africa, the Mediterranean Basin is a biodiversity hotspot with high species endemism (Myers et al., 2000).

However, this region is experiencing rapid anthropogenic change due to its distinctive geographical location and topography, as well as its high population density and growing annual tourist inflows (Tovar-Sánchez et al., 2019; UNWTO, 2017). According to the IUCN (2020), 20% of the species in the Mediterranean Basin are currently threatened with extinction; meanwhile, recent work by regional scientists (MedECC, 2019), has found the Mediterranean region to be warming faster than the global average. This warming is characterized by increased frequency in the intensity and duration of heat waves, which will likely impact ecosystems and their productivity, resulting in an increase in food insecurity. Due to rising temperatures, for instance, the average maximum body weight of fish is expected to decrease by approximately 50% by 2050 (Cramer et al., 2018).

The Mediterranean Sea is also home to some of the most valuable fish species for consumption, including the endangered Atlantic bluefin tuna (*Thunnus thynnus*), European pilchard (*Sardina pilchardus*), gilthead seabream (*Sparus aurata*), swordfish (*Xiphias gladius*), and European anchovy (*Engraulis encrasicolus*) (Jeffries, 2017). Local fish species are important to the Mediterranean diet and the local economy, especially for small-scale and artisanal fishers. These, in turn, are especially relevant for the livelihood of local communities as there are currently almost 150,000 people employed by small-scale fisheries (SSF) in the Mediterranean, with 60% of the SSF fleet located in Greece, Italy, Tunisia, and Turkey (FAO, 2018). According to the GFCM (2021), SSF represent 83% of the fishing vessels and 57% of the fishing-based jobs in the

* Corresponding author.
E-mail address: alessandro.galli@footprintnetwork.org (A. Galli).

https://doi.org/10.1016/j.ocecoaman.2021.105915
Received 1 August 2020; Received in revised form 6 September 2021; Accepted 16 September 2021
Available online 9 October 2021
0964-5691/

Mediterranean, playing a unique and irreplaceable social, economic, and cultural role in the region.

According to Mantziaris et al. (2021), SSF are linked to a family-run fishing activity model and provide a higher societal value for ton of product caught than business-oriented large-scale fisheries (LSF) (see also, FAO, 2019). SSF contributes to livelihoods, food and nutrition security, and the well-being of coastal communities worldwide (CFS HLPE, 2014) and, in the Mediterranean region, they have been the backbone of local coastal economies for centuries, with historic links to cultural heritage and traditional values. According to several researchers (see for instance Johnson et al., 2018), the societal and cultural values of SSF are likely more important than what economic statistics would seem to indicate, as they go beyond the sole material (e.g., biological) aspects of wellbeing to embrace immaterial aspects such as identity, community, and the significance of place, although the links between fisheries and poverty alleviation are complex and still not fully understood (Bene et al., 2016).

Small-scale fisheries face several economic and ecological challenges, such as the high consumer demand for certain fish species, and rapidly decreasing fish stocks in the Mediterranean Sea (Tsikliras et al., 2015). However, as approximately 80% of the scientifically assessed stocks are fished beyond safe biological limits in the region (FAO, 2018), small-scale fisheries are seen by several authors and institutions as possibly representing an alternative solution for reducing pressure on fish stocks (Alfaro-Shigueto et al., 2010; Cohen et al., 2019; FAO, 2018; Johnson, 2006; Kittinger et al., 2013; Kolding et al., 2014). Nonetheless, full knowledge about the sustainability of SSF and their capacity to meet regional seafood demand is still lacking (Kolding et al., 2014) and major shifts in their management are likely needed (Purcell and Pomeroy, 2015; Shester and Micheli, 2011).

1.2. The role of food consumption and the scope of this study

An increasing number of studies are pointing to the way human societies produce, transform, distribute, consume, and waste food as key intervention areas to reverse ongoing unsustainable trends (Godfray and Garnett, 2014; Tilman and Clark, 2014; Willett et al., 2019). Indeed, fundamental changes in the way food, including seafood, is sourced and consumed are seen as indispensable for achieving the global Sustainable Development Goals (SDGs) (Galli et al., 2020a; Gephart, 2019; Smith et al., 2010).

According to Baabou et al. (2017) for instance, the Ecological Footprint of food consumption in the Mediterranean region is high compared to other consumption categories (housing, transport, goods, and services), meaning that current food choices by Mediterranean residents constitute one of the primary drivers of anthropogenic pressure (Galli et al., 2017). Among the food Mediterranean residents consume, fish and seafood represent an important part of the diet – given their high-quality nutritional value (Prato and Biandolino, 2015) – with 12 out of 21 Mediterranean countries listed among the top-100 per capita seafood consumers: according to Guillen et al. (2019), annual fish and seafood consumption ranges among Mediterranean residents from 4.2 kg per capita in Algeria to 46.3 kg per capita in Spain, with values for Turkey, Croatia and Italy amounting to 8.8, 21.3 and 28.2 kg per person, respectively (consumption averages being 25.7 and 22.3 kg per person at EU and World average level); moreover, according to Jeffries (2017), only about 36% of the fish and seafood Euro-Mediterranean countries consume comes, on average, from domestic sources.

Over the last 60–70 years, traditional dietary patterns in the region have changed. Urbanization, social factors of city lifestyles (Clark, 2019; Kearney, 2010), globalization of food systems, and the homogenization of food behaviours (Bach-Faig et al., 2011), have led to a progressive change of the traditional diet. Moreover, increasing population and affluence have caused diets across nations to become more protein-intensive, thus contributing to an increased consumption of fish and seafood and an increased impact on marine ecosystems (Clark et al., 2018). Today, Mediterranean residents have a high dietary preference for processed and protein-intensive products, such as meat and high-trophic level fish species like Atlantic cod (*Gadus morhua*), for instance (Galli et al., 2017). These are also the most economically valuable fish species for commercial use in the region (Jeffries, 2017).

The aim of this study is thus to (1) identify the environmental externalities—the impact on the biosphere ecosystems—associated with the dietary choices of residents in three Mediterranean pilot countries (Croatia, Italy, and Turkey), and (2) assess which of these three countries would be most responsive to consumer awareness campaigns by understanding regional differences in consumer habits.

Ecological Footprint Accounting (EFA) was used to quantify the contribution of seafood consumption to the overall demand on the resource regenerative capacity of the three countries under study. A twenty-five-question survey was then used to track consumers' attitude towards seafood, to understand the factors that influence the purchase and consumption choices of residents and assess their willingness to modify dietary choices. Before initiating a wide regional application of this approach, we tested the approach in just three Mediterranean countries, which were selected due to (1) their representativeness of the different geographical and cultural contexts of the north Mediterranean, (2) the availability of high quality Ecological Footprint data from the National Footprint and Biocapacity Accounts, (3) the presence of numerous SSF fleets in these countries, which would eventually allow for a differentiation of the fish and seafood sourcing patterns, and (4) our ability to access consumers for the consumer survey.

While consumers' attitude towards seafood has been previously investigated in these three countries (Brécard et al., 2009; Can et al., 2015; Cosmina et al., 2012; Erdoğan et al., 2011; Jeffries, 2017; Mauracher et al., 2013; Stefani et al., 2012), this is—to our knowledge—the first study in which it is analysed together with the *footprint* it leaves on the planet ecosystems. We believe our results can shed light on the role dietary choices can play in the quest for sustainability and help identify the most appropriate geographical and cultural context(s) in which consumer campaigns can promote the creation of new markets for less Footprint-intensive seafood products.

2. Methodology

2.1. Ecological Footprint overview

The Ecological Footprint (EF) is a widely used resource accounting tool to measure human pressure on ecosystems (Yu et al., 2019). This area-based metric measures a population's consumption of biological resources across six Footprint land types: cropland, grazing land, fishing grounds, forest products, built-up land, and carbon (Borucke et al., 2013; Lin et al., 2015; Wackernagel and Rees, 1996). When paired with biocapacity (BC), a metric that quantifies the regenerative capacity of a land or sea area (i.e., the ecosystem's capacity to produce natural resources and absorb our waste in the form of CO_2 emissions), the two metrics shed light on a fundamental measure of environmental sustainability: the ability for a population to live within the means of their regenerative resource base (BC>EF). If living within ecological means is not possible, then the two metrics show the demand being place on wider geographical areas (EF>BC). In essence, the Ecological Footprint represents the human appropriation of the planet's ecological assets (Galli et al., 2014).

Ecological Footprint accounting (EFA) can be applied to various geographic scales: from a single product, individual, or industry, to cities, regions, countries, and the world. Two primary approaches are used to conduct EFA assessments: top-down and bottom-up, also referred to as the compound and component approaches, respectively (Baabou et al., 2017; Simmons et al., 2000). The top-down approach uses national data, such as the production and trade of commodities, to calculate a country's Footprint (Borucke et al., 2013; Lin et al., 2018). The national Footprint is then broken down into consumption categories via monetary multi-regional input-output (MRIO) tables (Baabou et al., 2017; Ewing et al., 2012) or actual material and energy flows (Global Footprint Network, 2019). The output is a consumption land use matrix (CLUM), which shows how the Footprint of final demand categories (housing, food, transportation, goods, and services) and final consumer types (government, households, and fixed capital) are distributed across the six Footprint land types (Baabou et al., 2017; Ewing et al., 2012; Galli et al., 2020b). This approach can be further applied to derive Footprint values for sub-national areas (Baabou et al., 2017; Galli et al., 2020b; Isman et al., 2018).

The bottom-up approach uses more localized data to calculate the Ecological Footprint at a smaller scale, such as for a commodity, organization, industry, or even a city (Moore et al., 2013; Wilson and Grant, 2009). This is achieved by either using local monetary input-output tables or by directly measuring physical flows of materials and energy to calculate the Footprint value of interest. This latter method has been applied to a few specific industries, commodities and food production processes, such as paper pulp production methods (Kissinger et al., 2007), marine aquaculture of reef fish (Warren-Rhodes et al., 2003), shrimp and tilapia (Kautsky et al., 1997), salmon and mussels (Tyedmers, 2000), tomato (Wada, 1993) and potato cropping (Deumling et al., 2003). The bottom-up approach better represents the local situation and is easily understood and accepted by local authorities (Moore et al., 2013). However, the bottom-up approach is more resource and data intensive.

In this study, we employ the top-down approach to calculate the Food and Seafood Footprints of Mediterranean countries.

2.1.1. Seafood Footprints

We calculated the Ecological Footprints of consuming fish and seafood in the three Mediterranean countries of study using a top-down Environmentally Extended Multi-Regional Input-Output (EE-MRIO) model. This approach is used to derive Ecological Footprint values by country and economic sector for any area or sector of interest (Baabou et al., 2017; Galli et al., 2017, 2020b; Isman et al., 2018; Weinzettel et al., 2014; Wiedmann et al., 2006).

The “environmental” input for our EE-MRIO model was the National Footprint and Biocapacity Accounts (NFAs) (Global Footprint Network, 2019), which in turn uses national-level data on the production and trade of commodities from UN datasets, spatial data from CORINE and Global Land Cover, and energy data from the International Energy Agency (see Borucke et al., 2013; Lin et al., 2018) to calculate the Ecological Footprint and biocapacity of nearly all countries and the world. Both metrics are expressed in global hectares (gha), a hectare-equivalent unit of world-average bioproductivity (Galli, 2015).

The NFAs quantify the land area appropriated by economic demand, but do not quantify the extent to which specific economic activities contribute to a country’s overall demand on nature (Mancini et al., 2018a and b). To calculate this, we applied an EE-MRIO analysis to the NFA results after Galli et al. (2017). We began by allocating country- and commodity-specific Footprint data from the NFAs to the production sectors of the MRIO tables from the Global Trade Analysis Project 10 (GTAP10, 2020) database (Aguiar et al., 2019). GTAP 10 consists of 65 economic sectors and includes 141 countries and regions. We then used a GTAP-COICOP concordance table to standardize the final demand sectors to the UN’s Classification Of Individual Consumption According to Purpose (COICOP), a standard classification system for reporting household consumption expenditures (UNSD, 2020). Since the latest reference year in the GTAP 10 database is 2014, we then scaled the COICOP-standardized sectors to NFA data year 2016, the latest data year in the NFA 2019 edition. The resulting output is a CLUM dataset, showing the contribution of each Footprint type to major consumption categories—food, housing, transportation, goods, and services—for data year 2016. While the analysis was run using a global dataset across all three consumer types (household, government, and fixed capital), here we only present results for household consumption of the three countries of interest (Croatia, Italy, and Turkey), with a focus on the food consumption category.

To calculate the Footprint of fish and seafood consumption, we derived a COICOP Land Use Matrix (CoLUM) as in Galli et al., (2017). The CoLUM is very similar to the CLUM, except that Footprint values are categorized into the COICOP classifications rather than the five primary demand categories from the CLUM. Using a household-to-sector concordance table with 59 sectors, we allocated the Ecological Footprint by sector to each COICOP category. The twelve 2-digit resolution household consumption categories are: (1) food and non-alcoholic beverages; (2) alcoholic beverages, tobacco and narcotics; (3) clothing and footwear; (4) housing, water, electricity, gas and other fuels; (5) household furnishings, equipment and maintenance; (6) health; (7) transportation; (8) communication; (9) recreation and culture; (10) education; (11) restaurants and hotels; and (12) miscellaneous goods and services. COICOP category *CP011 Food and non-alcoholic beverages* is further classified into ten 4-digit resolution sub-categories: bread and cereals; meat; fish and seafood; milk, cheese, and eggs; oils and fats; fruit; vegetables; sugar, jam, honey, chocolate, confectionery; food products n.e.c.[1]; and non-alcoholic beverages (UNSD, 2020).

The *Seafood Footprint* is thus the demand for all six Footprint land types connected to the individual consumption of the products listed within the COICOP sub-category *CP011.3 Fish and Seafood.*

2.2. Consumer survey

2.2.1. Survey development

The twenty-six-question survey used in this study, designed in collaboration with regional Footprint and seafood experts, intended to capture: (1) consumer awareness of small-scale fisheries and their impact on marine ecosystems; (2) consumer seafood purchase preferences and willingness to change dietary choices; and (3) the main barriers to changing dietary choices and seafood consumption patterns. Aquaculture and freshwater fish consumption were not included in this survey (see Appendix 1 for complete survey questions).

Survey questions were informed by a detailed literature review on consumer seafood consumption and preferences in the Mediterranean region and globally (Monterey Bay Aquarium, 2020; WWF, 2020). We found that despite an increase over time in studies focused on seafood consumption and preferences, societal knowledge about consumers’ attitudes remained geographically fragmented and primarily limited to taste and health-related aspects. According to Carlucci et al. (2015), further research is needed to understand the full range of motivational factors that drive consumer attitudes towards seafood such as eating habits, values, lifestyles, perceived risks, intention to buy, trust in information sources, knowledge of cooking and preparing fish, and ingrained habits. Moreover, many studies and campaigns aimed at promoting sustainable seafood consumption and production tended to focus solely on environmental sustainability, missing the impact of culture and socioeconomic behaviour on fisheries (Hilborn et al., 2015). Thus, we developed our survey questions to be inclusive of the socioeconomic, demographic, and environmental facets that drive consumer behaviour and preferences, to assess links between consumers and sustainable decision-making. The survey required about 10 min to complete and asked closed-ended questions only.

2.2.2. Survey distribution

A market research company was hired to distribute the survey to ensure access to a statistically significant and representative sample of respondents in each country. The questionnaire was computerized to carry out online interviews through the Computer Assisted Web Interviewed (CAWI) methodology, with survey collection lasting two weeks. The CAWI method was selected because of its cost-effectiveness, its

[1] Not elsewhere classified.

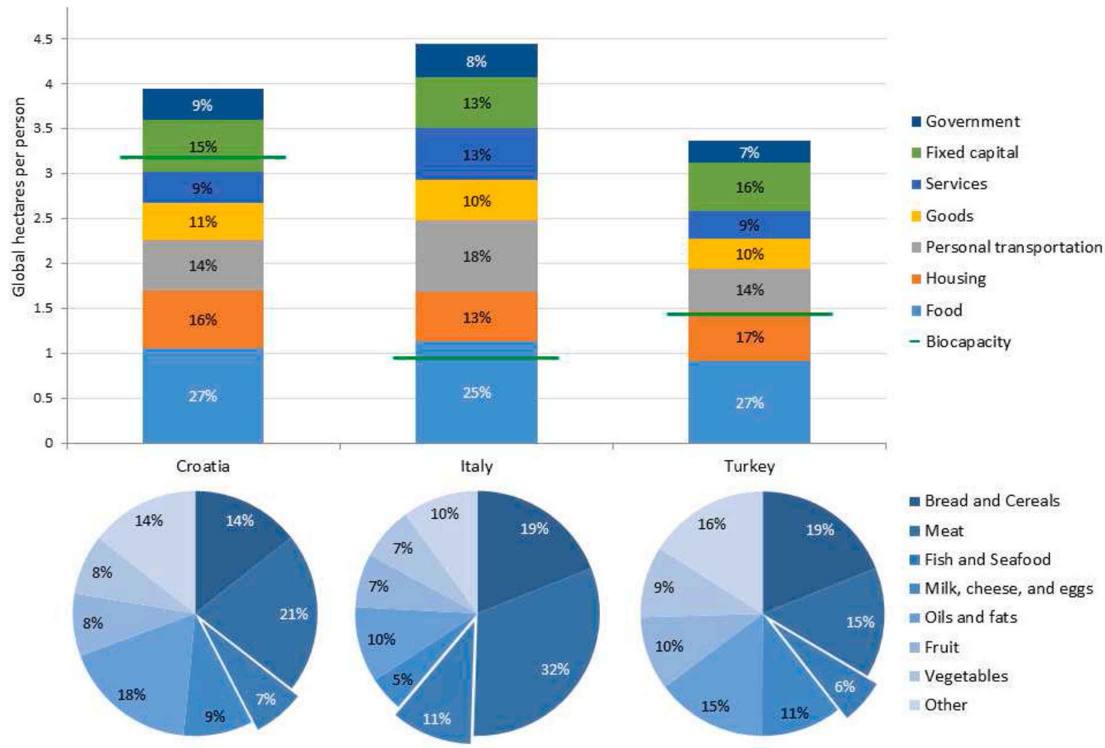

Fig. 1. The contribution of each CLUM category to the total Ecological Footprints of Croatia, Italy and Turkey in 2016 compared against each country's own biocapacity (top bar chart),[2] and the breakdown of the "Food" Footprint by COICOP categories (bottom pie charts), with a visual emphasis on the "Seafood Footprint".

capacity to meet a set of pre-determined quotas, its capacity to automatically correct errors and omissions during interviews, and to avoid falling response rates of traditional polling modes (e.g., Hansen and Pedersen, 2012; Christensen, 2013) (Christensen, 2013; Hansen and Pedersen, 2012). Interviewees were recruited through online panels (Italy) and social networks (Croatia and Turkey). Demographic representation across the three countries was guaranteed through quotas placed on gender, age group and geographic areas. Overall, 2800 interviews were conducted: 1000 in both Italy and Turkey, and 800 in Croatia, with surveys distributed in the national language of each country. Raw data was then cleaned and processed using SPSS statistical software, and the survey results analysed.

2.3. Methodological limits

Ecological Footprint Accounting (EFA) focuses broadly on human metabolism. It aims to measure whether or not humans are able to live within the overall ecological budget of the planet (Wackernagel, 1999). Answering this research question requires trade-offs between scope and resolution: EFAs employ a wide scope and systemic approach to assess the impact of multiple pressures that are usually evaluated independently, resulting in a decrease in the resolution of any single component (Kitzes et al., 2009). As such, EFA should not be considered a comprehensive indicator but should rather be complemented with other indicators, such as for instance GDP, fish stock assessment, land degradation, or the UN's Human Development Index, to arrive at comprehensive assessments of sustainability (Galli et al., 2012; Borucke et al., 2013).

Other limitations of EFAs include: (1) It tracks pressure on ecosystems, but does not quantify the immediate consequences of such pressures on ecosystem health, such as soil degradation or overfishing (Goldfinger et al., 2014; Kitzes et al., 2009); (2) it measures flows rather than stocks (Mancini et al., 2017), meaning it is not an ideal indicator to measure stock depletion, though it can be used to assess the extent to which the rate of seafood consumption is aligned with regeneration rates of marine ecosystems; (3) EFA only accounts for ecosystems where solar energy is captured by autotrophic organisms (i.e., photosynthesis) to create any form of biomass humans find useful, leaving out many of the regulating, maintaining and cultural services that the planet's ecosystems, including marine ecosystems, provide to humans. Thus, our analysis is partial and not representative of the full impacts of fisheries on the planet's ecosystems. Similarly, an understanding of the socio-economic and cultural impacts of fisheries is also missing from EFAs, meaning this must be complemented through other analyses. The current assessment also omitted investigation of the post-fishing operations (e.g., seafood storage, distribution and trade), which certainly play a role in affecting a person's Seafood Footprint.

3. Results

3.1. Food footprints of Croatia, Italy and Turkey

The top-down analysis of Croatia, Italy and Turkey's Footprints showed that in 2016, the total Ecological Footprint of these countries was 3.9, 4.4 and 3.4 global hectares (gha) per person, respectively (Fig. 1). Biocapacity deficits were found in all three countries as the available per capita biocapacity in Croatia, Italy and Turkey was 3.2, gha, 0.9 gha and 1.4 gha, respectively. Food consumption contributed the most to each country's Footprint, comprising 27% of the total Footprint in Croatia, 25% in Italy, and 27% in Turkey (Fig. 1). Other major drivers were housing, personal transportation, and fixed capital

[2] The five consumption categories in Fig. 1—food, housing, personal transportation, goods and services—represent final *household* consumption. The additional components that contribute to each country's Footprint – government and fixed capital – are the remaining two consumer types from the Consumption Land Use Matrix.

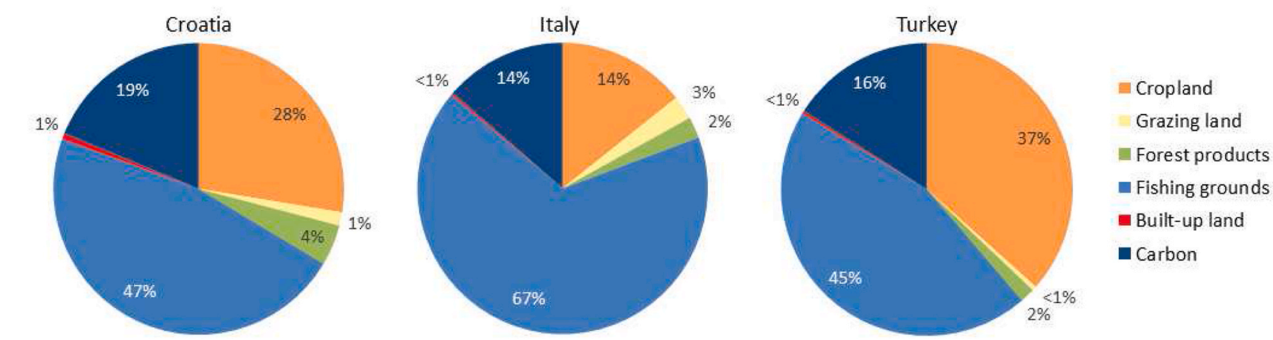

Fig. 2. The contribution of each Footprint land type to the "Seafood" Footprints of Croatia, Italy and Turkey in 2016.

(Fig. 1).

Upon analysing the contribution of COICOP categories to the household food Footprint, we found that the consumption of fish and seafood contributed to 7% of Croatia's food Footprint, 11% of Italy's food Footprint, and 6% of Turkey's food Footprint (Fig. 1; see Appendix 2 for full CoLUM results). Although Seafood Footprint accounts for just 6%–11% of these countries' food Footprint, it places anthropogenic pressure on already highly stressed marine ecosystems and fish stocks, while also contributing to carbon emissions, thus motivating the importance of complementing traditional sets of fisheries management measures with data and tools to inform consumer behaviour to indirectly influence fisheries practices.

Upon further analysing the contribution of each Footprint land type to the consumption of fish and seafood, we found the fishing grounds Footprint to contribute the most (67%, 47% and 45% in Italy, Croatia, and Turkey, respectively) to each country's Seafood Footprint; a more heterogeneous contribution was found for the cropland Footprint component (the amount of cropland used to produce resources – e.g., plant proteins for aquaculture feeds – used in the fish industry), as it contributed to 37%, 28% and 14% of the overall Seafood Footprint in Turkey, Croatia, and Italy, respectively (Fig. 2). The contribution of the carbon Footprint to each country's Seafood Footprint was highest in Croatia (19%), followed by Turkey (16%), then Italy (14%) (Fig. 2).

3.2. Consumer survey results

Results from the 2800 surveys showed that proximity to the coast and age were the primary factors influencing consumption in all three countries. Education level was also a driver in Croatia and Italy. While a higher education level corresponded to higher frequency of consumption in all countries, consumers with the highest consumption rates were in the age group 18–35 in Croatia and Turkey (with 83% and 80% of respondents consuming 1 to 2 servings of seafood per week or more, respectively), and 46–55 in Italy (80%). Gender was not a factor

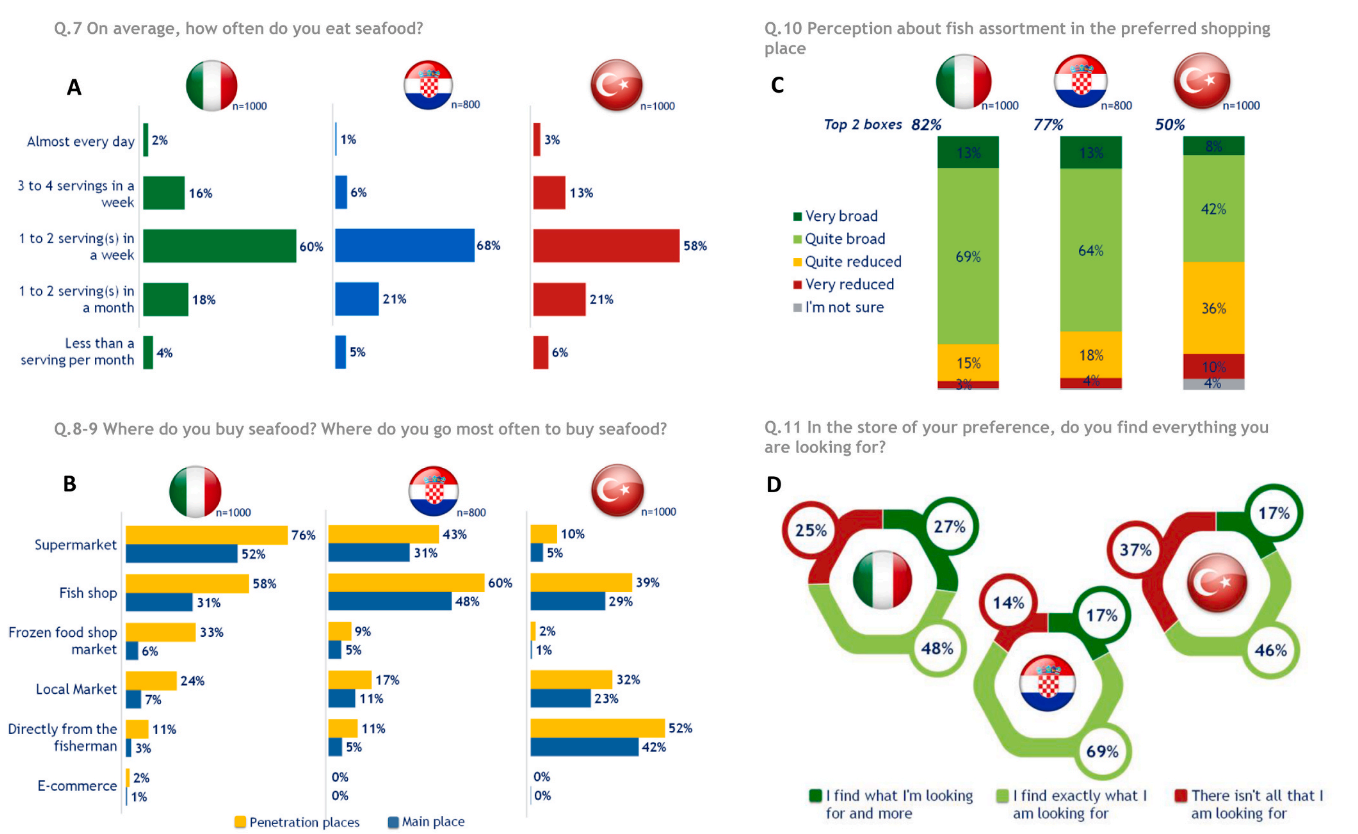

Fig. 3. (a) Frequency of seafood consumption, and consumer attitudes towards shopping for seafood in Croatia, Italy and Turkey, including (b) usual and single most preferred shopping place, (c) perception of product selection, and (d) and shopping satisfaction.

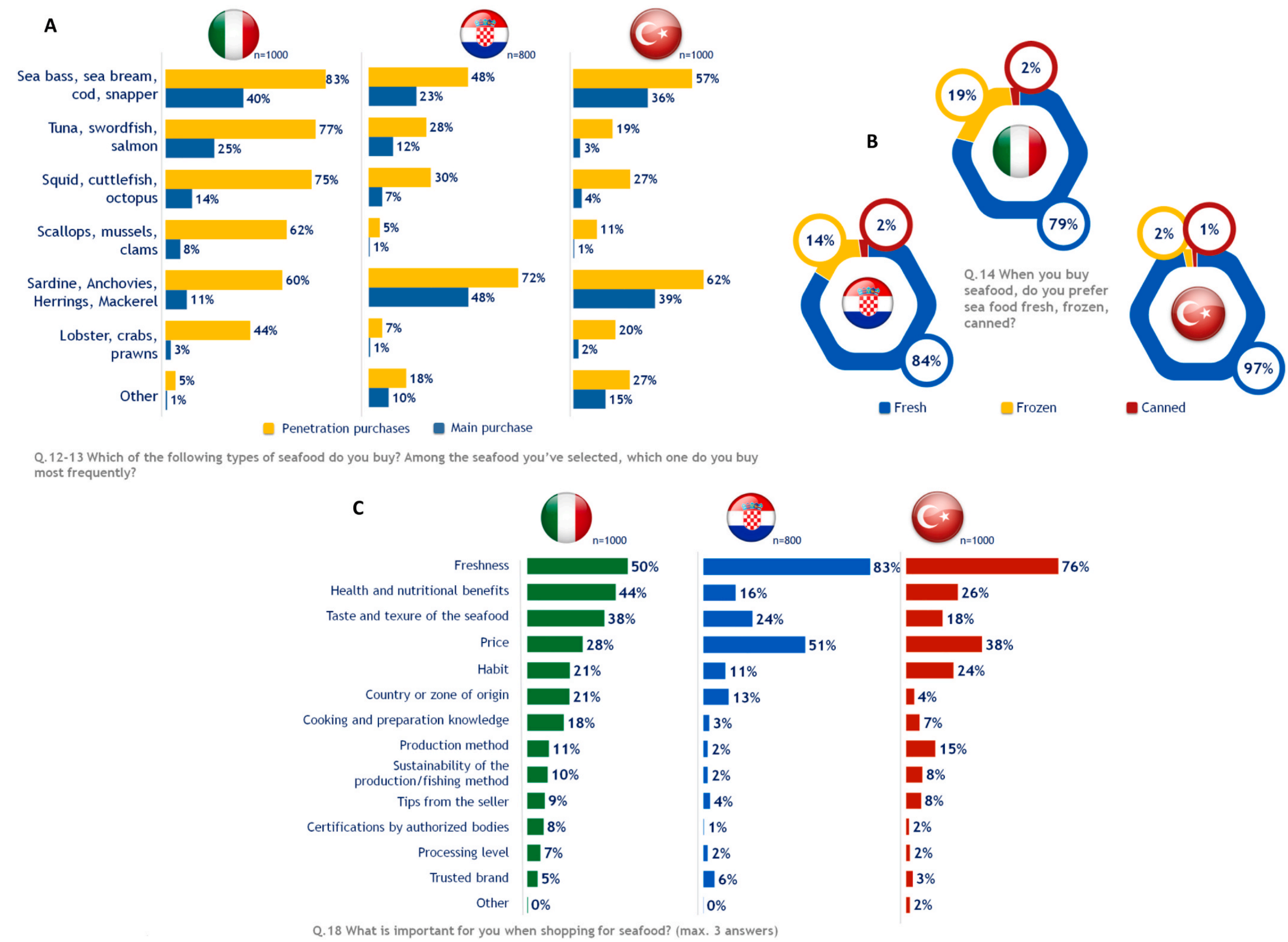

Fig. 4. Consumer preferences for seafood products in Italy, Croatia and Turkey. Details are reported for (a) the range of species preferred (yellow) and the main seafood choice (blue), (b) consumer preferences for fresh, frozen or canned seafood, and (c) the main drivers for purchasing seafood products in Croatia, Italy and Turkey. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

influencing consumption patterns (see Supplementary Online Material for full survey results).

Most survey respondents consumed 1 to 2 servings of seafood per week (58% in Turkey, 60% in Italy, and 68% in Croatia) (Fig. 3a). Preferences on where to buy seafood varied among countries (Fig. 3b), with consumers in Italy and Croatia preferring to purchase seafood from supermarkets and fish shops, and consumers from Turkey preferring to buy directly from fishers (42% on average, and up to 62% for residents living along Black Sea coast), with very few purchasing seafood from supermarkets.

More than three-quarters of consumers in Italy (82%) and Croatia (77%) perceived the selection of seafood and fish products to be quite broad or very broad, likely due to primarily shopping at supermarkets. In Turkey, 46% of consumers perceived the selection as quite reduced or very reduced (Fig. 3c), likely due to shopping directly from fishers and 37% of them indicated that in their preferred shopping place, they can't find the full range of seafood products they look for (Fig. 3d).

Italians tend to buy and consume a greater variety of seafood species than residents in Turkey and Croatia (see yellow bars in Fig. 4a) as almost all classes of fish and seafood listed are purchased by more than 60% of respondents except for "Lobster, crab, prawn" (44%) and "Other" (5%). Conversely, only one ("Sardine, Anchovies, Herrings, Mackerel") and two ("Sardine, Anchovies, Herrings, Mackerel" and "Sea bass, sea bream, cod, snapper") classes of fish and seafood are purchased by more than 50% of Croatian and Turks (yellow bar Fig. 4a), respectively.

Regarding the main seafood choice (blue bar Fig. 4a) purchased most frequently, Italians prefer high trophic level species such as "Sea bass, sea bream, cod, snapper" (40% of respondents) while Croatian (48%) and Turks (39%) prefer lower trophic level species such as "Sardine, Anchovies, Herrings, Mackerel". Across all three countries, most consumers preferred fresh seafood rather than frozen or canned seafood, especially in Turkey (97%) (Fig. 4b). Turks' very high preference for fresh seafood differs from the other two countries, where up to 14% of Italian and 19% of Croatian consumers preferred to purchase frozen seafood products (Fig. 4b). Across all three countries, freshness was the most important factor determining seafood consumption preferences, more so than price or health benefits (Fig. 4c).

Consumers in Turkey (92%) and Italy (93%) displayed the greatest level of curiosity towards new and unfamiliar seafood products (Fig. 5a). 61% of consumers in Italy and 58% in Turkey frequently or sometimes purchased unfamiliar seafood products, while only 22% of consumers did so in Croatia (Fig. 5c). In all three countries, the biggest barrier to buying unfamiliar seafood products was price, although unknown flavour was also a recurring barrier (Fig. 5b). However, for Italians and Turkish consumers, lack of knowledge on how to prepare or cook unfamiliar seafood products was also a significant barrier to consumption. In Italy, seafood origin and the perception of uninviting or unappetizing products were also barriers. Additional barriers to consumption in Turkey were production method (caught/bred) and cultural preferences. Unique to Croatia, 31% of consumers surveyed had no interest in

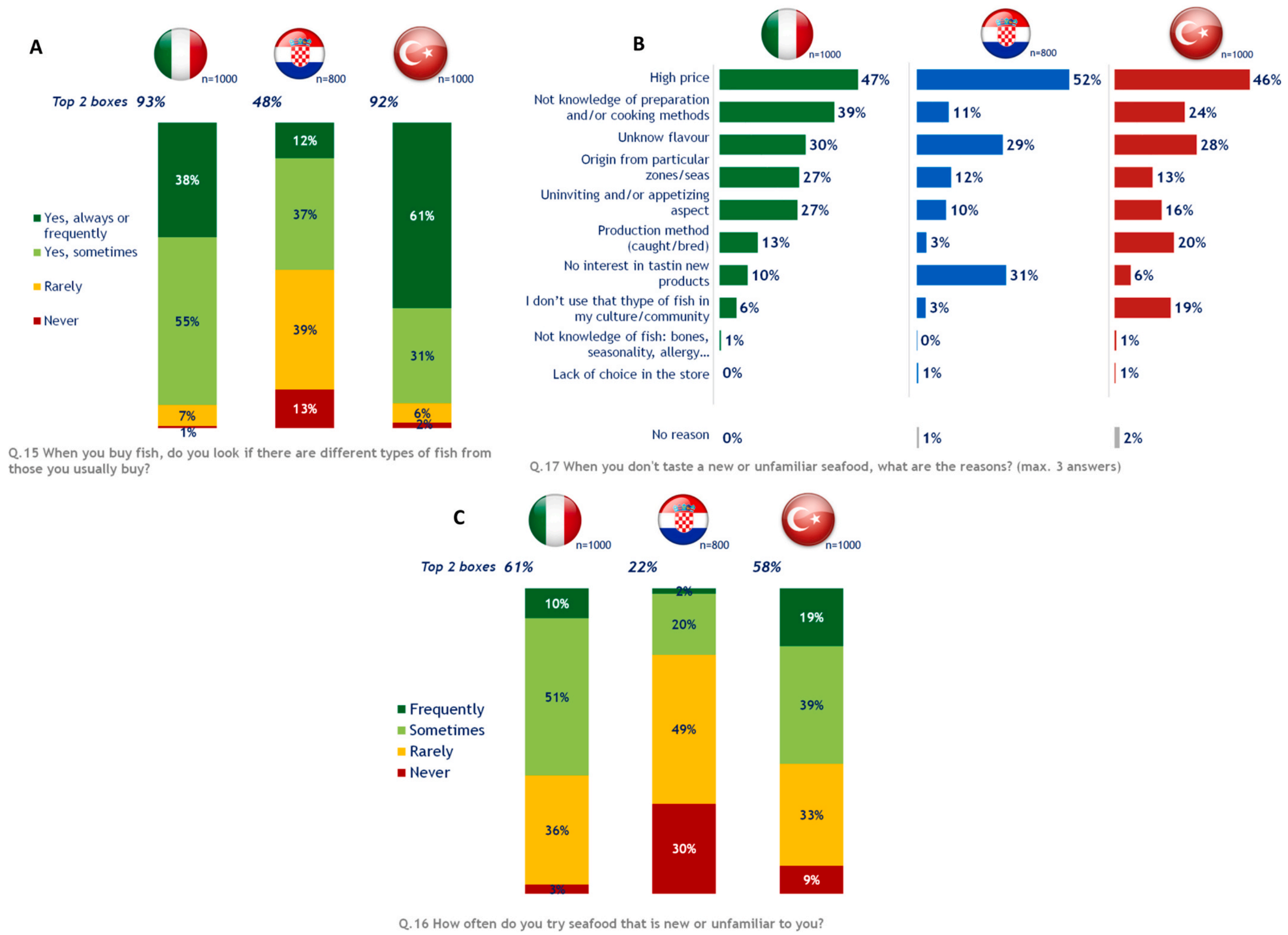

Fig. 5. Consumer (a) curiosity towards unfamiliar seafood products, (b) purchases of unfamiliar seafood products, (c) barriers to trying new and unfamiliar seafood products.

tasting unfamiliar seafood products, thus scoring as the second most relevant barrier for Croatian residents (Fig. 5b).

Consumers in Croatia and Turkey found *Seasonality* to be the single most important factor determining the sustainability of seafood (indicated by 33% and 51% of respondents respectively), followed by *Fishing practices and gear not damaging the environment*, the presence of a *Healthy fish population*, and *Minimizing unwanted catch of endangered species* (Fig. 6a). Consumers' perception on seafood sustainability was very similar in Italy, with the exception of *Fishing practices and gear not damaging the environment* being indicated as the single most important sustainability factor (by 25% of Italian respondents). Overall, Italian consumers seem to perceive fishing practices, seasonality, and the health of the fish population as equally important, while Croatian and Turks assign to seasonality a higher importance compared to the other factors. In future purchases of sustainable fish products, most consumers would look at the product label, and many would also acquire this information directly from the fish seller (Fig. 6b). In Italy and Turkey, many consumers would also learn about seafood sustainability from information boxes inside the store that indicate the most sustainable choices, and QR codes on the label that lead to information about seafood sustainability, thus showing a wider range of preferred information sources than consumers in Croatia.

Perceptions of knowledge and sustainability of small-scale fisheries were inversely related across the three countries. While 58% of Italians believed SSF to be more sustainable than LSF, only 32% of consumers in Croatia and 37% in Turkey agreed (Fig. 7a). Conversely, only 3% of Italians believed SSF to be *less* sustainable than LSF, compared to 30% of consumers in Croatia and 26% in Turkey (Fig. 7a). However, Italians claimed to be the least knowledgeable about SSF as just about a third (34%) of the respondents from Italy has heard about it before the survey, opposite to 61% and 64% of the respondents from Croatian and Turkey, respectively (Fig. 7c). Among those who heard about SSF, 44% of Italians indicated a limited knowledge about SSF while about 71% and 77% of respondents from Croatia and Turkey indicated to be *very* or *somewhat* informed about SSF (Fig. 7c).

After being shown the definition of "small-scale fisheries",[3] survey respondents were asked if they would consider purchasing a different fish product knowing it was caught by artisanal SSF rather than LSF (Fig. 7b). Most consumers considered (quite likely or very likely) doing so. Only 1% of Italians, 6% of Croatians and 11% of Turks were not likely to purchase different fish products.

4. Discussion

Any regional approach in the Mediterranean to conserve marine

[3] The following SSF definition was shown to survey respondents: "Small-scale fisheries (SSFs) are fishing households, as opposed to commercial companies, who are self-employed fishermen engaged in directly providing food for their household and communities using smaller vessels and relatively low-tech gear" (see also Appendix 1).

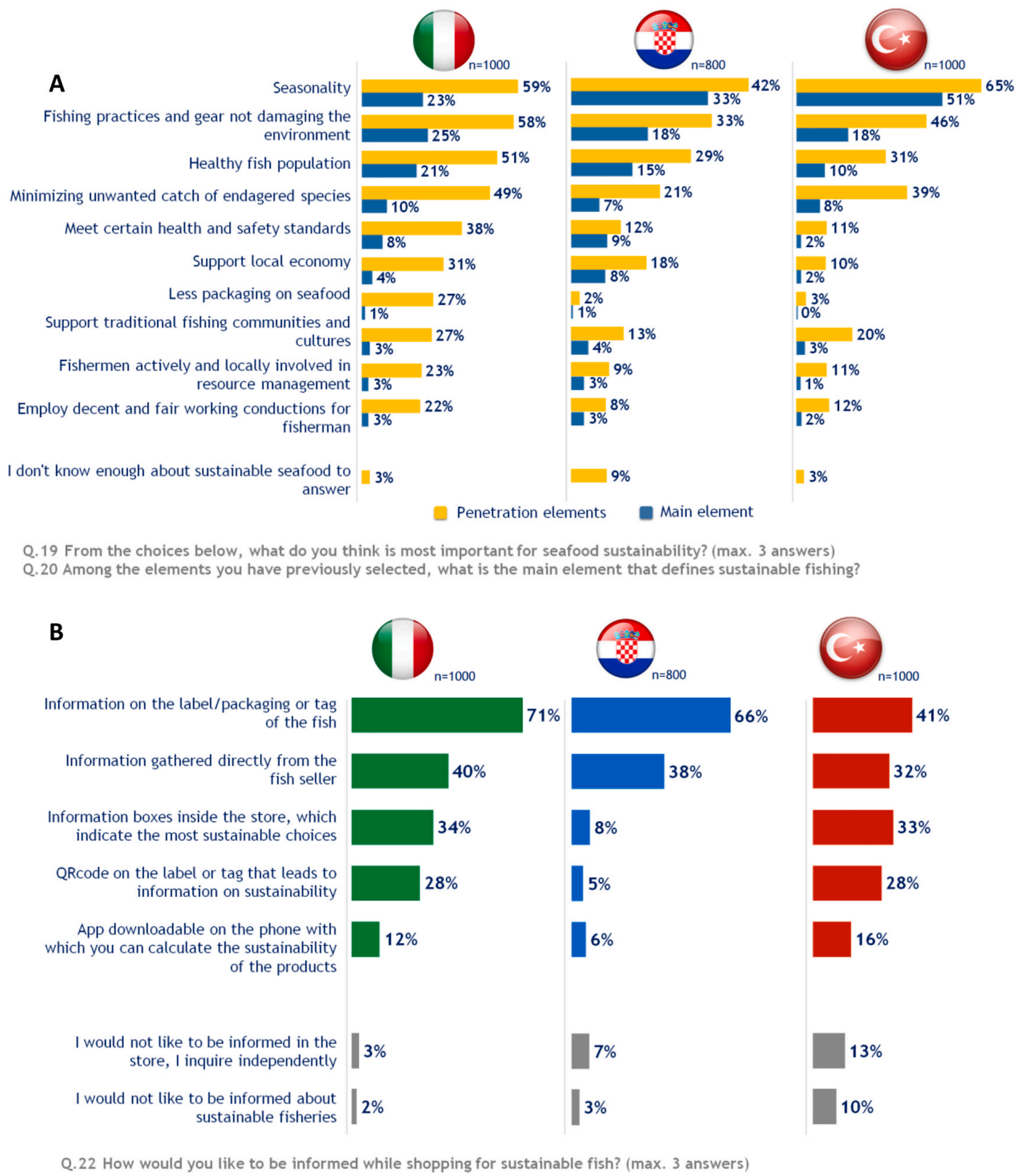

Fig. 6. (a) Consumer knowledge of seafood sustainability, and (b) their preferred information source to learn about sustainable seafood while shopping in Italy, Croatia and Turkey.

ecosystems through consumer behavioural changes must consider the unique socio-ecological contexts of Mediterranean countries. Here, we show that the three countries under study differ in the extent to which their seafood consumption patterns impacted ecosystems, as well as in their unique consumption preferences and perceptions of sustainability.

Results from the countries' Ecological Footprint analysis showed food consumption to be significant since it was the largest component of each country's overall Footprint, although Seafood Footprints were lower than the other food categories in all countries but Italy, where it was the third highest component. The highest Seafood Footprint of Italian residents is likely due to the higher per capita GDP of this country compared to Croatia and Turkey as, according to Clark et al. (2018), affluence is the key drivers of countries' fish and seafood consumption and Footprint. Looking at the land types making up the Seafood Footprint, beside the fishing ground Footprint comprising the largest share in the three countries (see Fig. 2), we found cropland to represent more than a third of the overall seafood Footprint in Turkey: this is likely due to the use of plants proteins (e.g., soybean meal) and animal trimmings as aquaculture feeds (Nates, 2016), as Turkey is among the 3 countries that contribute the most to European (EEA-39) aquaculture production, especially through the production of trout, sea bream and sea bass (EEA, 2018). The highest carbon share of the national Seafood Footprint in Croatia could be indicative of energy-inefficient fishing practices in this country.

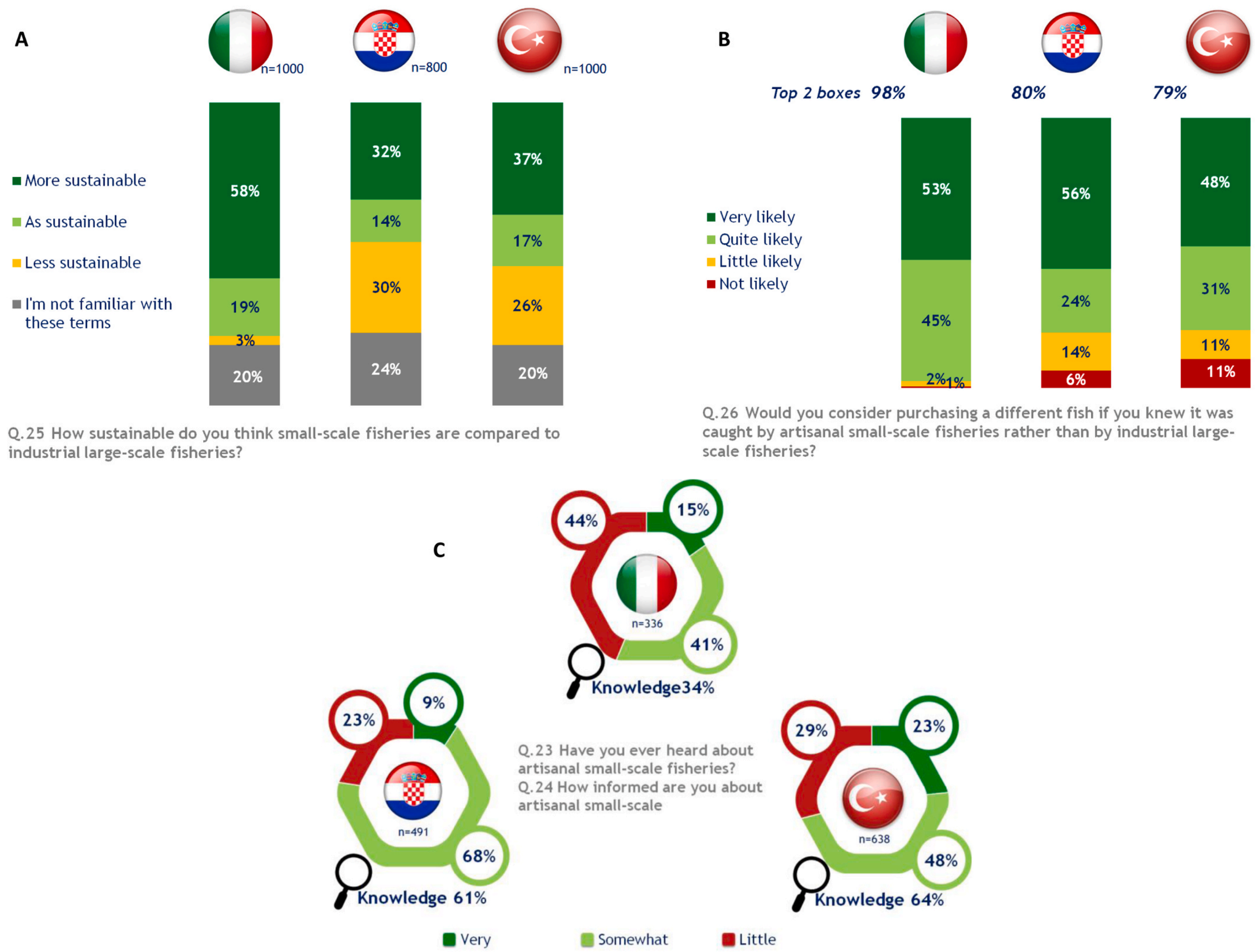

Fig. 7. (a) Consumer perceptions of the sustainability of SSF vs. LSF, (b) purchasing preferences based on knowledge of SSFs, and (c) overall perceptions of knowledge about SSFs in Italy, Croatia, and Turkey.

Given the importance food consumption has on the overall Ecological Footprint of countries, encouraging residents to diversify their traditional diets with species that have lower carbon emissions and lower Ecological Footprints per kg of product consumed (or kcal provided) could help lower residents' Seafood Footprints while also creating new markets for alternative seafood products that could benefit small-scale fishery production, thus helping fish and seafood catches to adjust to demand (Gómez and Maynou, 2021). According to previous studies (e.g., Parker and Tyedmers (2015), and Ziegler et al. (2016)) for instance, crustaceans, particularly tiger prawns, shrimps, and lobsters, require the highest amount of energy[4] (e.g., fuels) and thus cause the highest amount of carbon emissions to be landed (see also Farmery et al. (2014)) – especially when caught via bottom trawls or pots and traps – as do large pelagic species (e.g., tuna), while anchovies, mackerel, sardines, and herrings (see also Ramos et al. (2011)) – especially when caught via purse seine gear or other surrounding nets – are the most energy- and carbon-efficient fish and seafood species consumers could opt for. Similarly, a recent study by Galli et al. (2020a), reported that lower trophic level fish species such as cuttlefish, sardines and prawns have the lowest Ecological Footprint embedded per kg of product and

Table 1
Fish and seafood production and consumption characteristics in each country. Country "scores" have been defined as follows: High is above 75% of the surveyed population, medium is between 50% and 75%, and low is less than 50%.

Characteristic	Croatia	Italy	Turkey
Seafood contributes significantly to food Footprint (>10%)	No	Yes	No
Overall willingness to try new seafood products	Low	High	High
Self-reported knowledge about SSF	Medium	Low	Medium
Willingness to try new seafood upon gaining knowledge on SSFs in survey	Medium	High	High
Willingness to learn while shopping about sustainability seafood consumption	High	High	High

thus their consumption, as opposed to the consumption of high trophic fish and seafood species (e.g., tuna and cod) would help consumers reducing their food Footprint. Overall, as noted by Lucas et al. (2021), the species composition of the basket of fish and seafood products consumed has a strong influence on the environmental footprints of dietary choices, with consumption of trawled crustaceans and farmed shrimps listed among the greatest contributors to global warming (in terms of kg CO_2 eq. per ton live weight), and shellfish among the smallest. Moreover, reducing the consumption of animal source foods would contribute the most to increasing the environmental sustainability of dietary choices, and substituting such products with whole

[4] According to Ziegler et al. (2016), fuel use during fishing activities contributes about 75–95% of the overall carbon emissions embedded in a kg of landed fish and seafood.

grains, fruits, vegetables, nuts, seeds, and legumes would bring about numerous health benefits (Springmann et al., 2020).

A previous, theoretical study by Galli and colleagues (Galli et al., 2017) has shown that a reduction in the food Footprint of Croatia, Italy and Turkey could be in the range of 20%–40% and obtained via shifts to calories-adequate diets and changes in consumers' preferences; results from the consumer survey conducted here, however, showed that some countries may be more open to dietary shifts than others due to regional differences in culture and consumption preferences, although it should be noted that these results relate to respondents' self-reported willingness to change rather than actual behaviour changes, and that consumers are often locked in their consumption patterns due to social norms and institutional contexts (Jackson, 2005). Of the countries in this study, we identified Italy and Turkey as the countries most suited to prioritize such interventions, with Croatia showing possible challenges at the consumer level (Table 1). These findings complement those of Solarin et al. (2021) as they found the fish and seafood Footprint of upper-middle and high-income countries to be nonstationary, suggesting that actions (e.g., campaigns) and policies aimed at regulating fishing practices, protecting essential fish habitats, and influencing consumer attitudes have a higher likelihood of being effective (i.e., have long lasting impacts) than in low-income countries. This, they conclude, could guide companies prioritize where to focus their activities on.

In terms of possible tangible Footprint reductions, Italy was the only country where seafood contributed significantly (>10%) to the national food Footprint, meaning it has potential for greater impact from Footprint reductions than Turkey or Croatia. Italians consumed the highest variety of seafood among the three countries and displayed a high willingness to try new seafood products, particularly from SSFs, both of which are favourable characteristics for any efforts to diversify seafood diets.

Turkey also displayed a willingness to try new seafood products, which increased after gaining knowledge about SSFs, while Croatian residents expressed a general lower interest. Interestingly, we found highest shares of respondents perceiving SSF as more sustainable than LSF within those consumers that have the lowest self-reported knowledge of SSF (i.e., Italians); a tendency to perceive SSF as less sustainable than LSF as the self-perceived knowledge of SSF increases was also found and this indicates that any effort to increase the market penetration rate of SSF products should likely be coupled with an improved communication about the role and sustainability of SSF. Further research on the sustainability of small-scale fisheries - from an environmental, economic, and social viewpoint - would be needed, both in absolute terms and compared with LSF, as consumers in all three countries expressed high interest in buying seafood product from SSFs after learning about them briefly in the survey. In addition, Turkish survey respondents tended to buy more seafood products directly from fishermen than Croatians or Italians, who prefer to buy seafood in stores. Direct fisher-to-consumer communication may make Turks more open accepting of new seafood products.

Most consumers across all countries found seasonality to be an important part of sustainability—a perception that can be leveraged to encourage the diversification of seafood diets, and furthering education strategies. Most consumers prefer to learn about sustainability while shopping on the product labels and packaging or from information directly from the fish seller. For consumers shopping primarily at supermarkets, like Italians and Croatians, information about SSF or sustainable seafood directly on product labels and packaging would likely be an effective education strategy; yet, to increase consumers' understanding of the shown information, recent research has found (Rondoni and Grasso, 2021) that the eventual design of such labels (e.g., Footprint-related labels) should consider using consumers friendly symbols. For Turks, since consumers buy primarily from the fish seller, it may be more effective to receive such information directly from the fisher or from information boxes at seafood markets. The survey showed that education is important since consumers' perception about SSFs changed when they became more knowledgeable about them, showing that a shift in consumer attitudes is possible upon gaining new information.

5. Conclusions

Several major shifts are necessary to ensure a transition towards sustainable Mediterranean fisheries and sustainable seafood consumption by Mediterranean residents. Given the tight interlinkages between fish and seafood production and consumption activities, realizing these shifts require engaging both producers and consumers. As such, actions on the sustainable food production side must be coupled with action on the consumption side that promotes sustainable decision-making.

Our survey showed that most Mediterranean residents demand a limited number of fish and seafood species, thus causing excessive pressure on certain fish stocks. This shows a need to favour diversification of the baskets of fishes and seafood being consumed by Mediterranean residents. Such diversification could positively contribute to generating a market for fish species that usually get discarded because of perceived no commercial value, which would also have the added co-benefit of food waste reduction. Despite the positive contribution of diversifying the basket of fish and seafood being consumed, reducing the Seafood Footprint of consumers and thus the impact on marine ecosystems will likely also require a reconsideration of the quantities of fish and seafood being consumed. Our results indicate that more than half of respondents in Croatia (68%), Italy (60%) and Turkey (58%) eat 1 to 2 servings of seafood per week – with a small share (from 1% in Croatia to 3% in Turkey) eating seafood almost every day – whereas production of 1 unit (e.g., a kg) of seafood products requires more land displacement and CO_2 emissions (i.e., higher Footprint intensities) than that of plant-based foods such as vegetables, fruits, legumes and cereals (Clune et al., 2017; Galli et al., 2020a; Kim et al., 2019).

To conclude, fertile ground exists in the three Mediterranean countries addressed in this study, especially in Italy and Turkey, for a consumer behaviour change campaign encouraging the consumption of a larger and more diversified basket of fish and seafood species, which could contribute – via promoting the consumption of low trophic level species – to reduced Seafood Footprints. A comprehensive Pan-Mediterranean study would then be needed to identify similarities and differences across all other Mediterranean countries, thus helping prioritize areas in which to establish consumer campaigns across the whole Mediterranean region.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Acknowledgements

We would like to acknowledge MAVA Foundation pour la Nature (Grant No. 17077) for its support to Global Footprint Network's project "*Application and incorporation of Ecological Footprint to* support *sustainable artisanal seafood commodity markets*". Thanks are then due to our colleagues Maria Serena Mancini, Yuqi Song, David Lin and Debora Barioni for their help with the Footprint assessments and the survey development as well as to WWF Mediterranean Marine Initiative and WWF National Offices (Adria, Austria, Italy and Turkey) for fundamental discussions on the consumer survey development, and for feedbacks on earlier versions of this paper. We also thank representatives of the LIFE platform for their comments on the manuscript as well as the two anonymous reviewers for their help in identifying the right focus of the article. We finally note that the results and views expressed in this paper are our own and do not represent the viewpoints of MAVA, WWF and LIFE.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ocecoaman.2021.105915.

Appendix 1. Survey questions and results

1. Gender:
   a) Male
   b) Female
   c) Other
2. Age:
   a) Less than 18
   b) 18-35
   c) 36-45
   d) 46-55
   e) More than 55
3. Region of Residence:

ITALY	CROATIA	TURKEY
Abruzzo	Bjelovarsko-bilogorska županija	Adana
Basilicata	Brodsko-posavska županija	Agri
Calabria	Dubrovačko-neretvanska županija	Ankara
Campania	Grad Zagreb	Antalya
Emilia-Romagna	Istarska županija/Regione istriana	Aydin
Friuli Venezia-Giulia	Karlovačka županija	Balıkesir
Lazio	Koprivničko-križevačka županija	Bursa
Liguria	Krapinsko-zagorska županija	Erzurum
Lombardia	Ličko-senjska županija	Gaziantep
Marche	Međimurska županija	Hatay
Molise	Osječko-baranjska županija	Instanbul
Piemonte	Požeško-slavonska županija	Izmir
Puglia	Primorsko-goranska županija	Kastamonu
Sardegna	Šibensko-kninska županija	Kayseri
Sicilia	Sisačko-moslavačka županija	Kirikkale
Toscana	Splitsko-dalmatinska županija	Kocaeli
Trentino Alto-Adige	Varaždinska županija	Konya
Umbria	Virovitičko-podravska županija	Malatya
Valle d'Aosta	Vukovarsko-srijemska županija	Manisa
Veneto	Zadarska županija	Mardin
	Zagrebačka županija	Samsun
		Sanliurfa
		Tekirdağ
		Trabzon
		Van
		Zonguldak

4. **How far is the place you live from the sea in km (take into consideration the seaside place closest to your home)?**___________ *[Next, we will divide the sample responses into agreed bands. E.g..: lives on the coast, 20–*30 km *from the coast, away from the coast]*
5. The highest educational level completed:
   a) Elementary
   b) Middle-school
   c) High-school
   d) Higher Education (Master's, PhD, etc)
6. Family Relationship status:
   a) Single
   b) Married/partner without children
   c) Married/partner with children
   d) Widow/Widower
7. On average, how often do you eat seafood?
   a) Almost every day
   b) 3 to 4 servings in a week
   c) 1 to 2 servings in a week
   d) 1 to 2 serving(s) in a month
   e) Less than a serving per month
   f) Never/I don't eat seafood
8. **Where do you buy seafood?** *[Multiple answers possible]*

a) Supermarket
b) Local market (fixed or mobile)
c) Specialized sea shop
d) Frozen food shop market
e) Directly from the fisherman
f) E-commerce
g) I don't buy fish

9. [If you selected multiple places in question n.8] Among the places you've selected, where do you go most often to buy seafood?
   a) Supermarket
   b) Local market (fixed or mobile)
   c) Fish shop
   d) Frozen food shop market
   e) Directly from the fisherman
   f) E-commerce
10. Now think about the store where you buy fish most often and the assortment of fresh fish available. In your opinion, the assortment is:
   a) Very broad
   b) Quite broad
   c) Quite reduced
   d) Very reduced
   e) I'm not sure
11. When you go to the store of your preference to buy seafood, do you find everything you are looking for?
   a) Yes, I find what I'm looking for and more
   b) Yes, I find exactly what I am looking for
   c) No, there isn't all that I am looking for
12. **Which of the following types of seafood do you buy?** *[Multiple answers possible]*
   a) Tuna, Swordfish, salmon
   b) Sea bass, sea bream, cod, snapper
   c) Sardine, Anchovies, herrings, mackerel
   d) Squid, cuttlefish, octopus
   e) Lobster, crabs, prawns
   f) Scallops, mussels, clams
   g) Other
13. Among the seafood you've selected, which one do you buy most frequently?
   a) Tuna, Swordfish, salmon
   b) Sea bass, sea bream, cod, snapper
   c) Sardine, Anchovies, herrings, mackerel
   d) Squid, cuttlefish, octopus
   e) Lobster, crabs, prawns
   f) Scallops, mussels, clams
   g) Other
14. When you buy seafood, you prefer …
   a) Fresh
   b) Frozen
   c) Canned
15. When you buy fish, do you look if there are different types of fish from those you usually buy?
   a) Yes, always or frequently
   b) Yes, sometimes
   c) Rarely
   d) Never
16. How often do you try seafood that is new or unfamiliar to you?
   a) Frequently
   b) Sometimes
   c) Rarely
   d) Never
17. **When you don't taste a new or unfamiliar seafood, what are the reasons?** *[Multiple answers possible: max 3]*
   a) Unknown flavour
   b) No interest in tasting new products
   c) Not knowledge of preparation and/or cooking methods
   d) Uninviting and/or appetizing aspect
   e) High price
   f) Origin from particular zones/seas
   g) Production method (caught/bred)
   h) I don't use that type of fish in my culture/community
   i) Other *(specify)*
18. **What is important for you when shopping for seafood?** *[Multiple answers possible: max 3]*
   a) Freshness

b) Taste and texture of the seafood
c) Health and nutritional benefits
d) Price
e) Sustainability of the production/fishing method
f) Cooking and preparation knowledge
g) Habit (A type of fish I am familiar eating)
h) Production method (breeding/fishing)
i) Country or zone of origin
j) Tips from the seller
k) Processing level (whole, gutted, filleted, ready for consumption …)
l) Trusted brand
m) Certifications by authorized bodies (Friend of sea …)
n) Other

19. From the choices below, what do you think is most important for seafood sustainability?
a) Seasonality (e.g. avoiding certain species during reproductive seasons)
b) Fishing practices and gear not damaging the environment
c) Minimizing unwanted catch of endangered species
d) Healthy fish population (e.g. caught rate is proportional to fish availability)
e) Less packaging on seafood
f) Support local economy
g) Fishermen actively and locally involved in resource management
h) Support traditional fishing communities and cultures
i) Employ decent and fair working conditions for fisherman
j) Meet certain health and safety standards
k) Other
l) I don't know enough about sustainable seafood to answer

20. Among the elements you have previously selected, what is the main element that defines sustainable fishing?
a) Seasonality (e.g. avoiding certain species during reproductive seasons)
b) Fishing practices and gear not damaging the environment
c) Minimizing unwanted catch of endangered species
d) Healthy fish population (e.g. caught rate is proportional to fish availability)
e) Less packaging on seafood
f) Support local economy
g) Fishermen actively and locally involved in resource management
h) Support traditional fishing communities and cultures
i) Employ decent and fair working conditions for fisherman
j) Meet certain health and safety standards
k) Other

21. **How influential would the following be while shopping for seafood?** (indicate the level of influence for each answer choice)

	Very influential	Influential	Somewhat influential	Not influential at all
Discount or special promotion				
Recommendations from fish seller				
Fish assortment (availability of alternatives)				
Sustainability information about the fish				
Presentation of the fish (cleaned and/or ready to cook)				
Cooking/Recipe tips				
Production method information (breeding/fishing)				
Information on freshness/defrosted				
Origin				

22. **How would you like to be informed while shopping for sustainable fish?** *(Multiple answers possible: max 3)*
a) Information on the label/packaging or tag of the fish
b) App downloadable on the phone with which you can calculate the sustainability of the products
c) QRcode on the label or tag that leads to information on sustainability
d) Information boxes inside the store, which indicate the most sustainable choices
e) Information gathered directly from the fish seller
f) I would not like to be informed in the store, I inquire independently
g) I would not like to be informed about sustainable fisheries

23. Have you ever heard about artisanal small-scale fisheries?
a. Yes
b. No

24. [If the answer is Yes to the question n.22] How informed are you about artisanal small-scale fisheries?
a. Very
b. Somewhat

   c. Little
25. How sustainable do you think small-scale fisheries are compared to industrial large-scale fisheries<i>?</i>
   a. More sustainable
   b. As sustainable
   c. Less sustainable
   d. I`m not familiar with these terms

Small-scale fisheries (SSFs) are fishing households, as opposed to commercial companies, who are self-employed fishermen engaged in directly providing food for their household and communities using smaller vessels and relatively low-tech gear.

26. Would you consider purchasing a different fish if you knew it was caught by artisanal small-scale fisheries rather than by industrial large-scale fisheries?
   a. Very likely
   b. Quite likely
   c. Little likely
   d. Not likely

Appendix 2. Complete COICOP Land Use Matrix (CoLUM) results

			Global hectares per person						
Country	COICOP code	COICOP name	Cropland	Grazing land	Forest products	Fishing grounds	Built-up land	Carbon	Total
Croatia	CP011.1	Bread and Cereals	0.1280	0.0012	0.0037	0.0023	0.0006	0.0151	0.1508
Croatia	CP011.2	Meat	0.0638	0.0645	0.0204	0.0058	0.0026	0.0647	0.2217
Croatia	CP011.3	Fish and Seafood	0.0199	0.0011	0.0032	0.0338	0.0005	0.0135	0.0720
Croatia	CP011.4	Milk, cheese, and eggs	0.0315	0.0289	0.0089	0.0007	0.0009	0.0251	0.0959
Croatia	CP011.5	Oils and fats	0.1178	0.0082	0.0142	0.0014	0.0018	0.0439	0.1872
Croatia	CP011.6	Fruit	0.0633	0.0012	0.0038	0.0023	0.0006	0.0154	0.0865
Croatia	CP011.7	Vegetables	0.0605	0.0012	0.0037	0.0023	0.0006	0.0148	0.0831
Croatia	CP011.8	Sugar, jam, honey, chocolate, confectionery	0.0229	0.0011	0.0033	0.0021	0.0004	0.0114	0.0412
Croatia	CP011.9	Food products n.e.c.	0.0210	0.0011	0.0034	0.0022	0.0005	0.0120	0.0402
Croatia	CP012	Non-alcoholic beverages	0.0097	0.0005	0.0037	0.0003	0.0006	0.0138	0.0287
Croatia	CP021	Alcoholic beverages	0.0149	0.0008	0.0055	0.0005	0.0009	0.0190	0.0416
Italy	CP011.1	Bread and Cereals	0.1898	0.0032	0.0023	0.0016	0.0003	0.0171	0.2144
Italy	CP011.2	Meat	0.1086	0.1741	0.0089	0.0085	0.0013	0.0542	0.3556
Italy	CP011.3	Fish and Seafood	0.0172	0.0032	0.0028	0.0805	0.0003	0.0164	0.1204
Italy	CP011.4	Milk, cheese, and eggs	0.0185	0.0143	0.0026	0.0017	0.0004	0.0151	0.0525
Italy	CP011.5	Oils and fats	0.0687	0.0114	0.0047	0.0032	0.0007	0.0242	0.1130
Italy	CP011.6	Fruit	0.0603	0.0031	0.0021	0.0016	0.0003	0.0127	0.0801
Italy	CP011.7	Vegetables	0.0601	0.0031	0.0021	0.0016	0.0003	0.0127	0.0799
Italy	CP011.8	Sugar, jam, honey, chocolate, confectionery	0.0205	0.0028	0.0020	0.0017	0.0003	0.0099	0.0371
Italy	CP011.9	Food products n.e.c.	0.0166	0.0028	0.0017	0.0015	0.0002	0.0089	0.0316
Italy	CP012	Non-alcoholic beverages	0.0084	0.0010	0.0018	0.0006	0.0003	0.0119	0.0239
Italy	CP021	Alcoholic beverages	0.0071	0.0008	0.0015	0.0005	0.0002	0.0097	0.0199
Turkey	CP011.1	Bread and Cereals	0.1576	0.0003	0.0011	0.0003	0.0003	0.0122	0.1718
Turkey	CP011.2	Meat	0.0566	0.0488	0.0024	0.0005	0.0007	0.0234	0.1323
Turkey	CP011.3	Fish and Seafood	0.0197	0.0003	0.0009	0.0242	0.0002	0.0086	0.0538
Turkey	CP011.4	Milk, cheese, and eggs	0.0452	0.0237	0.0026	0.0005	0.0006	0.0241	0.0967
Turkey	CP011.5	Oils and fats	0.0847	0.0142	0.0039	0.0008	0.0007	0.0292	0.1336
Turkey	CP011.6	Fruit	0.0680	0.0003	0.0013	0.0003	0.0003	0.0182	0.0885
Turkey	CP011.7	Vegetables	0.0659	0.0003	0.0012	0.0003	0.0003	0.0177	0.0857
Turkey	CP011.8	Sugar, jam, honey, chocolate, confectionery	0.0290	0.0003	0.0011	0.0003	0.0002	0.0093	0.0403
Turkey	CP011.9	Food products n.e.c.	0.0196	0.0002	0.0006	0.0002	0.0001	0.0050	0.0258
Turkey	CP012	Non-alcoholic beverages	0.0228	0.0003	0.0029	0.0004	0.0006	0.0254	0.0524
Turkey	CP021	Alcoholic beverages	0.0128	0.0002	0.0015	0.0003	0.0003	0.0120	0.0270

References

Aguiar, A., Chepeliev, M., Corong, E.L., McDougall, R., van der Mensbrugghe, D., 2019. The GTAP data base: version 10. Journal of Global Economic Analysis 4 (1), 1–27.

Alfaro-Shigueto, J., Mangel, J.C., Pajuelo, M., Dutton, P.H., Seminoff, J.A., Godley, B.J., 2010. Where small can have a large impact: structure and characterization of small-scale fisheries in Peru. Fish. Res. 106 (1), 8–17. https://doi.org/10.1016/j.fishres.2010.06.004.

Baabou, W., Grunewald, N., Ouellet-Plamondon, C., Gressot, M., Galli, A., 2017. The Ecological Footprint of Mediterranean cities: awareness creation and policy implications. Environ. Sci. Pol. 69, 94–104. https://doi.org/10.1016/j.envsci.2016.12.013.

Bach-Faig, A., Berry, E.M., Lairon, D., Reguant, J., Trichopoulou, A., Dernini, S., Medina, F.X., Battino, M., Belahsen, R., Miranda, G., Serra-Majem, L., 2011. Mediterranean diet pyramid today. Science and cultural updates. Publ. Health Nutr. 14 (12A), 2274–2284. https://doi.org/10.1017/S1368980011002515. Mediterranean Diet Foundation Expert Group.

Bene, C., Arthur, R., Norbury, H., Allison, E.H., Beveridge, M., Bush, S., Campling, L., Leschen, W., Little, D., Squires, D., Thilsted, S.H., Troell, M., Williams, M., 2016. Contribution of Fisheries and Aquaculture to Food Security and Poverty Reduction: Assessing the Current Evidence. https://doi.org/10.1016/j.worlddev.2015.11.007.

Borucke, M., Moore, D., Cranston, G., Gracey, K., Iha, K., Larson, J., Lazarus, E., Morales, J.C., Wackernagel, M., Galli, A., 2013. Accounting for demand and supply of the biosphere's regenerative capacity: the National Footprint Accounts'

underlying methodology and framework. Ecol. Indicat. 24, 518–533. https://doi.org/10.1016/j.ecolind.2012.08.005.
Brécard, D., Hlaimi, B., Lucas, S., Perraudeau, Y., Salladarré, F., 2009. Determinants of demand for green products: an application to eco-label demand for fish in Europe. Ecol. Econ. 69 (1), 115–125. https://doi.org/10.1016/j.ecolecon.2009.07.017.
Can, M.F., Günlü, A., Can, H.Y., 2015. Fish consumption preferences and factors influencing it. Food Sci. Technol. 35 (2), 339–346. https://doi.org/10.1590/1678-457X.6624.
Carlucci, D., Nocella, G., De Devitiis, B., Viscecchia, R., Bimbo, F., Nardone, G., 2015. Consumer purchasing behaviour towards fish and seafood products. Patterns and insights from a sample of international studies. Appetite 84, 212–227. https://doi.org/10.1016/j.appet.2014.10.008.
CFS, H.L.P.E., 2014. Sustainable Fisheries and Aquaculture for Food Security and Nutrition: A Report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. http://www.fao.org/3/i3844e/i3844e.pdf.
Christensen, L., 2013. The role of Web interviews as part of a national travel survey. In: Zmud, J., Lee-Gosselin, M., Munizaga, M., Antonio Carrasco, J. (Eds.), Transport Survey Methods. Emerald Group Publishing Limited, pp. 115–154. https://doi.org/10.1108/9781781902882-006.
Clark, T.P., Longo, S.B., Clark, B., Jorgenson, A.K., 2018. Socio-structural drivers, fisheries footprints, and seafood consumption: a comparative international study, 1961-2012. J. Rural Stud. 57, 140–146.
Clark, M., 2019. Changing dietary patterns as drivers of changing environmental impacts. Encyclopedia of Food Security and Sustainability 1, 172–177.
Clune, S., Crossin, E., Verghese, K., 2017. Systematic review of greenhouse gas emissions for different fresh food categories. J. Clean. Prod. 140, 766–783.
Cohen, P.J., Allison, E.H., Andrew, N.L., Cinner, J., Evans, L.S., Fabinyi, M., Garces, L.R., Hall, S.J., Hicks, C.C., Hughes, T.P., Jentoft, S., Mills, D.J., Masu, R., Mbaru, E.K., Ratner, B.D., 2019. Securing a just space for small-scale fisheries in the blue economy. Frontiers in Marine Science 6. https://doi.org/10.3389/fmars.2019.00171.
Cosmina, M., Demartini, E., Gaviglio, A., Mauracher, C., Prestamburgo, S., Trevisan, G., 2012. Italian Consumer Attitudes towards Small Pelagic Fish.
Cramer, W., Guiot, J., Fader, M., Garrabou, J., Gattuso, J.-P., Iglesias, A., Lange, M.A., Lionello, P., Llasat, M.C., Paz, S., Peñuelas, J., Snoussi, M., Toreti, A., Tsimplis, M.N., Xoplaki, E., 2018. Climate change and interconnected risks to sustainable development in the Mediterranean. Nat. Clim. Change 8 (11), 972–980. https://doi.org/10.1038/s41558-018-0299-2.
Deumling, D., Wackernagel, M., Monfreda, C., 2003. EATING UP THE earth: HOW SUSTAINABLE FOOD systems shrink our ecological footprint. Agriculture Footprint Brief 12.
Erdoğan, B.E., Mol, S., Coşansu, S., 2011. Factors influencing the consumption of seafood in istanbul. Turkey 9.
Ewing, B.R., Hawkins, T.R., Wiedmann, T.O., Galli, A., Ercin, A.E., Weinzettel, J., Steen-Olsen, K., 2012. Integrating ecological and water footprint accounting in a multi-regional input–output framework. Ecol. Indicat. 23, 1–8.
FAO, 2018. The State of World Fisheries and Aquaculture 2018 - Meeting the Sustainable Development Goals (P. 210). Food and Agriculture Organization of the United Nations. http://www.fao.org/3/i9540en/i9540en.pdf.
FAO, 2019. Social Protection for Small-Scale Fisheries in the Mediterranean Region – A Review. Food and Agriculture Organization of the United Nations. http://www.fao.org/3/ca4711en/ca4711en.pdf Farmery, A.
Farmery, A., Gardner, C., Green, B.S., Jennings, S., 2014. Managing fisheries for environmental performance: the effects of marine resource decision-making on the footprint of seafood. J. Clean. Prod. 64, 368–376.
Galli, A., 2015. On the rationale and policy usefulness of Ecological Footprint Accounting: the case of Morocco. Environ. Sci. Pol. 48, 210–224. https://doi.org/10.1016/j.envsci.2015.01.008.
Galli, A., Kitzes, J., Niccolucci, V., Wackernagel, M., Wada, Y., Marchettini, N., 2012. Assessing the global environmental consequences of economic growth through the Ecological Footprint: a focus on China and India. Ecol. Indicat. 17, 99–107. https://doi.org/10.1016/j.ecolind.2011.04.022.
Galli, A., Wackernagel, M., Iha, K., Lazarus, E., 2014. Ecological footprint: implications for biodiversity. Biol. Conserv. 173, 121–132. https://doi.org/10.1016/j.biocon.2013.10.019.
Galli, A., Iha, K., Halle, M., El Bilali, H., Grunewald, N., Eaton, D., Capone, R., Debs, P., Bottalico, F., 2017. Mediterranean countries' food consumption and sourcing patterns: an Ecological Footprint viewpoint. Sci. Total Environ. 578, 383–391. https://doi.org/10.1016/j.scitotenv.2016.10.191.
Galli, A., Moreno Pires, S., Iha, K., Alves, A.A., Lin, D., Mancini, M.S., Teles, F., 2020a. Sustainable food transition in Portugal: assessing the Footprint of dietary choices and gaps in national and local food policies. Sci. Total Environ. 749, 141307.
Galli, A., Iha, K., Moreno Pires, S., Mancini, M.S., Alves, A., Zokai, G., Lin, D., Murthy, A., Wackernagel, M., 2020b. Assessing the Ecological Footprint and biocapacity of Portuguese cities: critical results for environmental awareness and local management. Cities 96, 102442. https://doi.org/10.1016/j.cities.2019.102442.
General Fisheries Commission for the Mediterranean GFCM, 2021. GFCM 2030 Strategy for Sustainable Fisheries and Aquaculture in the Mediterranean and the Black Sea. Available on-line at: https://gfcmsitestorage.blob.core.windows.net/website/4.Publications/GFCM%202030%20STRATEGY_FINAL.pdf.
Gephart, J., 2019. Global seafood trade. Encyclopedia of Food Security and Sustainability 1, 93–97.
Global Footprint Network, 2019. National Footprint Accounts, 2019 Edition. www.data.footprintnetwork.org.
Godfray, H.C.J., Garnett, T., 2014. Food security and sustainable intensification. Phil. Trans. Biol. Sci. 369 (1639), 20120273. https://doi.org/10.1098/rstb.2012.0273.
Goldfinger, S., Wackernagel, M., Galli, A., Lazarus, E., Lin, D., 2014. Footprint facts and fallacies: a response to giampietro and saltelli (2014) "footprints to nowhere. Ecol. Indicat. 46, 622–632.
Gómez, S., Maynou, F., 2021. Alternative seafood marketing systems foster trasformative processes in Mediterranean Fisheries. Mar. Pol. 127, 104432.
GTAP10, 2020. GTAP Data Bases: GTAP 10 Data Base. https://www.gtap.agecon.purdue.edu/databases/v10/index.aspx.
Guillen, J., Natale, F., Carvalho, N., Casey, J., Hofherr, J., et al., 2019. Global seafood consumption footprint. Ambio 48, 111–122.
Hansen, K.M., Pedersen, R.T., 2012. Efficiency of different recruitment strategies for Web panels. Int. J. Publ. Opin. Res. 24 (2), 238–249. https://doi.org/10.1093/ijpor/edr020.
Hilborn, R., Fulton, E.A., Green, B.S., Hartmann, K., Tracey, S.R., Watson, R.A., 2015. When is a fishery sustainable? Can. J. Fish. Aquat. Sci. 72 (9), 1433–1441. https://doi.org/10.1139/cjfas-2015-0062.
Isman, M., Archambault, M., Racette, P., Konga, C.N., Llaque, R.M., Lin, D., Iha, K., Ouellet-Plamondon, C.M., 2018. Ecological Footprint assessment for targeting climate change mitigation in cities: a case study of 15 Canadian cities according to census metropolitan areas. J. Clean. Prod. 174, 1032–1043. https://doi.org/10.1016/j.jclepro.2017.10.189.
IUCN, 2020. The IUCN red list of threatened species. IUCN Red List of Threatened Species. https://www.iucnredlist.org/en.
Jackson, T., 2005. Motivating Sustainable Consumption: a Review of Evidence on Consumer Behaviour and Behavioural Change: a Report to the Sustainable Development Research Network. Centre for Environmental Strategy, University of Surrey, Guildford, UK. Available at: http://books.google.com/books?as_q=Infrastructures+of+Consumption:+Environmental+Innovation+in+the+Utilities+Industries&as_auth=Van Vliet.
Jeffries, E., 2017. Seafood and the Mediterranean: Local Tastes, Global Markets. WWF, Gland, Switzerland.
Johnson, D.S., 2006. Category, narrative, and value in the governance of small-scale fisheries. Mar. Pol. 30 (6), 747–756. https://doi.org/10.1016/j.marpol.2006.01.002.
Johnson, D.S., Acott, T.G., Stacey, N., Urquhart, J., 2018. Social Wellbeing and the Values of Small-Scale Fisheries. MARE Publication Series, Springer International Publishing AG, ISBN 978-3-319-60750-4.
Kautsky, N., Berg, H., Folke, C., Larsson, J., Troell, M., 1997. Ecological footprint for assessment of resource use and development limitations in shrimp and tilapia aquaculture. Aquacult. Res. 28 (10), 753–766. https://doi.org/10.1046/j.1365-2109.1997.00940.x.
Kearney, J., 2010. Food consumption trends and drivers. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences 365 (1554), 2793–2807. https://doi.org/10.1098/rstb.2010.0149.
Kim, B.F., Santo, R.E., Scatterday, A.P., Fry, J.P., Synk, C.M., et al., 2019. Country-specific dietary shifts to mitigate climate and water crises. Global Environ. Change, 101926.
Kissinger, M., Fix, J., Rees, W.E., 2007. Wood and non-wood pulp production: comparative ecological footprinting on the Canadian prairies. Ecol. Econ. 62 (3–4), 552–558. https://doi.org/10.1016/j.ecolecon.2006.07.019.
Kittinger, J.N., Finkbeiner, E.M., Ban, N.C., Broad, K., Carr, M.H., Cinner, J.E., Gelcich, S., Cornwell, M.L., Koehn, J.Z., Basurto, X., Fujita, R., Caldwell, M.R., Crowder, L.B., 2013. Emerging frontiers in social-ecological systems research for sustainability of small-scale fisheries. Current Opinion in Environmental Sustainability 5 (3), 352–357. https://doi.org/10.1016/j.cosust.2013.06.008.
Kitzes, J., Galli, A., Bagliani, M., Barrett, J., Dige, G., Ede, S., Erb, K., Giljum, S., Haberl, H., Hails, C., Jungwirth, S., Lenzen, M., Lewis, K., Loh, J., Marchettini, N., Messinger, H., Milne, K., Moles, R., Monfreda, C., Wiedmann, T., 2009. A research agenda for improving national Ecological Footprint accounts. Ecol. Econ. 68, 1991–2007.
Kolding, J., Béné, C., Bavinck, M., 2014. Small-scale fisheries. In: Governance of Marine Fisheries and Biodiversity Conservation. John Wiley & Sons, Ltd, pp. 317–331. https://doi.org/10.1002/9781118392607.ch22.
Lin, D., Galli, A., Borucke, M., Lazarus, E., Grunewald, N., Martindill, J., Zimmerman, D., Mancini, S., Iha, K., Wackernagel, M., 2015. Tracking supply and demand of biocapacity through ecological footprint accounting. In: DeWulf, J., De Meester, S., Alvarenga, R.A.F. (Eds.), Sustainability Assessment of Renewables-Based Products: Methods and Case Studies. Wiley, pp. 179–199. https://doi.org/10.1002/9781118933916.ch12.
Lin, D., Hanscom, L., Murthy, A., Galli, A., Evans, M., Neill, E., Mancini, M.S., Martindill, J., Medouar, F.-Z., Huang, S., Wackernagel, M., 2018. Ecological footprint accounting for countries: updates and results of the national footprint accounts, 2012–2018. Resources 7 (3), 58. https://doi.org/10.3390/resources7030058.
Lucas, S., Soler, L.G., Irz, X., Gascuel, D., Aubin, J., Cloatre, T., 2021. The environmental impact of the consumption of fishery and aquaculture products in France. J. Clean. Prod. 299, 126718.
Mancini, M.S., Galli, A., Niccolucci, V., Lin, D., Hanscom, L., Wackernagel, M., Bastianoni, S., Marchettini, N., 2017. Stocks and flows of natural capital: implications for ecological footprint. Ecol. Indicat. 77, 123–128. https://doi.org/10.1016/j.ecolind.2017.01.033.
Mancini, M., Evans, M., Iha, K., Danelutti, C., Galli, A., Mancini, M.S., Evans, M., Iha, K., Danelutti, C., Galli, A., 2018a. Assessing the ecological footprint of ecotourism packages: a methodological proposition. Resources 7 (2), 38. https://doi.org/10.3390/resources7020038.

Mancini, M.S., Galli, A., Coscieme, L., Niccolucci, V., Lin, D., Pulselli, F.M., Bastianoni, S., Marchettini, N., 2018b. Exploring ecosystem services assessment through Ecological Footprint accounting. Ecosystem Services 30, 228–235. https://doi.org/10.1016/j.ecoser.2018.01.010.

Mantziaris, S., Liontakis, A., Valakas, G., Tzouramani, I., 2021. Family-run or business-oriented fisheries? Integrating socioeconomic and environmental aspects to assess the societal impact. Mar. Pol. 131, 104591.

Mauracher, C., Tempesta, T., Vecchiato, D., 2013. Consumer preferences regarding the introduction of new organic products. The case of the Mediterranean sea bass (Dicentrarchus labrax) in Italy. Appetite 63, 84–91. https://doi.org/10.1016/j.appet.2012.12.009.

MedECC, 2019. MedECC. https://www.medecc.org/.

Monterey Bay Aquarium, 2020. Monterey Bay Aquarium. https://www.montereybayaquarium.org/.

Moore, J., Kissinger, M., Rees, W.E., 2013. An urban metabolism and ecological footprint assessment of Metro Vancouver. J. Environ. Manag. 124, 51–61.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B., Kent, J., 2000. Biodiversity hotspots for conservation priorities. Nature 403 (6772), 853–858. https://doi.org/10.1038/35002501.

Nates, S.F. (Ed.), 2016. Aquafeed Formulation. Academic Press, Waltham, USA, ISBN 978-0-12-800873-7.

Parker, R.W.R., Tyedmers, P.H., 2015. Fuel consumption of global fishing fleets: current understanding and knowledge gaps. Fish Fish. 16, 684–696.

Prato, E., Biandolino, F., 2015. The contribution of fish to the mediterranean diet. In: The Mediterranean Diet: an Evidence-Based Approach, pp. 165–174. https://doi.org/10.1016/B978-0-12-407849-9.00016-6.

Purcell, S.W., Pomeroy, R.S., 2015. Driving small-scale fisheries in developing countries. Frontiers in Marine Science 2. https://doi.org/10.3389/fmars.2015.00044.

Ramos, S., Vazquez-Rowe, I., Artetxe, I., Zufıa, J., 2011. Environmental assessment of the Atlantic mackerel (Scomber scombrus) season in the Basque Country. Increasing the timeline delimitation in fishery LCA studies. Int. J. Life Cycle Assess. 16, 599–610.

Rondoni, A., Grasso, S., 2021. Consumers behaviour towards carbon footprint labels on food: a review of the literature and discussion of industry implications. J. Clean. Prod. 301, 127031.

Shester, G.G., Micheli, F., 2011. Conservation challenges for small-scale fisheries: bycatch and habitat impacts of traps and gillnets. Biol. Conserv. 144 (5), 1673–1681. https://doi.org/10.1016/j.biocon.2011.02.023.

Simmons, C., Lewis, K., Barrett, J., others, 2000. Two feet-two approaches: a component-based model of ecological footprinting. Ecol. Econ. 32 (3), 375–380.

Smith, M.D., Roheim, C.A., Crowder, L.B., Halpern, B.S., Turnipseed, M., Anderson, J.L., Asche, F., Bourillón, L., Guttormsen, A.G., Khan, A., Liguori, L.A., McNevin, A., O'Connor, M.I., Squires, D., Tyedmers, P., Brownstein, C., Carden, K., Klinger, D.H., Sagarin, R., Selkoe, K.A., 2010. Sustainability and global seafood. Science 327 (5967), 784–786. https://doi.org/10.1126/science.1185345.

Solarin, S.A., Gil-Alana, L.A., Lafuente, C., 2021. Persistence and sustainability of fishing grounds footprint: evidence from 89 countries. Sci. Total Environ. 751, 141594.

Spingmann, M., Spajic, L., Clark, M.A., Poore, J., Herforth, A., Webb, P., Rayner, M., Scarborough, P., 2020. The healthiness and sustainability of national and global food based dietary guidelines: modelling study. BMJ2020 370, m2322. https://doi.org/10.1136/bmj.m2322.

Stefani, G., Scarpa, R., Cavicchi, A., 2012. Exploring consumer's preferences for farmed sea bream. Aquacult. Int. 20 (4), 673–691. https://doi.org/10.1007/s10499-011-9495-z.

Tilman, D., Clark, M., 2014. Global diets link environmental sustainability and human health. Nature 515 (7528), 518–522. https://doi.org/10.1038/nature13959.

Tovar-Sánchez, A., Sánchez-Quiles, D., Rodríguez-Romero, A., 2019. Massive coastal tourism influx to the Mediterranean Sea: the environmental risk of sunscreens. Science of the Environment 656, 316–321.

Tsikliras, A.C., Dinouli, A., Tsiros, V.-Z., Tsalkou, E., 2015. The mediterranean and Black Sea fisheries at risk from overexploitation. PloS One 10 (3). https://doi.org/10.1371/journal.pone.0121188.

Tyedmers, P.H., 2000. Salmon and Sustainability: the Biophysical Cost of Producing Salmon through the Commercial Salmon Fishery and the Intensive Salmon Culture Industry. https://doi.org/10.14288/1.0099686.

UNSD — Welcome to, U.N.S.D., 2020. https://unstats.un.org/home/.

UNWTO, 2017. Tourism Highlights, 2017 Edition. In: World Tourism Organization, 42. calle Poeta Joan Maragall, Madrid, Spain, p. 28020.

Wackernagel, M., 1999. How many? People can the earth support? Ecol. Econ. 29 (3), 485–488.

Wackernagel, Mathis, Rees, W., 1996. Our ecological footprint - reducing human impact on the Earth. Environ. Urbanization 8 (2), 216, 216.

Wada, Y., 1993. The Appropriated Carrying Capacity of Tomato Production: Comparing the Ecological Footprints of Hydroponic Greenhouse and Mechanized Field Operations. https://doi.org/10.14288/1.0086320.

Warren-Rhodes, K., Sadovy, Y., Cesar, H., 2003. Marine ecosystem appropriation in the Indo-Pacific: a case study of the live reef fish food trade. Ambio 32 (7), 481–488.

Weinzettel, J., Steen-Olsen, K., Hertwich, E.G., Borucke, M., Galli, A., 2014. Ecological footprint of nations: comparison of process analysis, and standard and hybrid multiregional input–output analysis. Ecol. Econ. 101, 115–126. https://doi.org/10.1016/j.ecolecon.2014.02.020.

Wiedmann, T., Minx, J., Barrett, J., Wackernagel, M., 2006. Allocating ecological footprints to final consumption categories with input–output analysis. Ecol. Econ. 56 (1), 28–48.

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L.J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J.A., Vries, W.D., Sibanda, L.M., Murray, C.J.L., 2019. Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. Lancet 393 (1017), 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4.

Wilson, J., Grant, J.L., 2009. Calculating ecological footprints at the municipal level: what is a reasonable approach for Canada? Local Environ. 14 (10), 963–979.

WWF, 2020. Transforming Small-Scale Fisheries. WWF. Retrieved July 30, 2020, from. https://www.wwfmmi.org/what_we_do/fisheries/transforming_small_scale_fisheries/.

Yu, H., Wang, Y., Li, X., Wang, C., Sun, M., Du, A., 2019. Measuring ecological capital: state of the art, trends, and challenges. J. Clean. Prod. 219, 833–845. https://doi.org/10.1016/j.jclepro.2019.02.014.

Ziegler, F., Hornborg, S., Green, B.S., Eigaard, O.E., Farmery, A.K., et al., 2016. Expanding the concept of sustainable seafood using Life Cycle Assessment. Fish Fish. 17, 1073–1093.