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Implications of consumer understanding and valuation of environmental attributes for sustainable seafood markets

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Table of Contents

Executive summary 1

Introduction 2

Seafood sector and food security 2

Capture fisheries and aquaculture 2

Sustainability issues in aquaculture and their influence on stakeholders 2

Trends and directions in aquaculture 3

Consumers, their attitudes and stakeholder roles 4

Purpose and objectives of report 5

METHODS 5

Perceptions and acceptance of IMTA and sustainable aquaculture 6

Consumers' perceptions, attitudes and preferences 6

Canada 7

United States of America 7

Europe 8

Market assessments on IMTA and sustainable aquaculture: Asia 9

What do consumers truly value? 10

Discussion: Moving towards more sustainable aquaculture markets 11

Consumer knowledge and awareness 12

Linking WTP with actual purchasing behaviour 13

The aquaculture value chain: the power of wholesalers and retailers 13

Achieving sustainability under the policy domain 15

Conclusion 17

REFERENCES 1

APPENDIX 1 1

Executive summary

Expanding markets for sustainably farmed seafood is widely acknowledged as an essential element in advancing the sustainability within the aquaculture sector. Many consumer studies indicate that fish buyers care about environmental quality, and some indicate that they would be willing to pay a premium for sustainably farmed fish. Nevertheless, these expressions rarely translate into purchasing behaviours. Often, other product attributes, notably location of production and price play a stronger role in influencing purchases. Moreover, many respondents in aquaculture surveys lack knowledge and awareness about production methods and their sustainability and there may not be enough information (e.g., certification label) at points of purchase to guide their decisions. From the producers' side, sustainable practices are usually more expensive than conventional ones and unless fish farmers believe that they can recoup the added expense, they are unlikely to independently change production methods. This of course creates a role for policy and regulation and within the EU, sustainable aquaculture is an integral part of blue bioeconomy initiatives, multiple Directives, and the Green Deal. Some of these initiatives incorporate supporting public education and increasing consumer awareness together with supports for sustainable production.

This report is a desktop review investigating drivers of sustainable fish farming practice from the standpoint of the aquaculture value chain. It includes factors influencing consumer's WTP for sustainably farmed products, including attributes of farmed fish and seafood and characteristics of consumers (e.g., demographics, environmental awareness, and concern). Other nodes in the value chain, in particular producers, wholesalers and large retailers are also investigated. The role of the general public is also touched upon. Attitudes towards sustainably farmed fish are a proxy for attitudes towards environmental quality. Therefore, regardless of whether a person purchases fish, their expressed support for more sustainable aquaculture is a signal to policy makers and regulators. That is, if markets fail to ensure sustainability, the gap needs to be addressed by public authorities.

In preparing the report, we conducted a systematic scan of the literature and narrative review of revealed preference studies of consumer and public attitudes and value chain analyses. We also conducted a semi-quantitative review of revealed preference studies to obtain insights into the correspondence between consumer profiles and the WTP for specific product attributes, including sustainability. This study also incorporates results of several interviews with stakeholders along the aquaculture supply chain from producers to consumers and a scan of literature on aquaculture markets and value chains.

Notwithstanding the substantial body of literature on consumers' preferences for sustainably farmed fish, there is ample evidence that consumers may have relatively less influence on production decisions compared to wholesalers and large retailers. These two stakeholders exert tremendous influence on the types of fish produced and the price that producers receive. They also have a role in shaping consumer attitudes and influencing their decisions through advertising and promotion. This situation reinforces the role of regulation and raises the question of whether and how wholesalers and large retailers can be influenced.

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Introduction

Seafood sector and food security

The seafood sector in general, and aquaculture in particular has become an increasingly central topic in discussions about global food security. In many regions, fish, shellfish and marine plants are an essential part of traditional diets and livelihoods. In others, fish have become more prominent because it is seen as a healthy alternative to other sources of animal protein such as poultry, beef, and pork. Coupled with rising population growth, these changing tastes have caused increased demand that has driven expansion in capture fisheries and aquaculture. Over the past 62 years, global fish consumption has actually outpaced population growth, rising on average 3.1% annually between 1961 and 2017, with per capita annual consumption rising from approximately 9 kg in 1961 to >25 kg in 2018, almost double the rate of global population increase (1). Seafood comprised 35% of the global animal protein production in 2013 (2). Without functional marine habitats, 10% of the world's population would face imminent threats to their survival (3,4).

Capture fisheries and aquaculture

Satisfying this rising demand has put unprecedented pressure on many wild stocks. It has also created opportunities for aquaculture that were non-existent 40 years ago. Aquaculture production has expanded from under 20 million Mt in 1980 to 122 million Mt in 2022 (3). Aquaculture has also been the fastest growing livestock sector in the world for at least a decade, outstripping beef, pork, and poultry (5). In 2020, cultured fish production was 87.5mm MT or 46% of global fish harvested (1). Adding seaweed increases aquaculture's share of global aquatic food output to 54.1% (6). By 2030, aquaculture production is expected to reach 140mm MT and will overtake that of capture fisheries (7–9). In most aquaculture sectors, Europe lags behind Asia, with total production of 3,291.7 thousand Mt or 2.69% of global production (122,578.5 thousand Mt) (3). EU production is distributed over fed finfish (2,673,669 Mt), molluscs (578,712 tons), algae (21,792 Mt), crustaceans (3,563 Mt), and all other aquatic animals (6,671 Mt) (3).

Sustainability issues in aquaculture and their influence on stakeholders

Notwithstanding its importance as a supplier of aquatic products, the aquaculture value chain has numerous sustainability issues (10). These include pollution (nutrient, chemical, and pharmaceutical) (11,12) and pressures on wild stocks caught to manufacture feed for fed finfish (13). Additional problems for all types of aquatic farming range from local impacts such as visual disamenity, escapees, and biosecurity risks to global issues related to international trade of aquaculture products (e.g., transportation, exportation of benefits) and competition over the

use of sea space (11,12,14–16). Concerns about the health and safety of aquaculture and farmed fish has negatively influenced public perceptions and stakeholder acceptance of the sector and has attracted considerable attention from policy and regulatory decision-makers. They have also led to a considerable amount of scientific evidence that now informs aquaculture governance. Debates around sustainable aquaculture fall within larger discussions related to transforming agri-food systems so that they are economically and environmentally sustainable and capable of supporting healthy communities (17–19). Sustainable aquaculture also plays a central role in EU policy priorities including the Green Deal, Marine Spatial Planning, Marine Strategy Framework, and Water Framework Directives (MSPD, MSFD, WFD) (20–22).

Trends and directions in aquaculture

Some problems outlined above have been addressed (10). For example, reductions in waste and improved resource efficiency were observed in the early 2000's (9,23). Recent progress in salmon farming shows that the replacement of fish meal with plant-based alternatives has significantly reduced the sector's reliance (and impact) on wild fish stocks (24,25). Organic aquaculture has emerged as a growth sector that addresses both human and environmental health concerns by limiting the use of chemicals and pharmaceuticals (26). Certain types of aquaculture are inherently more sustainable than others, with plants and lower trophic animals such as bivalves extracting significant quantities of nutrients from their growth environments (10). In some regions, these low trophic species are being promoted and research into their potential environmental performance is increasing. Seaweed culture in parts of northern Europe is one example as algae can extract nutrients and sequester CO_2. Coupled with growing markets for macro-algae products, these benefits have created the basis for industrial expansion in several European regions (27–30).

Integrated multi-trophic aquaculture (IMTA) is a form of polyculture that combines fed finfish with at least one lower trophic species (31). For many years, it has been promoted as a way of replicating the natural ecosystem's nutrient cycling and preventing excessive releases of uneaten food and other wastes from fish cages. Notwithstanding its limited adoption at industrial scales, IMTA principles are promoted as part of the EU's blue bioeconomy (32) and alternatives to farm-level IMTA have been considered by several researchers (33). An alternative studied in the FutureEUAqua project is basin or regional IMTA. It incorporates the principle of replicating or maintaining ecosystem nutrient cycling by planned combinations of fed finfish and extractive species in waterbodies where they are grown together. However, the requirement that all species are cultivated in a single farm unit is abandoned (33,34). The main advantage of the spatial separation is that basin-level IMTA farms are simpler to deploy and operate because they essentially operate as monoculture farms with well-understood technological, engineering and operating concepts. The main barrier to implementing basin-level IMTA is that monitoring environmental impacts requires is more advanced carrying

capacity methods and coordinated approaches to regulation than are currently available(33,34).

Consumers, their attitudes and stakeholder roles

Fish consumers are among the stakeholders that are highly integrated in the aquaculture value chain. Consumer theory posits that consumers make choices about the products that they buy according to a complex mix of personal attitudes, tastes and budget constraints, and attributes of the products themselves. Consumer considerations may include price, the availability of close substitutes, and a range of other characteristics (35,36). In the case of fish and seafood this can be the species, appearance, level of processing (e.g., fresh, frozen, whole, fillet, ready-to-eat, etc.), type of production (e.g., aquaculture vs wild caught), and country of origin. While most product attributes are directly observable, many of the personal characteristics underlying consumer choices are not. They can be inferred from purchasing behaviours or expressed through other activities. For example, a person who is active in conservation activities may be more likely to purchase sustainably produced seafood. Also, attitudes and awareness are fluid and can be influenced by education, communication and advertising (37). For this reason, observation of purchasing behaviours (e.g., what, when, where, items are purchased, how frequently they are purchased, etc.) is central to marketing (38).

In highly competitive seafood markets, understanding consumers' preferences is key for differentiating one product from another (39–41). The purchasing decision is a complex one. Expected flavour, appearance, form (e.g., whole, filet, processed), beliefs about food safety (e.g., microbial, chemical) and healthfulness compared to other foods, the product's origin, and sustainability, price, and alternatives available all contribute to the type of fish that a person buys. Similarly, personal attributes such as age, income, education, eating habits, family status, and personal tastes play a central role in determining preferences for the mix of product characteristics(42,43).

In the case of environmental sustainability, differentiating one's product generally requires being able to demonstrate that a particular production process is less polluting, more resource efficient or otherwise less damaging to the environment. In general, these "greener" practices are more costly than their conventional counterparts. Examples include integrated multi-trophic aquaculture (IMTA) and organic aquaculture. More research is required to establish the sustainability other systems such as recirculating aquaculture systems (RAS) which may. Be less polluting but also consume considerable amounts of energy and may be moreproblematic with respect to animal welfare. Whether the additional costs can be recouped is a key to whether producers will be willing to adopt such processes.

Information on consumer beliefs and preferences for more sustainably produced aquaculture products also provides information on public preferences for environmental attributes such as

clean water, visual amenity, and the use of coastal and aquatic spaces (44). For aquaculture planners and regulators, this type of information provides important signals for managing the sector with respect to site selection, types of aquaculture permitted, monitoring, and communication.

The issue of fish consumers' awareness and understanding of fish farming processes and their willingness to pay a premium for fish that is produced using more sustainable methods has, for many years been a major factor in fish farmers' production decisions. Potentially sustainable farming methods such as IMTA and RAS are more expensive than conventional monoculture. Moreover, unless these expenses can be recouped, producers are unlikely to independently choose these methods. Therefore, producers' perceptions of consumers' willingness to pay a premium (behavioural intention) for more sustainably farmed fish is as important as their actual purchases (actual behaviour) (45).

Purpose and objectives of report

This report reviews the current literature on consumer attitudes and preferences related to aquaculture products. It has two objectives. The first is to determine how sustainability attributes influence consumers' purchasing decisions. It also reflects on synergies between these other attributes and environmental sustainability in influencing purchasing behaviour. The second objective is to examine aquaculture value chains and factors other than consumer decisions that may influence the profitability of adopting more sustainable practices. The report focuses on IMTA, an important form of sustainable aquaculture.

METHODS

This is a desktop study that incorporates peer-reviewed literature and grey literature, including multiple EU and national policy-related documents on sustainable aquaculture and IMTA in particular.

Literature was identified using a systematic scan of EBSCO Host data bases, Google Scholar, EU and selected national websites. Keywords searched included combinations of the following terms and Boolean combinations: aquaculture, mariculture, sustainable, integrated multi-trophic aquaculture, IMTA, salmon, finfish, nutrient, eutrophication, consumer, public preference, willingness to pay, WTP, revealed preference, Contingent Valuation Method (CVM), Discrete Choice Experiment (DCE) method, conjoint analysis. The search returned over 500 titles. The literature selection was a tiered process involving three researchers. The first tier, a title search reduced the total by half. The second tier, an abstract scan identified approximately 100 documents which were read and summarized and used in the preparation of this report.

The following information from survey studies was extracted and compared: Attitudes, perceptions and levels of knowledge regarding IMTA, monoculture, and where relevant other sustainable production systems; WTP a premium for products of different systems; consumer and product attributes in relation to attitudes, perceptions, levels of knowledge and WTP.

Perceptions and acceptance of IMTA and sustainable aquaculture

Consumers' perceptions, attitudes and preferences

Consumers play a vital role in the economics of IMTA or other sustainable forms of aquaculture. They can be the ultimate barrier or economic incentive for sustainable product marketing opportunities even under ideal economic and biological conditions (46,47). Their purchasing decisions can provide incentives or disincentives to producers' decisions to adopt more sustainable practices (48).

Consumers' perceptions and awareness of farmed seafood, depend on many factors (49) and inform their preferences that are commonly measured as the price that they are willing to pay (WTP) for farmed fish with particular attributes (50). The underlying factors include objective knowledge and attitudes towards or beliefs about a production system and its products. Consumers' perceptions are influenced by the demographics of a surveyed population and perceived hazards (43,51). Many hazards surveyed are related to environmental impacts (48,52–54), human health (55–57), socio-economic benefit and costs (56,58,59), the public's trust of the industrial and governance sectors, in particular the perception of transparency (52), and levels of seafood consumption (60,61). The product attributes that drive consumer's purchasing behaviours often include price (62,63)(64,65), type of production system (43,63,66), geographic origin (51,61,67), level of experience with the product (68), sensory characteristics (69,70), and animal welfare (24,51,56,71,72)

Much of the research into market potential for sustainably farmed aquaculture products concerns consumers' preferences for sustainably farmed fish and other attributes such as health and animal welfare. There are several possible reasons for this. The first is that WTP provides is a signal to producers about consumers' desires and intentions. . A second reason relates to social acceptability and environmental values because consumers preferences for IMTA products can be a proxy for values placed on environmental attributes such as clean water. Thus, the results of surveys that include consumers can be useful for policy making. A review of existing studies therefore provides insights into both the economic feasibility of sustainable aquaculture systems and the acceptability of such systems on a broader social scale, both of which are required if IMTA and other sustainable systems are to be successfully deployed on an industrial scale (63,73–77).

IMTA preference studies have been conducted in Canada, United States and Europe, and to a lesser extent Asia. Most of these studies use either the CVM or DCE approaches with a smaller number using hedonic and contingent behaviour (CBM) methods. All include background questions related to environmental and purchasing behaviours, demographics, and questions related to respondents' level of knowledge, perceptions and attitudes towards aquaculture in general. The structure of the WTP questions depends primarily on the method chosen. The

WTP question is preceded by descriptions of the production method and its potential environmental benefits compared to monoculture and/or other production methods.

Canada

In Canada, one of the earliest studies to address the financial benefits of IMTA systems focused on consumers' attitudes (47). This CVM study found generally positive social attitudes toward salmon monoculture and greater approval rates for IMTA, notwithstanding relatively low levels of knowledge as to how IMTA systems function (47). A second CVM survey of local residents and restauranteurs in the aquacultural region of Bay of Fundy in Canada found that respondents regarded IMTA (salmon-seaweed-bivalves) production as a less polluting approach compared to monoculture (74). The same respondents were also concerned about hazards such as parasitic/disease outbreaks, natural stock replenishment, and improved food quality. These respondents had a higher level of knowledge than many others with weaker connections to the industry. Despite these concerns, respondents considered IMTA products safe to eat, and 50% of them were willing to pay a 10% premium for IMTA-labelled products. Barrington et al. (2010) and Martinez-Espiniera (2015) whose work was based on a contingent behaviour analysis (CBM) and modelling techniques, estimated that Canadian salmon consumers were willing to pay a higher price for the IMTA product as opposed to the products of monoculture (78,79).

United States of America

Evidence from the USA reveals positive levels of social acceptance. A market analysis of a mussels produced by IMTA in New York has shown that 88% of the seafood consumers supported IMTA either completely (16%) or mostly (72%) as a sustainable tool in industry (73). Respondents with higher levels of concern for the environment, animal welfare, food safety, health, and sensory characteristics of the product, were most favourably inclined towards IMTA systems as compared to conventional production methods. These attitudes were reflected in a WTP premium for IMTA eco-labelled mussels by 56% of the respondents (73). Similarly, oyster consumers in San Francisco were willing to pay 24-36% more for oysters produced by IMTA in contrast to oysters produced via conventional methods (80). Yip et al. (2017)'s DCE study explored the perceptions and preferences of US salmon consumers for Canadian produced Atlantic salmon from IMTA and CCA, both of which are considered sustainable forms of aquaculture (81). Although CCA was more familiar to the respondents, they favoured IMTA because they believed it is a more environmentally friendly and sustainable production method, and closer to the natural ecosystem. Results from the sample revealed a 39% marginal WTP premium for IMTA compared to a 15.7% for CCA.

Europe

European public and consumer surveys tend to focus on either northern regions or the Mediterranean Sea basin, mainly addressing salmon and sea bream, respectively (e.g., (43,51,63,82). Alexander et al. (2016) examined the public perceptions from Ireland, UK, Norway, Israel, and Italy, but without considering WTP. In general, respondents' baseline views of conventional aquaculture were favourable, yet awareness regarding IMTA was low. After the concept of IMTA was explained, respondents were positively inclined towards it. Similarly, Altintzoglou and Honkanen (2020) conducted a survey in the UK, France, Germany, Spain and Italy regarding consumers' awareness and perceptions on four distinct aquaculture production methods, including conventional, organic, IMTA and RAS. Awareness was low within the pooled sample, although respondents were knowledgeable about conventional and organic production. Attitudes towards all systems was generally positive. The participants were more accepting of systems with which they were more familiar (i.e. conventional and organic) and organic aquaculture products had the highest WTP overall. Three pan-European CVM studies found that overall consumers had a rather positive attitude towards sustainable aquaculture-driven specific environmental improvements offered by sustainable production methods. The study also found strong preferences for domestically produced products, especially among consumers in Italy, Spain, and France. Local production was important for Finland and the UK as well, whereas the Germans and the Polish were very supportive of European originating products. WTP was highest for locally produced, sustainably produced fish, followed by European sourced, sustainable products. There was also a clear WTP distinction between countries for certain attributes, including animal welfare, organic standards, and sustainable production, all of which were possibly reflected by different levels of awareness and cultural sensibilities(85–87).

Awareness and knowledge levels vary widely across Europe, and as a result, so do perceptions and WTP estimates especially when studies involve only one or two farming methods. For instance, an Irish study investigated the perceptions and WTP for IMTA produced salmon using a DCE in which the sustainability attribute was illustrated by an ecolabel with five levels. The label chosen was similar to the widely used EU energy rating label (88). The other product attributes were place of origin (Ireland or imported), and price. Participants had highest WTP for locally produced salmon with higher levels of sustainability. About 30% of the participants were WTP for the highest premium salmon rating, 20% the middle-class rating, and 10% the minimum premium level. The same concept of study has been repeated on a wider European Atlantic Ocean scale and the Mediterranean Sea region, with Ireland, Norway, UK, Italy and Israel included as the areas of interest (64). The social experiment used comparisons between conventionally produced products (monoculture) and those produced via IMTA. The study's latent class analysis identified three main profiles, green, local, and determined buyers. An interesting finding here is that although green buyers were expected to pay for a price premium

IMTA product, members of the other profile classes expressed the same intention, especially for locally produced fish.

IMTA is only one type of a sustainable production system that consumers appear to value. Other systems that reduce organic pollution were also regarded favourably. For instance, positive social acceptance and WTP for premium farmed salmon has been evident in various regions of Scotland only if conventional production methods were replaced by environmentally friendly ways to reduce organic pollution. Ferrer Llagostera et al. (2019) demonstrated that sustainable feeds are also valued. Their study found that Spanish consumers were willing to pay a premium for gilthead sea bream fed with insect meal instead of conventional fishmeal-based feed (90).

Market assessments on IMTA and sustainable aquaculture: Asia

In Asia, Yi (2019) found that higher WTP was associated with higher household income in South Korea for red seabream grown in copper-alloy aquaculture nets – a production method that was presented as more sustainable (92). A study in Bangladesh revealed that local consumers favoured organically farmed shrimp and were willing to pay a premium for these organic products (93). In addition, Bangladeshi consumers preferred fish attributes such as freshness, local and indigenous species and were less inclined to purchase wild-caught fish (94). Danso et al. (2017) reported that Vietnamese consumers from Hanoi, were willing to pay premium prices if the fish were cultivated in treated wastewater, and even higher premiums if the fish were certified for this form of sustainable aquaculture (96). Xuan and Sandorf (2020) performed DCE using a latent class model to analyse the behaviour of Vietnamese farmers and the wider public. They found that the public supports sustainable aquaculture policies and is willing to pay a premium to improve the treatment of wastewater used for local shrimp aquaculture (98). This study framed the WTP in the context of taxpayer-funded subsidies to encourage farmers to invest in sustainable infrastructure such as RAS. Respondents from the public belonging to the first latent class were insensitive to price costs per month for 5 years, whereas in the second class, respondents were WTP 0.9 USD per month for 5 years (98). It was shown that the costs of a credit subsidy program designed to encourage farmers to invest in aquaculture technology could be covered by the public's aggregate WTP, suggesting that sustainable shrimp aquaculture in Vietnam is an achievable target (98).

A study in China (99) revealed that awareness of, and WTP for eco-labelled seafood products have increased as a result of consumer concerns for seafood safety and negative environmental impacts. Fifty-nine percent of the respondents showed WTP for premiums of between 1-9% for eco-labelled seafood and 41% of the respondents were willing to pay premiums of more than 10%. Similar results; preference for certified seafood, emerged for male consumers who shop at mid-sized to large supermarkets, people who consume seafood at rates higher than the average and people familiar with certification schemes (99). (99) Chinese consumers from

Shanghai were willing to pay more for organic seafood, despite its unavailability, and would pay for more costly certified products that guarantee a higher level of quality (100). A Japanese study suggested that eco-labelling of seafood products would be ineffective with Japanese consumers, unless it was paired with a programme to increase awareness about the environmental impacts of conventional practices and the improvements offered by certified alternatives (101). Hori et al. (2020) (103) found that Japanese consumers are increasingly willing to pay for certified seafood products, especially those with sustainability attributes. In Malaysia, aquaculture falls into two categories: conventional practices and the certified Malaysian Good Agriculture Practice (GAqP), which fosters sustainable methods of farming. The size of the premium may vary with the elicitation method employed. Kamaruddin et al. (2023) (105) found that Malaysian consumers were willing to pay 114% more for GAqP-compliant fish when assessed by CVM and 46% more based on an open-ended model. Moreover, since GAqP-compliant fish are considered both safe and healthy food, wealthy consumers, elderly consumers, educated and environmentally concerned consumers are willing to pay a premium for these aquaculture products (104).

What do consumers truly value?

Drawing conclusions from the review of individual studies mentioned above, about what how sustainability attributes influence purchasing behaviours is challenging. Different study designs and statistical approaches used in these studies limits our ability to compare the results. Broadly speaking, it is possible to say that awareness about the environmental impacts of conventional aquaculture and the potential improvements offered by IMTA and by other sustainable practices is variable. It does appear that consumers care about the environment and some are willing to pay a premium for fish produced in a manner that is less harmful.

In order to address the issue of heterogeneity in methods, we examine several systematic reviews (with or without meta-analyses) addressing the willingness to pay for sustainably produced aquaculture products.

A systematic review and meta-regression analysis on consumers' acceptance based on 45 peer-reviewed papers addressed the relationship between study characteristics, product attributes and WTP (106)Consumers are willing to pay premiums for locally produced seafood, fresh products and products sold with environmental certification. Consumer characteristics, in particular average income and gender increase the likelihood of a higher WTP. With respect to sustainability, environmental certification was positively correlated with WTP for IMTA or other sustainable culture methods. Other systematic meta-analyses in the context of general eco-labelled food (107) and sustainable food products (108) demonstrated support for organic certification, which reflects the sustainability concept in food. Specifically, Bastounis et al. (2021) (109) found that female and younger consumers were more likely to buy organic products, whereas Li et al. (2021) (110) suggested that being female, region, and certain

sustainability attributes have the strongest positive correlation with average WTP premiums. The latter further concluded that Asian consumers were more willing to pay premiums for sustainable products compared to consumers in North America and Europe, partly because of the need to consume safer food.

Evidence from systematic reviews without meta-analysis further supports the findings of the meta-analyses above. Carlucci et al. (2015) (69) reviewed the preferences of consumers about quality features on seafood and finfish from within 49 international studies and found that the most relevant attributes influencing consumers' choices are the production and preservation methods, country of origin, product innovation, packaging and ecolabelling. Another systematic review collated 39 studies on finfish aquaculture products reviewed in studies published between 2000–2019 (111). All studies were conducted with DCE, i.e. study designs resembling real market decision-making settings and thus can address more effectively consumers' behaviour towards a product. The overall findings suggest that consumers are willing to pay a premium for products of domestic origin, but this is somewhat biased as it was only tested on consumers from Italy and Germany. Secondly, there is a high preference for wild-caught products over farmed products, which means that a negative public image towards aquaculture still prevails (112,113), even if farmed products are certified (e.g. Bronnmann and Hoffmann 2018). High WTP estimates for premiums were further evidenced for certified products, but only if the labels are related to sustainability, nutrition, health and safety information or even source feed (106,111). It was further concluded that the success of certification schemes may largely depend on the species, country of origin, type of label and claim (e.g. sustainability level label vs. standard ecolabel).

In the context of aquaculture-raised seafood, consumers mostly value locally produced seafood, freshness, and products with ecolabels or certifications. The latter can be a strong motivator for premium products when labelling is associated with nutritional value, health and safety information, and sustainability either in the form of sustainable type of feed or innovative infrastructure and practices that reduce environmental impact. The findings from the studies cited here strengthen the evidence for what consumers truly value in seafood products, but the implications of these in the context of sustainable aquaculture and the role they play in the food governance system are yet unclear.

Discussion: Moving towards more sustainable aquaculture markets

Individual preference studies and systematic reviews reveal that fish consumers and the general public care about the negative spillovers from aquaculture production and are willing to pay to prevent damages. The fact that eco-labelling is generally positively correlated with WTP indicates that there is a latent demand for sustainable aquaculture products that is not yet supplied. There are also indications that the demand could grow if awareness about

sustainability of aquaculture production was more consistent. Large segments of the population are relatively uninformed about aquaculture practices, but there is evidence that once made aware, people are more likely to value sustainability.

Another important factor in developing sustainable aquaculture markets is producer beliefs and behaviours. In principle, a positive WTP should be a signal to producers that adopting more sustainable practices and investing in certification is a channel to increase and expand their market share and profitability. The relatively low levels of industrialisation of IMTA and other sustainable practices thus raises the question of why producers seem to be unresponsive to market signals.

In this section, we examine both the demand and supply side of sustainable aquaculture markets and address specific barriers related to consumer behaviours, producer decisions, and concentrations of market power that may influence what is produced, marketed and consumed. Additional attention is paid to policy and regulation, in particular its responsiveness to public preferences for sustainable production.

Consumer knowledge and awareness

Many sustainable aquaculture technologies are advanced enough to provide the basis for strong and rapid growth yet the commercialization of sustainable aquaculture products has been thus far struggling as a result of insufficient economic incentives (115). Consumers' lack of awareness, negative perceptions, distrust, and product pricing have been suggested as the main economic barriers. At this point it has been established that consumer awareness regarding sustainable seafood products is largely heterogeneous, with some consumer segments having very low awareness and others moderate to high. The general public is more aware and more concerned about environmental issues now than ever before (116), but in many cases, these are not reflected in fish and seafood markets where consumer awareness may lag and other attributes are ranked more highly than sustainability (102). Increasing awareness requires efforts from stakeholders and producers in balanced marketing initiatives that provide information about sustainability and other product attributes (e.g., health and nutrition, place of production, etc.) in a transparent manner about the benefits of aquaculture, and specifically the environmental advantages of sustainable aquaculture practices (42,117,118)

For consumers who demonstrate a great deal of support towards sustainable aquaculture, products are expected to live up to their green reputation – that is to address environmental issues (e.g. Zander and Feucht 2018). Eco-labels and certification schemes are assumed to be important tools to address this particular concern and enhance WTP. In fact, an acceptable proportion of consumers are willing to pay for sustainable aquaculture products at a significant premium price, especially when eco-labelled or certified for certain attributes e.g.

environmental, nutritional and health aspects (106). Labels with additional information on seafood packaging can further affect the purchasing choice, even to those who are less sensitive to sustainability issues. For instance, local or domestic production are consistently shown as attributes imperative to consumer demand and WTP (49,106,111,119). At least within Europe, the underlying reasons for this preference are greater freshness, higher food safety, higher environmental standards, and better regulations (119). These attributes could further influence the consumption frequency, which is also determined by various consumer profiles (120). At least within countries that conform to EU standards, 20% of consumers have a very low probability of consuming seafood in general, as the information presented on the product labels is unclear and inadequate (120). In this respect, producers should redirect their efforts into alternative production methods that are more sustainable, ecologically friendly, and in which their products are presented with unambiguous labels, with adequate well-understood information and distributed in local or domestic markets.

Linking WTP with actual purchasing behaviour

The extent to which producers are ready/willing to transform their production systems to more sustainable practices, based on these market assessments, is uncertain. Green aquaculture products are still a niche market in many places, and their reliance for further growth on research has been largely determined by the consumers' WTP metric. In fact, the WTP metrics reflect the consumers' ethical views around a product's attribute and are advised not to be considered anything but good intentions as they are not always translated into behaviours (121–123). Some consumers appear to be cause-driven when surveyed, but economic conservatives at the checkout lines (124). To that end, the development of green markets and expansion of sustainable products cannot be solely assigned to consumers' responsibility and behaviour intentions (125). Similarly, several studies reveal anomalies and caution needs to be exercised in interpreting the relevance of WTP. A good example is Latent Class Analysis in Yip et al. which revealed that consumers with strong preferences for wild-caught salmon had a 166.7% WTP although the statistical framework suggests that the average consumer from this particular class is the least likely to purchase cultured salmon (126). Several interpretations for this have been put forward, including the fact that while a wild-salmon purchaser might not by cultured salmon, they strongly value sustainability (126)..

Although consumers do have a role to play in terms of demand and satisfaction, as well as shaping the overall expectations as a society from the food industry, the ruling power lies within the core of the market chain intermediaries – the wholesalers and mainly the retailers (127,128).

The aquaculture value chain: the power of wholesalers and retailers

For a long time, global food governance was characterised by an oligopoly, with manufacturers playing a central role in the market food chain supply. At the same time, the food retail sector

had a minimal structural and low market power (129). This global oligopoly and market power has grown but shifted towards the food retailers and wholesalers, whose influence now exert a leading role in the food value chain (130). Two decades ago, Durieu (2003) further argued that large retailers "can greatly influence changes in production processes and consumption patterns and are well positioned to exert pressure on producers in favour of more sustainable choices" (131). Nowadays, most high profile retailers are in the singularly powerful position to control the product chain from its development to the shelves through central and critical partnerships with raw material producers, manufacturers, wholesalers, transporters, warehousers and their daily interactions with millions of serving consumers (129,132,133). The economic trends of market power have been previously reported (129,134) and stressed (135), demonstrating staggering evidence and implications on the capability of global leading food retailers to wield power-pressure on pricing and on the producers (129). There are also insights about product selectivity and specificity, which often pertain to the exclusion of small businesses or local farmers from entering the grocery chains, suggesting that food retail corporations exercise immense structural power both in the international and domestic markets (129).

This market power has expanded even more, with food retail corporates becoming rule-setters rather than rule-takers by enforcing rules and developing private standards, which wish to translate requirements for both product and process specifications to other parts of the supply chain (129). These private standards could be related to food safety and social welfare, such as pesticide- or herbicide-free production, corporate social responsibility policies and labour standards. Although some retail organizations have created their own quality assurance/safety schemes, the development of private standards is carried out collectively, so that they can force the upstream sector to adopt these by limiting other available options (136). The resulting shift to this privatization was partially formed to address society's concerns regarding food safety and political requests for food transparency in the food supply chain (137). Despite concerns over its legitimacy (138), it was hypothesized to have important and positive implications for the future of sustainable products in the food system (129).

In recent years, after the sector has seen sharp increases in revenues of organic and sustainable goods from smaller businesses, it was predicted that this "niche market" would be earning most of the money in the future (129). Large retailers have seized this opportunity and pledged commitment to sustainability goals as part of their developing corporate and social responsibility strategies (139,140). Specifically, many high-profile retailers transformed the nature of their businesses as they are driven by antagonism from price-driven models to both price and quality attributes (130,141). They have integrated sustainable product sections with distinct labelling, offering a range of organic and social or ecological friendly goods (141), thus further enriching their merchant inventory to differentiate from other competitors and attract additional types of consumers (132). At this point, the proliferation of private standards has

grown more stringent and further involved environmental criteria in which the public regulatory framework was inadequate to address. That is, ensuring sustainability designed for food production but increasingly being applied specifically in the context of fisheries and aquaculture (142). When it comes to wholesalers, whose role is key in the food and beverage distribution, they are largely outpaced by their retail counterparts in their approach to sustainability, partly because they have far less pressure to publicly demonstrate their accountability (128).

By acknowledging the fact that a portion of a given population has low awareness towards sustainability, retailers have developed a range of marketing intervention and mechanism tools to engage consumers with sustainable products, to prevent their efforts in sustainability from impacting their overall sales (143). Such tools can have a radical shift in consumers' psychology with respect to green consciousness, responsibility, beliefs and attitudes for sustainable and ecological friendly goods (143). Retailers can attract consumers' attention and promote their role as supporters of sustainability through campaigns, promotions, advertisements and educational programs. They also use in-store merchandising strategies such as digital displays, verbal communication from personnel, product arrangement and exhibition with nature sounds, green claims (i.e. certifications) and eco-packaging with visually attractive cues for certain attributes e.g., eco-labels, product origin, carbon footprint, various dietary ingredients, and seasonality (144) Drawing shoppers' attention to eco-friendly goods, is an effective tactic in persuading consumers purchase even at a premium (145). Achieving sustainable consumption through these approaches however, is not always guaranteed (127,143) for a number of reasons relevant to consumers' scepticism regarding the retailer's intervention; buying intentions; undermining sustainable consumption; purchasing behaviour, and negative impacts on perceptions (143). In some cases, mainstream markets harnessed the choice-editing approach, whereby sustainable options become the default; but it's generally less renowned as it could impose overall sales decline as shown for seafood products (146). For this reason, many large-chain retailers are avoiding choice-editing strategies as they clash with their lucrative business motives (147).

Achieving sustainability under the policy domain

It is increasingly recognized that orienting producers towards sustainable production practices by means of consumer pressure may not necessarily achieve the development of sustainable consumption/demand (125,148). Moreover, although retailers are highly acknowledged for their capacity to be drivers towards food sustainability, their efforts could be hampered in the context of long-term goals at the face of many impediments. Specifically, due to the complexity in global food systems, human cognition and behaviour and the structural characteristics of the food environment, the concept of sustainability and resilience should be addressed by a holistic approach that encompasses all the interconnecting actors of the food governance system (149–152). To surpass such multidimensional complexity, attempts on sustainable development

would have to transition under the embodiment of a policy regime (147,149,151). To date, there has been an increasing focus in the literature to prompt the transition of sustainable food systems within the policy domain (149–151,153). The integration of such regulations is assumed at different levels of governance (i.e. public, private, and civil society), operational scales (i.e. local, regional, national and international), and sustainability spheres (i.e. agriculture/aquaculture, climate and the environment, health, and worker's rights), so that policy framework addresses challenges in coordinated and collaborative manner (150,152). The realization of this holistic vision implies setting new policy goals, policy frames, and new evaluation approaches that consider the perspectives from each of these levels (149,151).

Previous work by Saviolidis et al. (2020) has identified policy recommendations targeted to different stakeholder groups in support of sustainable food consumption. Looking from a civil society's point of view, regulations should target pressure towards Food Value Chain (FVC) actors and governmental bodies who have the power to implement transformative policies (149). The power of retailers has already been discussed alongside the inherent risks they take in sustainable consumption when confronted with specific consumer profiles. If, however, national (or international) regulations exert pressure on producers, market requirements will change. Therefore, food retailers can operate with a greater degree of certainty in their sustainability efforts by adopting choice-editing strategies, so that sustainable products become the norm (154). In the past, innovative aquaculture systems did not mirror positive public perceptions in consumer surveys attributed (among others) to technophobia (e.g. Altintzoglou and Honkanen 2020)(43). Awareness raising for these topics should be at the forefront of governments' environmental agendas and together with targeted policies on sustainable production, these systems (e.g. RAS, IMTA, etc.) may thrive in the forthcoming future.

Within the EU, such an ambitious regulatory framework is progressively being materialized in the "Farm to Fork strategy", which is at the heart of EU's Green Deal and aligned with the European Commission's agenda for achieving the United Nations' Sustainable Development Goals (155). Specifically, the strategy aims to reconcile the food system through a just transition operating within planetary boundaries, which benefits both the producers and consumers, as well as reduces the environmental and climate footprints. The Farm to Fork strategy also envisages the adoption of EU guidelines for all member states to promote sustainable aquaculture practices. Despite the positive feedback it has received, it was critiqued for its inability to tackle the power asymmetries in the food system and the likelihood for perpetuating current unsustainable practices (150).

Conclusion

This report addresses opportunities, challenges and barriers in value chains for the products of IMTA and other sustainable aquaculture practices. We conducted a systematic search and narrative review of the literature on preferences for sustainable aquaculture and a review of selected issues related to producers, wholesalers and retailers and the policy sector.

Opportunities appear to exist on the demand side. Studies of consumer preferences indicate that at the very least, there are niche markets for more sustainable products and in all likelihood the consumer base for such products could be expanded. Surveys of the public also indicate widespread support for greater sustainability and WTP via increased taxes to support greater sustainability in aquaculture. The expansion of sustainable aquaculture markets appears to be constrained by two elements. First, producers remain reluctant to adopt more sustainable practices for a variety of reasons. Some doubt the market receptiveness and are therefore unwilling to invest in more costly production methods, promotion activities to raise awareness and certification to demonstrate sustainability. An additional factor in producers' reluctance may be their perception of their limited capacity to influence consumer behaviours. Power in aquaculture value chains tends to be heavily concentrated in wholesalers and large retailers. These stakeholders can and do shape consumer preferences and influence their behaviours. They also have a major role in determining producer decisions. This is particularly true when there is a high level of vertical integration between large wholesalers and producers. For smaller producers, access to markets may hinge on conforming to the requirements of large wholesalers and retailers or alternatively focusing on niche markets. Engaging various stakeholders within the fish value chain (e.g., producers, consumers, wholesalers, retailers, independent certifiers) is essential to initiatives to promote sustainable production. Examples of initiatives include regulation to ensure that site selection and production operations minimise environmental impacts and measures by commercial stakeholders and consumer advocates to increase awareness and market acceptance of more sustainable products.

Several directions for additional research are indicated:

1. Consumers: improve the understanding of consumer characteristics to better understand how these interact with product attributes, in particular sustainability. This is needed in order to develop effective marketing activities to raise awareness that translates into actual purchasing behaviours.
2. Consumers: Understand and resolve anomalous WTP results.
3. Value chain: examine aquaculture value chains to determine scope for encouraging more sustainable production.
4. Producers: Improve the understanding of beliefs of producers and the constraints they face in deciding what to produce and how to produce it.

REFERENCES

1. FAO. The State of World Fisheries and Aquaculture 2020 [Internet]. Vol. 32, Sustainability in action. Rome: FAO; 2020. 6–10 p. Available from: http://www.fao.org/documents/card/en/c/ca9229en

2. Anderson JL, Asche F, Garlock T. Economics of Aquaculture Policy and Regulation. Annu Rev Resour Economics. 2019 Oct 5;11(1):101–23.

3. FAO. The State of World Fisheries and Aquaculture 2022 [Internet]. FAO; 2022. 266 p. Available from: http://www.fao.org/documents/card/en/c/cc0461en

4. FAO. The State of World Fisheries and Aquaculture 2018. Meeting the sustainable development goals. Rome; 2018. 227 p.

5. Anderson JL, Asche F, Garlock T. Economics of Aquaculture Policy and Regulation. Annu Rev Resour Economics [Internet]. 2019 Oct;11(1):101–23. Available from: https://www.annualreviews.org/doi/10.1146/annurev-resource-100518-093750

6. Chopin T, Tacon AGJ. Importance of Seaweeds and Extractive Species in Global Aquaculture Production. Reviews in Fisheries Science & Aquaculture [Internet]. 2021 Apr;29(2):139–48. Available from: https://doi.org/10.1080/23308249.2020.1810626

7. Ahmed N, Thompson S, Glaser M. Global Aquaculture Productivity, Environmental Sustainability, and Climate Change Adaptability [Internet]. World Resources Institute. Washington DC: Springer US; 2014. 60 p. Available from: http://dx.doi.org/10.1007/s00267-018-1117-3

8. Kobayashi M, Msangi S, Batka M, Vannuccini S, Dey MM, Anderson JL. Fish to 2030: The Role and Opportunity for Aquaculture. Aquaculture Economics & Management [Internet]. 2015 Jul;19(3):282–300. Available from: http://www.tandfonline.com/doi/full/10.1080/13657305.2015.994240

9. Waite R, Beveridge M, Brummett R, Castine S, Chaiyawannakarn N, Kaushik S, et al. Improving productivity and environmental performance of aquaculture [Internet]. Creating a Sustainable Food Future. 2014. 1–60 p. Available from: http://www.wri.org/sites/default/files/wrr_installment_5_improving_productivity_environmental_performance_aquaculture.pdf

10. Naylor RL, Hardy RW, Buschmann AH, Bush SR, Cao L, Klinger DH, et al. A 20-year retrospective review of global aquaculture. Nature. 2021 Mar 25;591(7851):551–63.

11. Ottinger M, Clauss K, Kuenzer C. Aquaculture: Relevance, distribution, impacts and spatial assessments – A review. Ocean Coast Manag [Internet]. 2016 Jan;119(2016):244–66. Available from: http://dx.doi.org/10.1016/j.ocecoaman.2015.10.015

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12. Carballeira Braña CB, Cerbule K, Senff P, Stolz IK. Towards Environmental Sustainability in Marine Finfish Aquaculture. Front Mar Sci [Internet]. 2021 Apr;8(April):1–24. Available from: https://www.frontiersin.org/articles/10.3389/fmars.2021.666662/full

13. Naylor RL, Hardy RW, Bureau DP, Chiu A, Elliott M, Farrell AP, et al. Feeding aquaculture in an era of finite resources. Proceedings of the National Academy of Sciences [Internet]. 2009 Sep;106(36):15103–10. Available from: https://pnas.org/doi/full/10.1073/pnas.0905235106

14. Atalah J, Sanchez-Jerez P. Global assessment of ecological risks associated with farmed fish escapes. Glob Ecol Conserv [Internet]. 2020 Mar;21:e00842. Available from: https://doi.org/10.1016/j.gecco.2019.e00842

15. Krüger L, Casado-Coy N, Valle C, Ramos M, Sánchez-Jerez P, Gago J, et al. Plastic debris accumulation in the seabed derived from coastal fish farming. Environmental Pollution [Internet]. 2020 Feb;257:113336. Available from: http://www.ncbi.nlm.nih.gov/pubmed/31753624

16. Barrett LT, Swearer SE, Dempster T. Impacts of marine and freshwater aquaculture on wildlife: a global meta-analysis. Rev Aquac [Internet]. 2019 Nov;11(4):1022–44. Available from: https://onlinelibrary.wiley.com/doi/10.1111/raq.12277

17. Stark S, Biber-Freudenberger L, Dietz T, Escobar N, Förster JJ, Henderson J, et al. Sustainability implications of transformation pathways for the bioeconomy. Sustain Prod Consum [Internet]. 2022 Jan;29:215–27. Available from: https://doi.org/10.1016/j.spc.2021.10.011

18. McGreevy SR, Rupprecht CDD, Niles D, Wiek A, Carolan M, Kallis G, et al. Sustainable agrifood systems for a post-growth world. Nat Sustain [Internet]. 2022 Aug;5(12):1011–7. Available from: https://www.nature.com/articles/s41893-022-00933-5

19. Béné C. Why the Great Food Transformation may not happen – A deep-dive into our food systems' political economy, controversies and politics of evidence. World Dev [Internet]. 2022 Jun;154:105881. Available from: https://doi.org/10.1016/j.worlddev.2022.105881

20. European Parliment, Council of the European Union. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) [Internet]. Official Journal of the European Union, 2008/56/EU Euro-Lex; 2008. Available from: http://data.europa.eu/eli/dir/2008/56/oj

21. European Parliment, Council of the European Union. Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning [Internet]. Official Journal of the European Union. Available from: http://data.europa.eu/eli/dir/2014/89/oj

22. European Parliment, Council of the European Union. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy Select: 1 [Internet]. Official Journal of the European Union,

2000/60/EC EUR-Lex; 200AD. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32000L0060&qid=1678018636980

23. Boyd CE, Tucker C, Mcnevin A, Bostick K, Clay J. Indicators of Resource Use Efficiency and Environmental Performance in Fish and Crustacean Aquaculture. Reviews in Fisheries Science [Internet]. 2007 Nov;15(4):327–60. Available from: https://www.tandfonline.com/doi/full/10.1080/10641260701624177

24. Cottrell RS, Metian M, Froehlich HE, Blanchard JL, Sand Jacobsen N, McIntyre PB, et al. Time to rethink trophic levels in aquaculture policy. Rev Aquac. 2021 Jun 8;13(3):1583–93.

25. Albrektsen S, Kortet R, Skov PV, Ytteborg E, Gitlesen S, Kleinegris D, et al. Future feed resources in sustainable salmonid production: A review. Rev Aquac [Internet]. 2022 Sep;14(4):1790–812. Available from: https://onlinelibrary.wiley.com/doi/10.1111/raq.12673

26. Gambelli D, Vairo D, Solfanelli F, Zanoli R. Economic performance of organic aquaculture: A systematic review. Mar Policy [Internet]. 2019 Oct 1;108. Available from: http://10.0.3.248/j.marpol.2019.103542

27. EUMOFA. Blue Bioeconomy Report 2018. Luxembourg; 2019 Jan.

28. EUMOFA. Blue Bioeconomy Report 2020. Luxembourg; 2021 Jan.

29. EUMOFA. Blue Bioeconomy report 2022 [Internet]. Luxembourg; 2023 Jan [cited 2023 Mar 2]. Available from: https://www.eumofa.eu/documents/20178/84590/blue+bioeconomy+report+2022+final.pdf/eb889d94-74a6-2c15-e136-4d2204118c6a?t=1673441855108

30. European Commission. The EU Blue Economy Report, 2022. . Luxembourg; 2022.

31. Soto D (Ed.). Integrated mariculture. A global review. Rome; 2009.

32. Lloyd-Evans M. Integrated multi-trophic aquaculture (IMTA). In: European Commission DG for MA and F, editor. Blue bioeconomy report [Internet]. European Union Market Observatory for Fisheries and Aquaculture (EUMOFA); 2021 [cited 2022 Jan 30]. Available from: https://www.eumofa.eu/documents/20178/84590/blue+bioeconomy.pdf/f5a87949-c541-416b-16e7-521155cdff06?t=1608051570785#page=13

33. Sanz-Lazaro C, Sanchez-Jerez P. Regional Integrated Multi-Trophic Aquaculture (RIMTA): Spatially separated, ecologically linked. J Environ Manage. 2020 Oct;271:110921.

34. Freeman S, Greenfeld A, Angel D. 4.1 Salmon-seaweed co-culture: Beyond farm-level integrated multi-trophic aquaculture (IMTA), FutureEUAqua project report 4.11. Haifa; 2022 Feb.

35. Thaler R. Toward a positive theory of consumer choice. J Econ Behav Organ. 1980 Mar;1(1):39–60.

36. Kahneman D, Tversky A. Prospect Theory: An Analysis of Decision under Risk. Econometrica. 1979 Mar;47(2):263.

37. Weddle DE, Bettman JR. Marketing Underground: an Investigation of Fishbein's Behavioral Intention Model . Advances in Consumer Research . 1974;1:310-318.

38. Schiffman LG, Kanuk LL. Consumer Behavior (7th ed.). . Upper Saddle River, NJ: Prentice-Hall; 2002.

39. Dolgopolova I, Li B, Pirhonen H, Roosen J. The effect of attribute framing on consumers' attitudes and intentions toward food: A Meta-analysis. Bio-based and Applied Economics [Internet]. 2022 Mar 1;10(4). Available from: http://ezproxy.haifa.ac.il/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=edsdoj&AN=edsdoj.744e72099ee34341a318a717d4fc2932&site=eds-live&scope=site

40. López-Mas L, Claret A, Reinders MJ, Banovic M, Krystallis A, Guerrero L. Farmed or wild fish? Segmenting European consumers based on their beliefs. Aquaculture [Internet]. 2021 Feb;532(June 2020):735992. Available from: https://doi.org/10.1016/j.aquaculture.2020.735992

41. Kumar G. Aquaculture Production and Marketing: A Peek into the World of Producers and Consumers. Aquaculture Economics and Management [Internet]. 2018;22(3):279–83. Available from: http://www.tandfonline.com/loi/uaqm20

42. Cantillo J, Martín JC, Román C. Discrete choice experiments in the analysis of consumers' preferences for finfish products: A systematic literature review. Food Qual Prefer [Internet]. 2020;84(April):103952. Available from: https://doi.org/10.1016/j.foodqual.2020.103952

43. Altintzoglou T, Honkanen P. Report on consumer awareness, perception and acceptance of European aquaculture and methods. 2020.

44. Inderst R, Thomas S. Reflective Willingness to Pay: Preferences for Sustainable Consumption in a Consumer Welfare Analysis. Journal of Competition Law & Economics. 2021 Dec 14;17(4):848–76.

45. Kleitou P, Kletou D, David J. Is Europe ready for integrated multi-trophic aquaculture? A survey on the perspectives of European farmers and scientists with IMTA experience. Aquaculture. 2018 Mar;490:136–48.

46. Valor C. Can Consumers Buy Responsibly? Analysis and Solutions for Market Failures. J Consum Policy (Dordr). 2008 Sep 17;31(3):315–26.

47. Ridler N, Robinson B, Chopin T, Robinson SMC, Page F. Development of integrated multi-trophic aquaculture in the Bay of Fundy, Canada: a socio-economic case study. J World Aquac Soc. 2006;37(3):43–8.

48. Lembo G, Jokumsen A, Spedicato MT, Facchini MT, Bitetto I. Assessing stakeholder's experience and sensitivity on key issues for the economic growth of organic aquaculture

production. Mar Policy [Internet]. 2018 Jan;87(June 2017):84–93. Available from: https://doi.org/10.1016/j.marpol.2017.10.005

49. Carlucci D, Nocella G, De Devitiis B, Viscecchia R, Bimbo F, Nardone G. Consumer purchasing behaviour towards fish and seafood products. Patterns and insights from a sample of international studies. Appetite. 2015 Jan;84:212–27.

50. Smetana K, Melstrom RT, Malone T. A Meta-regression Analysis of Consumer Willingness to Pay for Aquaculture Products. Journal of Agricultural and Applied Economics [Internet]. 2022 Aug;54(3):480–95. Available from: http://ezproxy.haifa.ac.il/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=ecn&AN=1996705&site=eds-live&scope=site

51. Alexander KA, Freeman S, Potts T. Navigating uncertain waters: European public perceptions of integrated multi trophic aquaculture (IMTA). Environ Sci Policy. 2016;61.

52. Mazur NA, Curtis AL. Risk Perceptions, Aquaculture, and Issues of Trust: Lessons From Australia. Soc Nat Resour [Internet]. 2006 Oct;19(9):791–808. Available from: http://www.tandfonline.com/doi/abs/10.1080/08941920600835551

53. Mazur NA, Curtis AL. Understanding community perceptions of aquaculture: lessons from Australia. Aquaculture International [Internet]. 2008 Dec;16(6):601–21. Available from: https://link.springer.com/10.1007/s10499-008-9171-0

54. Thomas JBE, Nordström J, Risén E, Malmström ME, Gröndahl F. The perception of aquaculture on the Swedish West Coast. Ambio [Internet]. 2017 Sep;47(4):398–409. Available from: http://link.springer.com/10.1007/s13280-017-0945-3

55. Verbeke W, Sioen I, Pieniak Z, Van Camp J, De Henauw S. Consumer perception versus scientific evidence about health benefits and safety risks from fish consumption. Public Health Nutr. 2005;8(4):422–9.

56. Schlag AK. Aquaculture: an emerging issue for public concern. J Risk Res [Internet]. 2010 Oct;13(7):829–44. Available from: http://www.tandfonline.com/doi/abs/10.1080/13669871003660742

57. Jacobs S, Sioen I, Pieniak Z, De Henauw S, Maulvault AL, Reuver M, et al. Consumers' health risk–benefit perception of seafood and attitude toward the marine environment: Insights from five European countries. Environ Res [Internet]. 2015 Nov;143:11–9. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0013935115000638

58. KATRANIDIS S, NITSI E, VAKROU A. Social Acceptability of Aquaculture Development in Coastal Areas: The Case of Two Greek Islands. Coastal Management [Internet]. 2003 Jan;31(1):37–53. Available from: http://www.tandfonline.com/doi/abs/10.1080/08920750390168291

59. Whitmarsh D, Palmieri MG. Social acceptability of marine aquaculture: The use of survey-based methods for eliciting public and stakeholder preferences. Mar Policy [Internet]. 2009

May;33(3):452–7. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0308597X08001504

60. Verbeke W, Vanhonacker F, Sioen I, Van Camp J, De Henauw S. Perceived importance of sustainability and ethics related to fish: A consumer behavior perspective. Ambio. 2007;36(7):580–5.

61. Vanhonacker F, Altintzoglou T, Luten J, Verbeke W. Does fish origin matter to European consumers? British Food Journal [Internet]. 2011 Apr;113(4):535–49. Available from: https://www.emerald.com/insight/content/doi/10.1108/00070701111124005/full/html

62. Rickertsen K, Alfnes F, Combris P, Enderli G, Issanchou S, Shogren JF. French Consumers' Attitudes and Preferences toward Wild and Farmed Fish. Marine Resource Economics [Internet]. 2017;32(1):59–81. Available from: http://ezproxy.haifa.ac.il/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=ecn&AN=1624513&site=eds-live&scope=site

63. van Osch S, Hynes S, Freeman S, O'Higgins T. Estimating the public's preferences for sustainable aquaculture: A country comparison. Sustainability (Switzerland). 2019;11(3).

64. van Osch S, Hynes S, Freeman S, O'Higgins T. Estimating the Public's Preferences for Sustainable Aquaculture: A Country Comparison. Sustainability. 2019 Jan 22;11(3):569.

65. Rickertsen K, Alfnes F, Combris P, Enderli G, Issanchou S, Shogren JF. French Consumers' Attitudes and Preferences toward Wild and Farmed Fish. Marine Resource Economics. 2017 Jan;32(1):59–81.

66. Bronnmann J, Asche F. Sustainable Seafood from Aquaculture and Wild Fisheries: Insights from a Discrete Choice Experiment in Germany. Ecological Economics [Internet]. 2017 Dec;142:113–9. Available from: http://ezproxy.haifa.ac.il/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=ecn&AN=1926822&site=eds-live&scope=site

67. Rickertsen K, Gustavsen GW, Nayga Jr. RM. Consumer Willingness to Pay for Genetically Modified Vegetable Oil and Salmon in the United States and Norway. AgBioForum [Internet]. 2017;20(2):94–104. Available from: http://www.agbioforum.org/

68. Kecinski M, Messer KD, Knapp L, Shirazi Y. Consumer Preferences for Oyster Attributes: Field Experiments on Brand, Locality, and Growing Method. Agric Resour Econ Rev [Internet]. 2017 Aug;46(2):315–37. Available from: https://www.cambridge.org/core/product/identifier/S1068280517000211/type/journal_article

69. Carlucci D, Nocella G, De Devitiis B, Viscecchia R, Bimbo F, Nardone G. Consumer purchasing behaviour towards fish and seafood products. Patterns and insights from a sample of international studies. Appetite [Internet]. 2015 Jan;84:212–27. Available from: http://dx.doi.org/10.1016/j.appet.2014.10.008

70. Calanche JB, Beltrán JA, Hernández Arias AJ. Aquaculture and sensometrics: the need to evaluate sensory attributes and the consumers' preferences. Rev Aquac. 2020;12(2):805–21.

71. Aarset B, Beckmann S, Bigne E, Beveridge M, Bjorndal T, Bunting J, et al. The European consumers' understanding and perceptions of the "organic" food regime. British Food Journal [Internet]. 2004 Feb;106(2):93–105. Available from: https://www.emerald.com/insight/content/doi/10.1108/00070700410516784/full/html

72. Stubbe Solgaard H, Yang Y. Consumers' perception of farmed fish and willingness to pay for fish welfare. British Food Journal [Internet]. 2011 Aug;113(8):997–1010. Available from: https://www.emerald.com/insight/content/doi/10.1108/00070701111153751/full/html

73. Shuve H, Ridler N, Sawhney M, Marvin R, Powell F, Robinson S. Survey Finds Consumers Support Integrated Multitrophic Aquaculture. Global Aquaculture Advocate. 2009;12(2):22–3.

74. Barrington K, Ridler N, Chopin T, Robinson S, Robinson B. Social aspects of the sustainability of integrated multi-trophic aquaculture. Aquaculture International. 2010;18(2):201–11.

75. Yip WWY. Assessing the Willingness to Pay in the Pacific Northwest for Salmon Produced by Integrated Multi-Trophic Aquaculture [Internet]. 2012. Available from: http://summit.sfu.ca/item/12249#310

76. Knowler D, Chopin T, Martínez-Espiñeira R, Neori A, Nobre A, Noce A, et al. The economics of Integrated Multi-Trophic Aquaculture: where are we now and where do we need to go? Rev Aquac [Internet]. 2020 Jan;12(3):raq.12399. Available from: https://onlinelibrary.wiley.com/doi/10.1111/raq.12399

77. van Osch S, Hynes S, O'Higgins T, Hanley N, Campbell D, Freeman S. Estimating the Irish public's willingness to pay for more sustainable salmon produced by integrated multi-trophic aquaculture. Mar Policy. 2017;84.

78. Barrington K, Ridler N, Chopin T, Robinson S, Robinson B. Social aspects of the sustainability of integrated multi-trophic aquaculture. Aquaculture International. 2010;18(2):201–11.

79. Martínez-Espiñeira R, Chopin T, Robinson S, Noce A, Knowler D, Yip W. Estimating the biomitigation benefits of Integrated Multi-Trophic Aquaculture: A contingent behavior analysis. Aquaculture [Internet]. 2015 Feb;437:182–94. Available from: http://ezproxy.library.ubc.ca/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=100759246&site=ehost-live&scope=site

80. Kitchen P, Knowler D. Market implications of adoption of Integrated Multi-Trophic Aquaculture: shellfish production in British Columbia. Vol. 3, Ocean Canada Network (OCN) Policy BriefSeries . Ocean Canada Network (OCN); 2013. p. 17–20.

81. Yip W, Knowler D, Haider W, Trenholm R. Valuing the Willingness-to-Pay for Sustainable Seafood: Integrated Multitrophic versus Closed Containment Aquaculture. Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie. 2017 Mar;65(1):93–117.

82. Osch S van, Hynes S, Freeman S, O'Higgins T. Estimating the Public's Preferences for Sustainable Aquaculture: A Country Comparison. Sustainability [Internet]. 2019 Jan 1;11(3):569. Available from: http://ezproxy.haifa.ac.il/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=edsdoj&AN=edsdoj.fdee85b6d92d418dbc9372fb9546444c&site=eds-live&scope=site

83. Alexander KA, Freeman S, Potts T. Navigating uncertain waters: European public perceptions of integrated multi trophic aquaculture (IMTA). Environ Sci Policy. 2016;61:230–7.

84. Altintzoglou T, Honkanen P. Report on consumer awareness, perception and acceptance of European aquaculture and methods. 2020.

85. Zander K, Feucht Y. How to increase demand for carp? Consumer attitudes and preferences in Germany and Poland. British Food Journal [Internet]. 2020 Jun 30;122(11):3267–82. Available from: http://ezproxy.haifa.ac.il/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=edsemr&AN=edsemr.10.1108.BFJ.11.2019.0875&site=eds-live&scope=site

86. Zander K, Feucht Y. Consumers' Willingness to Pay for Sustainable Seafood Made in Europe. Journal of International Food & Agribusiness Marketing [Internet]. 2018 Jul;30(3):251–75. Available from: https://doi.org/10.1080/08974438.2017.1413611

87. Zander K(1), Feucht Y(1), Risius A(2), Janssen M(3), Hamm U(3). Sustainable Aquaculture Products: Implications of Consumer Awareness and of Consumer Preferences for Promising Market Communication in Germany. Journal of Aquatic Food Product Technology [Internet]. 2018 Jan 2;27(1):5–20. Available from: http://ezproxy.haifa.ac.il/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=edselc&AN=edselc.2-52.0-85033392574&site=eds-live&scope=site

88. van Osch S, Hynes S, O'Higgins T, Hanley N, Campbell D, Freeman S. Estimating the Irish public's willingness to pay for more sustainable salmon produced by integrated multi-trophic aquaculture. Mar Policy. 2017;84(August):220–7.

89. Ferrer Llagostera P, Kallas Z, Reig L, Amores de Gea D. The use of insect meal as a sustainable feeding alternative in aquaculture: Current situation, Spanish consumers' perceptions and willingness to pay. J Clean Prod. 2019 Aug;229:10–21.

90. Ferrer Llagostera P, Kallas Z, Reig L, Amores de Gea D. The use of insect meal as a sustainable feeding alternative in aquaculture: Current situation, Spanish consumers' perceptions and willingness to pay. J Clean Prod [Internet]. 2019 Aug;229:10–21. Available from: https://doi.org/10.1016/j.jclepro.2019.05.012

91. Yi S. Willingness-to-Pay for Sustainable Aquaculture Products: Evidence from Korean Red Seabream Aquaculture. Sustainability. 2019 Mar 15;11(6):1577.

92. Yi S. Willingness-to-Pay for Sustainable Aquaculture Products: Evidence from Korean Red Seabream Aquaculture. Sustainability [Internet]. 2019 Mar;11(6):1577. Available from: https://www.mdpi.com/2071-1050/11/6/1577

93. Hoque MZ, Akhter N, Mawa Z. Consumers' Willingness to Pay (WTP) for Organically Farmed Fish in Bangladesh. Journal of Agricultural and Applied Economics [Internet]. 2021 Nov;53(4):482–509. Available from: https://www.cambridge.org/core/product/identifier/S1074070821000122/type/journal_article

94. Alam MA, Alfnes F. Consumer Preferences for Fish Attributes in Bangladesh: A Choice Experiment. Journal of International Food & Agribusiness Marketing [Internet]. 2020 Oct;32(5):425–40. Available from: https://doi.org/10.1080/08974438.2019.1697409

95. Danso G, Otoo M, Linh N, Madurangi G. Households' Willingness-to-Pay for Fish Product Attributes and Implications for Market Feasibility of Wastewater-Based Aquaculture Businesses in Hanoi, Vietnam. Resources. 2017 Jul 21;6(3):30.

96. Danso G, Otoo M, Linh N, Madurangi G. Households' Willingness-to-Pay for Fish Product Attributes and Implications for Market Feasibility of Wastewater-Based Aquaculture Businesses in Hanoi, Vietnam. Resources [Internet]. 2017 Jul;6(3):30. Available from: http://www.mdpi.com/2079-9276/6/3/30

97. Xuan BB, Sandorf ED. Potential for Sustainable Aquaculture: Insights from Discrete Choice Experiments. Environ Resour Econ (Dordr). 2020 Oct 4;77(2):401–21.

98. Xuan BB, Sandorf ED. Potential for Sustainable Aquaculture: Insights from Discrete Choice Experiments. Environ Resour Econ (Dordr) [Internet]. 2020 Oct;77(2):401–21. Available from: https://doi.org/10.1007/s10640-020-00500-6

99. Xu X, Zhang W, Wang T, Xu Y, Du H. Impact of subsidies on innovations of environmental protection and circular economy in China. J Environ Manage. 2021 Jul;289.

100. Meng T, Wang C, Florkowski WJ, Yang Z. Determinants of urban consumer expenditure on aquatic products in Shanghai, China. Aquaculture Economics & Management [Internet]. 2023 Jan;27(1):1–24. Available from: https://doi.org/10.1080/13657305.2021.1996480

101. Uchida H, Onozaka Y, Morita T, Managi S. Demand for ecolabeled seafood in the Japanese market: A conjoint analysis of the impact of information and interaction with other labels. Food Policy. 2014;44:68–76.

102. Hori J, Wakamatsu H, Miyata T, Oozeki Y. Has the consumers awareness of sustainable seafood been growing in Japan? Implications for promoting sustainable consumerism at the Tokyo 2020 Olympics and Paralympics. Mar Policy. 2020 May;115(January):103851.

103. Hori J, Wakamatsu H, Miyata T, Oozeki Y. Has the consumers awareness of sustainable seafood been growing in Japan? Implications for promoting sustainable consumerism at the Tokyo 2020

Olympics and Paralympics. Mar Policy [Internet]. 2020 May;115(January):103851. Available from: https://doi.org/10.1016/j.marpol.2020.103851

104. Kamaruddin R, Samah R, Soon J jan, Musa R, Nur Amin NA. Consumers' preference and willingness-to-pay for GAqP-compliant farmed fish produce: Evidence from Malaysia. Aquaculture. 2023 Apr;568(January):739305.

105. Kamaruddin R, Samah R, Soon J jan, Musa R, Nur Amin NA. Consumers' preference and willingness-to-pay for GAqP-compliant farmed fish produce: Evidence from Malaysia. Aquaculture. 2023 Apr;568(January):739305.

106. Smetana K, Melstrom RT, Malone T. A Meta-Regression Analysis of Consumer Willingness to Pay for Aquaculture Products. Journal of Agricultural and Applied Economics. 2022 Aug 1;54(3):480–95.

107. Bastounis A, Buckell J, Hartmann-Boyce J, Cook B, King S, Potter C, et al. The Impact of Environmental Sustainability Labels on Willingness-to-Pay for Foods: A Systematic Review and Meta-Analysis of Discrete Choice Experiments. Nutrients. 2021 Jul 31;13(8):2677.

108. Li S, Kallas Z. Meta-analysis of consumers' willingness to pay for sustainable food products. Appetite. 2021 Aug;163(September 2020):105239.

109. Bastounis A, Buckell J, Hartmann-Boyce J, Cook B, King S, Potter C, et al. The Impact of Environmental Sustainability Labels on Willingness-to-Pay for Foods: A Systematic Review and Meta-Analysis of Discrete Choice Experiments. Nutrients [Internet]. 2021 Jul;13(8):2677. Available from: https://www.mdpi.com/2072-6643/13/8/2677

110. Li S, Kallas Z. Meta-analysis of consumers' willingness to pay for sustainable food products. Appetite [Internet]. 2021 Aug;163(September 2020):105239. Available from: https://doi.org/10.1016/j.appet.2021.105239

111. Cantillo J, Martín JC, Román C. Discrete choice experiments in the analysis of consumers' preferences for finfish products: A systematic literature review. Food Qual Prefer. 2020;84(April):103952.

112. López-Mas L, Claret A, Reinders MJ, Banovic M, Krystallis A, Guerrero L. Farmed or wild fish? Segmenting European consumers based on their beliefs. Aquaculture. 2021 Feb;532(June 2020):735992.

113. Hoerterer C, Petereit J, Krause G. Informed choice: The role of knowledge in the willingness to consume aquaculture products of different groups in Germany. Aquaculture. 2022;556(May):738319.

114. Bronnmann J, Hoffmann J. Consumer preferences for farmed and ecolabeled turbot: A North German perspective. Aquaculture Economics & Management. 2018 Jul 3;22(3):342–61.

115. Trujillo-Barrera A, Pennings JME, Hofenk D. Understanding producers' motives for adopting sustainable practices: the role of expected rewards, risk perception and risk tolerance. European Review of Agricultural Economics. 2016 May;43(3):359–82.

116. Peattie K. Green Consumption: Behavior and Norms. Annu Rev Environ Resour. 2010 Nov 21;35(1):195–228.

117. Cantillo J, Martín JC, Román C. Determinants of fishery and aquaculture products consumption at home in the EU28. Food Qual Prefer [Internet]. 2021 Mar;88. Available from: http://ezproxy.haifa.ac.il/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2020-88591-001&site=eds-live&scope=site

118. Cantillo J, Martín JC, Román C. Assessing the label's mandatory information for fishery and aquaculture products in the EU28. A consumer approach based on a consistent fuzzy preference relation with geometric Bonferroni mean. Mar Policy [Internet]. 2021 Jun 1;128. Available from: http://10.0.3.248/j.marpol.2021.104515

119. Zander K, Feucht Y. Consumers' Willingness to Pay for Sustainable Seafood Made in Europe. Journal of International Food & Agribusiness Marketing. 2018 Jul 3;30(3):251–75.

120. Cantillo J, Martín JC, Román C. Determinants of fishery and aquaculture products consumption at home in the EU28. Food Qual Prefer. 2021 Mar;88(May 2020):104085.

121. Thøgersen J. Country Differences in Sustainable Consumption: The Case of Organic Food. Journal of Macromarketing. 2010 Jun 24;30(2):171–85.

122. Akenji L. Consumer scapegoatism and limits to green consumerism. J Clean Prod [Internet]. 2014 Jan;63:13–23. Available from: http://dx.doi.org/10.1016/j.jclepro.2013.05.022

123. Devinney TM, Auger P, Eckhardt GM. The Myth ofthe Ethical Consumer [Internet]. Cambridge: Cambridge University Press; 2010. 260 p. Available from: https://www.ptonline.com/articles/how-to-get-better-mfi-results

124. Devinney TM, Auger P, Eckhardt GM. The Myth ofthe Ethical Consumer. Cambridge: Cambridge University Press; 2010. 260 p.

125. Akenji L. Consumer scapegoatism and limits to green consumerism. J Clean Prod. 2014 Jan;63:13–23.

126. Yip W, Knowler D, Haider W, Trenholm R. Valuing the Willingness-to-Pay for Sustainable Seafood: Integrated Multitrophic versus Closed Containment Aquaculture. Canadian Journal of Agricultural Economics [Internet]. 2017 Mar;65(1):93–117. Available from: http://ezproxy.haifa.ac.il/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=ecn&AN=1900333&site=eds-live&scope=site

127. Lehner M. Translating sustainability: the role of the retail store. Anne Wiese, Associate Professor Ste D, editor. International Journal of Retail & Distribution Management. 2015 May 11;43(4/5):386–402.

128. Jones P, Comfort D, Hillier D. European Food and Drink Wholesalers and Sustainability. European Journal of Sustainable Development Research. 2017 Jan 17;1(1):0–2.

129. Fuchs D, Kalfagianni A, Arentsen M. Retail Power, Private Standards, and Sustainability in the Global Food System. In: Clapp J, Fuchs D, editors. Corporate Power in Global Agrifood Governance. Cambridge: The MIT Press; 2009. p. 29–60.

130. Busch L, Bain C. New! Improved? The transformation of the global agrifood system. Rural Sociol. 2004;69(3):321–46.

131. Durieu X. How Europe's retail sector helps promote sustainable production. Industry and Environment. 2003 Jan 1;26:7–9.

132. Ellram LM, La Londe BJ, Margaret Weber M. Retail Logistics. International Journal of Physical Distribution & Logistics Management. 1999 Dec 1;29(7):477–94.

133. Jespersen KS, Kelling I, Ponte S, Kruijssen F. What shapes food value chains? Lessons from aquaculture in Asia. Food Policy. 2014 Dec;49(P1):228–40.

134. Nes Kjersti, Colen Liesbeth, Ciaian Pavel. Market power in food industry in selected EU Member States. European Commission. 2021.

135. Clapp J. The problem with growing corporate concentration and power in the global food system. Nat Food. 2021 Jun 3;2(6):404–8.

136. Busch L. The moral economy of grades and standards. J Rural Stud. 2000 Jul;16(3):273–83.

137. Kalfagianni A. Transparency in the Food Chain: Policies and Politics. Krooshoop A, editor. PhD Dissertation. Twente University Press; 2006. 300 p.

138. Fuchs D, Kalfagianni A, Havinga T. Actors in private food governance: The legitimacy of retail standards and multistakeholder initiatives with civil society participation. Agric Human Values. 2011;28(3):353–67.

139. Jones P, Comfort D, Hillier D. European Food and Drink Wholesalers and Sustainability. European Journal of Sustainable Development Research [Internet]. 2017 Jan;1(1):0–2. Available from: http://www.ejosdr.com/article/X9XHKFW7

140. Jones P, Hillier D, Comfort D. Shopping for tomorrow: promoting sustainable consumption within food stores. British Food Journal [Internet]. 2011 Jul;113(7):935–48. Available from: https://www.emerald.com/insight/content/doi/10.1108/00070701111148441/full/html

141. Reardon T, Farina E. The rise of private food quality and safety standards: illustrations from Brazil. The International Food and Agribusiness Management Review. 2002;4:413–21.

142. Washington S, Ababouch L. Private standards and certification in fisheries and aquaculture: Current practice and emerging issues. Vol. 4. Rome, Italy: FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS; 2011.

143. Bălan C. How Does Retail Engage Consumers in Sustainable Consumption? A Systematic Literature Review. Sustainability. 2020 Dec 24;13(1):96.

144. Bălan C. How Does Retail Engage Consumers in Sustainable Consumption? A Systematic Literature Review. Sustainability [Internet]. 2020 Dec;13(1):96. Available from: https://www.mdpi.com/2071-1050/13/1/96

145. Guyader H, Ottosson M, Witell L. You can't buy what you can't see: Retailer practices to increase the green premium. Journal of Retailing and Consumer Services. 2017 Jan;34:319–25.

146. Hallstein E, Villas-Boas SB. Can household consumers save the wild fish? Lessons from a sustainable seafood advisory. J Environ Econ Manage. 2013 Jul;66(1):52–71.

147. Gunn M, Mont O. Choice editing as a retailers' tool for sustainable consumption. International Journal of Retail & Distribution Management. 2014 Jun;42(6):464–81.

148. Keskitalo C, Bujnicki J, Heuer RD, Dykstra P, Fortunato E, Grobert N, et al. Towards a sustainable agri-food system. European Commission. 2020.

149. Saviolidis NM, Olafsdottir G, Nicolau M, Samoggia A, Huber E, Brimont L, et al. Stakeholder Perceptions of Policy Tools in Support of Sustainable Food Consumption in Europe: Policy Implications. Sustainability. 2020 Sep 2;12(17):7161.

150. Davies AR. Toward a Sustainable Food System for the European Union: Insights from the Social Sciences. One Earth. 2020 Jul;3(1):27–31.

151. Galli F, Prosperi P, Favilli E, D'Amico S, Bartolini F, Brunori G. How can policy processes remove barriers to sustainable food systems in Europe? Contributing to a policy framework for agri-food transitions. Food Policy. 2020 Oct;96(February):101871.

152. SAPEA. A Sustainable Food System for the European Union. 2020.

153. David LH, Pinho SM, Agostinho F, Kimpara JM, Keesman KJ, Garcia F. Emergy synthesis for aquaculture: A review on its constraints and potentials. Rev Aquac. 2021;13(2):1119–38.

154. EC. Farm to Fork Strategy. 2020.

155. Pe'er G, Zinngrebe Y, Moreira F, Sirami C, Schindler S, Müller R, et al. A greener path for the EU Common Agricultural Policy. Science (1979). 2019 Aug 2;365(6452):449–51.

APPENDIX 1 – GLOSSARY OF TERMS

Closed Containment System (CCS) is an aquaculture system that uses tanks or ponds with impermeable walls to contain the fish, thus preventing any contact with the environment.

Integrated Multi-Trophic Aquaculture (IMTA) is an approach to aquaculture that combines different species in order to create a balanced ecosystem. It involves growing multiple species together in order to take advantage of their complementary roles in the food chain.

Recirculating Aquaculture System (RAS) is a type of aquaculture system that uses a closed-loop water circulation system to maintain water quality and reduce the need for water exchange.

Contingent behaviour method (CBM): A method of estimating the WTP for a good or service that uses a combination of observed behaviour and preferences. It is based on the assumption the people reveal their preferences through their behaviour and expression and that these preferences can be used to estimate the value of the good or service. Its use is generally limited to market goods.

Contingent Valuation Method (CVM): A method of estimating the value of goods or services that are not bought and sold in the market, by asking individuals directly what they are willing to pay for them. It may be used for market, quasi-market and non-market valuation.

Discrete Choice Experiment (DCE): A survey-based method used to analyse consumer preferences and evaluate the trade-offs between different features of a product or service, including its price. It may be used for market, quasi-market and non-market valuation.

Hedonic Method (HM): A method of estimating the economic value of a good or service by examining how different attributes of the good or service affect its price.

Latent Class Analysis (LCA): A statistical method used to identify and quantify the underlying structure of preferences among individuals, by grouping people into distinct classes that share similar preferences.

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