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Perceptions and misconceptions of aquaculture

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Perceptions and misconceptions of aquaculture: a global overview

by

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This report provides a global overview and synthesis of studies on perceptions of aquaculture in both developed and developing countries. Its aim is to better understand the main concerns of the public and diverse stakeholder groups. The second part provides recommendations for policy-makers, the industry and other stakeholders on improving public understanding of aquaculture and on the roles various actors can play in this process.

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ABBREVIATIONS AND ACRONYMS

ASEM	Asia-Europe Meeting
CCRF	Code of Conduct for Responsible Fisheries
DFO	Department of Fisheries and Oceans (Canada)
EAAE	European Association of Agricultural Economists
EC	European Commission
EFSA	European Food Safety Authority
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
G.A.P.	good agricultural practice
GFCM	General Fisheries Commission for the Mediterranean
GSI	Global Salmon Initiative
IDH	Sustainable Trade Initiative
LC-PUFA	long-chain polyunsaturated fatty acid
NGO	non-governmental organization
NZ	New Zealand
PCB	polychlorinated biphenyl
USDA	United States Department of Agriculture
WFT	World Fisheries Trust
WHO	World Health Organization
WWF	World Wildlife Fund

EXECUTIVE SUMMARY

The rapid growth of intensive aquaculture production, in some cases not well planned, has caused concern about environmental impact, human health and social issues. The bulk of global aquaculture production is in Asia. Yet opposition to aquaculture development is strongest in the Western world, where modern aquaculture is still a relatively new industry competing with well-established activities. In addition, the increasing dependence of developed countries on farmed seafood imports from developing countries and insecurity regarding product environmental, social and safety credentials have attracted considerable negative media attention. Moreover, scientific uncertainties and conflicting information on seafood consumption have further confused the public.

With a growing world population, annual supply needed from the aquaculture sector must further surpass that from capture fisheries, reaching 62 percent in 2030, to maintain current consumption levels per capita. This presents tremendous challenges to the sector, to policy-makers and to the aquaculture community at large. Improving perceptions of the sector will be instrumental if the goal is to be achieved.

This report consists of two parts: the first provides a global overview and synthesis of studies on perceptions of aquaculture in both developed and developing countries. Its aim is to better understand the main concerns of the public and diverse stakeholder groups. This information can serve the industry as the basis for arriving at recommendations for reducing uncertainty about its products and farming practices, enabling more-effective communication strategies. The second part provides specific recommendations for addressing the public concerns identified in the first part, and discusses the roles various key stakeholders can play in this process.

The findings show that – apart from objective knowledge – personal experience, preconceived ideas and the demographic and regional context strongly influence perceptions of aquaculture. The strongest consumer concerns regard the health and safety aspects of farmed products. Evidence is mixed on whether people perceive aquaculture as causing environmental and animal welfare problems, and it differs among countries and regions. Interestingly, when purchasing fish, the majority of consumers are not aware of the farmed or wild origin of the seafood they buy. This suggests that other factors, such as quality, price, taste and convenience, seem to play more-important roles, whereas sustainability aspects are only taken into account by a limited number of consumers. Overall, the public debate on aquaculture has focused mainly on risks, often lacking a balanced evaluation of costs and benefits.

To improve public awareness of aquaculture, the industry needs a more-open, broader dialogue that will increase transparency in the sector. If it is to communicate the benefits of aquaculture more effectively, it must collaborate more with other stakeholder groups viewed as credible by the public. Moreover, greater synergy and cooperation are needed among the various subsectors of aquaculture, so as to speak with one voice and achieve a greater political hearing. While important social and environmental issues are still to be addressed, it is important to put aquaculture in a wider perspective by comparing its costs and benefits with other animal production systems. To date, a holistic view – taking into account a balanced evaluation of aquaculture's risks and benefits – has been lacking, impeding the development of policies that reflect production realities.

REPORT BACKGROUND

The idea for this desk study was based on a social science study entitled “Stakeholders' perceptions of marine fish farming in Catalonia (Spain): a Q-methodology approach”, conducted by the author as part of her Ph.D. thesis (Bacher, Gordoia and Mikkelsen, 2014). The present study was conducted during a six-month consultancy at FAO headquarters in Rome, Italy. The industry and other stakeholders consider perceptions of aquaculture an important topic: in collaboration with the Global Salmon Initiative and the Sustainable Trade Initiative, FAO is organizing an international workshop entitled Increasing Public Understanding and Acceptance of Aquaculture – the Role of Truth, Transparency and Transformation (10–11 October 2015, Vigo, Spain). The workshop is bringing together key stakeholders in aquaculture to exchange ideas and experiences to improve public understanding of aquaculture.

1. INTRODUCTION

Global demand for fish products has increased over the last decades, and this trend is expected to continue due to population growth, increasing wealth, urbanization and a growing preference for healthy foods. In the context of stagnating capture fisheries, aquaculture will have to meet most of the future increase in demand for seafood.¹ Consequently, in 2014, human consumption of farmed seafood overtook that of wild-caught seafood for the first time (FAO, 2014). This increasing importance of aquaculture occurs at a time when the world has become more conscious of environmental issues, and consumers have also become more aware of and demand safer products. Recent food crises, such as bovine spongiform encephalopathy in cattle, salmonella in eggs and mercury in wild-caught tuna, have raised serious food-safety concerns in general (Burbridge *et al.*, 2001). Consequently, there is a tendency among some consumers in developed countries to distrust the use of new technologies in food production, which can negatively affect product acceptance and prices (Yeung and Morris, 2001). A growing unease regarding the health and safety of modern food production is also increasingly observed in emerging economies, such as China, where higher incomes and better education may lead to more awareness of environmental issues and a demand for safer food products (Wang *et al.*, 2009).

Some forms of aquaculture, such as the polyculture of milkfish, shrimp and other species in brackish water ponds in Asia, have been an integral part of coastal development for many centuries (Burbridge *et al.*, 2001). However, the increasing demand for selected species in commercial aquaculture has led to a rapid increase in the expansion of this sector in both tropical and temperate regions. This rapid growth of intensive aquaculture production has heightened criticism – raising questions about its environmental compatibility with other activities and the potential negative economic or social effects on local communities (Burbridge *et al.*, 2001). While such concerns exist worldwide, opposition to aquaculture development is strongest in the Western world, where modern aquaculture is still a relatively new industry, competing with well-established activities and traditional users for space and access to natural resources (e.g. the fishing sector, tourism and coastal residents). In addition, the increasing dependence of developed countries on farmed seafood imports from developing countries and insecurity regarding product environmental, social and safety credentials have attracted considerable negative media attention (Little *et al.*, 2012). Such negative reports by the mass media and some non-governmental organizations (NGOs) have amplified public mistrust of the sector. Moreover, scientific uncertainties and conflicting information on seafood consumption have further confused the public.

While the negative image is often driven by concerns associated with a few commodities or aquaculture systems (e.g. shrimp or salmon farming), it prejudices the whole industry. As a consequence, the aquaculture sector has encountered much-more-stringent public scrutiny compared with other protein-producing industries. In some instances, this has influenced decision-makers, pressuring them to regulate the aquaculture sector more strictly or even to stop its expansion (Hishamunda, Poulain and Ridler, 2009). It can be argued that pressure from this public attention has also helped improve the sector's farming practices – reducing environmental impact, and increasing quality, food safety and traceability. However, public opposition to aquaculture has not been triggered only by adverse impacts of the industry; negative perceptions are also caused through misinformation (Hishamunda, Poulain and Ridler, 2009). Particular groups, such as the wild capture fishery, some NGOs and

¹ In this report, 'seafood' is used to denote fish and fishery products in general.

competing aquaculture subsectors have at times spread negative, unbalanced and even incorrect information on the sector, in particular for imported aquaculture products – further influencing public perceptions.

Even though the wealth of information on food production available to consumers has never been better, the public's lack of awareness of and experience with aquaculture makes it difficult for people to know what information to trust. When confronted with negative information, most people cannot refer to previous experiences with this activity, as they can for agricultural farming and fishing. Thus fear of the unknown can lead to opposition to an activity and refusal of its products without even understanding why. Modern aquaculture is still at an early stage of development, and despite many improvements in its production processes towards greater sustainability, a 'perception gap' exists between the way modern aquaculture is carried out and public understanding of the industry. Thus it is crucial to communicate better the important role that a responsible aquaculture sector can play in addressing urgent social and economic issues such as food security, employment and maintenance of essential services in deprived rural areas. Moreover, from an environmental perspective, it is argued that fish is a more sustainable source of protein compared with other livestock production systems, owing to its efficient conversion of feed into high-quality food (Béné *et al.*, 2015). Thus aquaculture must be put in a broader perspective, by comparing its benefits and costs with other food-production systems and not only with wild-caught fish. In the future, aquaculture must become even more efficient in producing more with fewer resources to meet the global demand for seafood. This may generate even greater concern about meeting the challenge of increasing overall production sustainably. Consequently, irrespective of the correctness of the varying range of arguments against aquaculture, the industry must take the expressed concerns seriously and demonstrate to the public and policy-makers that aquaculture development can be socially and environmentally responsible and still continue to be an important provider of healthy animal protein (De Silva and Davy, 2010).

This report consists of two parts: the first provides an overview and synthesis of studies on perceptions of aquaculture in both developed and developing countries. Its aim is to better understand the main concerns of the public and diverse stakeholder groups. The second part provides recommendations for improving public understanding of aquaculture, and discusses the roles various key stakeholders can play in this process.

2. GLOBAL OVERVIEW OF PERCEPTIONS OF AQUACULTURE

2.1. WHY STUDY SOCIAL PERCEPTIONS OF AQUACULTURE?

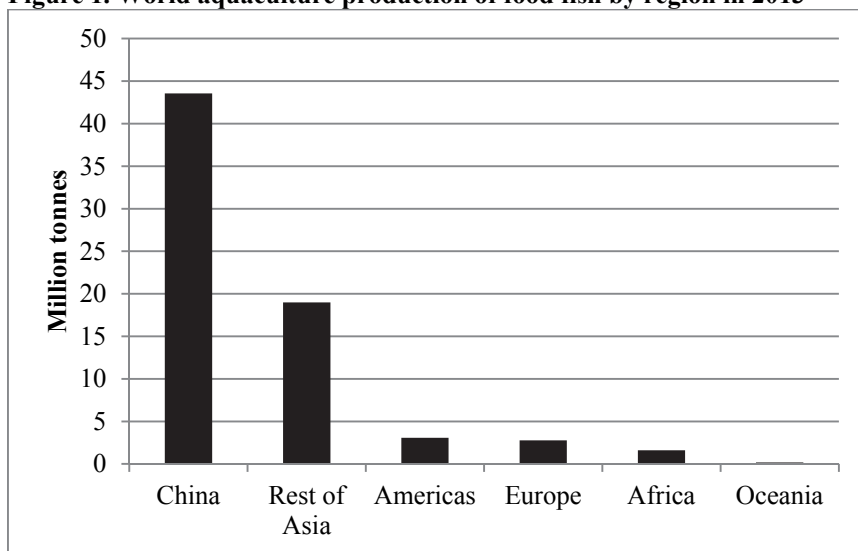
Understanding the various perceptions of aquaculture is an important part of aquaculture management and planning (Chu *et al.*, 2010; Mazur and Curtis, 2008; Robertson, Carlsen and Bright, 2002). Insufficient participation and consultation of relevant stakeholder groups could lead to mismanagement of resources, social conflict and/or decreased public support and trust (Kaiser and Stead, 2002; Shindler, Wilton and Wright, 2002). Stakeholder concerns and societal expectations have (and have had) the potential to steer the industry on a different path, and to speed up or slow down its expansion. Different perceptions tell us what stakeholder groups consider the most important issues (Mazur and Curtis, 2008) and their attitudes towards improvement. Moreover, social science studies reveal the public's knowledge of aquaculture products and the industry, and can identify potential misconceptions. This information can serve the industry in reducing uncertainty about its products and farming practices, enabling more-effective communication strategies. Finally, consumer studies can identify factors that affect purchasing behaviour, which can aid the promotion of farmed-fish consumption.

2.2. WHAT HAS BEEN DONE ON THE TOPIC SO FAR?

Social science studies of aquaculture, and especially of fish farming, have generated increasing interest in recent years (e.g. DFO, 2005; Schlag, 2010). Most of this research has focused on consumer attitudes towards aquaculture products (Altintzoglou *et al.*, 2010; Fernández-Polanco and Luna, 2010, 2012; Verbeke *et al.*, 2007a), but also on the general public's opinions of the aquaculture industry (Freeman *et al.*, 2012; Katranidis, Nitsi and Vakrou, 2003; Shafer, Inglis and Martin, 2010) and on the perceptions of aquaculture-related key stakeholder groups (Bacher, Gordo and Mikkelsen, 2014; Chu *et al.*, 2010; Rudell and Miller, 2012). These investigations predominantly applied survey-based methods (Whitmarsh and Palmieri, 2009), qualitative focus-group discussions (Schlag and Ystgaard, 2013; Verbeke *et al.*, 2007a) and Q-methodology (Bacher, Gordo and Mikkelsen, 2014; Rudell and Miller, 2012). To date, consumer studies and investigations on perceptions of aquaculture have primarily been conducted in developed countries, including Australia (Mazur and Curtis, 2008; Mazur *et al.*, 2004), Canada (DFO, 2005), Israel (Freeman *et al.*, 2012), Japan (Uchida *et al.*, 2014), New Zealand (Shafer, Inglis and Martin, 2010; NZ, 2014), the United States (Robertson, Carlsen and Bright, 2002), and a wide range of European countries (Schlag and Ystgaard, 2013; EC, 2008). In contrast, information from developing countries is very limited, with the exception of Ghana and Kenya (Darko, 2011; Githukia *et al.*, 2014) and some information on public perceptions of the socio-economic impacts of aquaculture in Chile (Barrett, Caniggia and Read, 2002) and the Philippines (Irz *et al.*, 2007).

The relatively high number of social science studies of aquaculture in the Western world compared with developing countries seems to reflect the concerns associated with aquaculture in these regions. The bulk of cultured seafood is produced (Figure 1) and consumed in Asia, yet opposition to aquaculture development is strongest in the Western world, where modern aquaculture is still perceived as a relatively new industry.

Figure 1. World aquaculture production of food fish by region in 2013



Source: FAO.

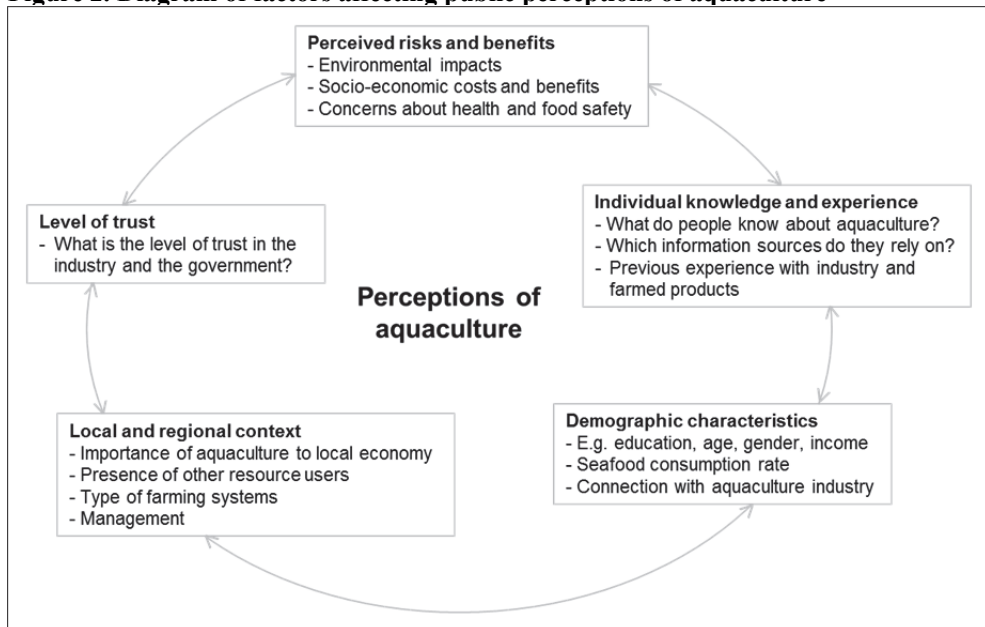
Negative consumer perceptions in western countries can directly affect sales and prices of farmed products from developing countries. Moreover, the intensification of aquaculture production processes, in combination with higher education levels and income in emerging economies, may lead to increased public awareness of environmental impacts and fish product safety in these regions. An example is China, where recent quality and safety scares for fish products have increased consumer awareness and caused (temporarily) significant reduction in seafood consumption (Wang *et al.*, 2009). Thus public perceptions of aquaculture are likely to become more critical to the future success or failure of the industry. A global Delphi study on constraints facing aquaculture found that experts in all regions, except Africa and eastern Europe, expect opposition to aquaculture to be a threat to its future development (Hishamunda, Poulain and Ridler, 2009). In Asia, public mistrust was expected to have a large negative effect over the next 15 years, and a large or very large negative impact in the Americas and western Europe. This emphasizes the need to better understand the factors that influence public perceptions of aquaculture in these areas.

The present report provides a global overview of people's perceptions of aquaculture. However, it is beyond the scope of this work to describe in detail the concerns associated with different farming systems and cultivated species. Depending on where surveys were conducted, perceptions towards different farming systems and/or species were investigated. The vast majority of studies examined attitudes towards marine fish farming, probably because this type of aquaculture represents the most contentious activity. The most common species included in perception studies was farmed salmon, especially in Canada and the United States, but also in Europe and Japan. Gilthead seabream, European seabass and Atlantic cod culture were also included in some surveys in Europe, whereas in Australia, the perception towards sea-cage cultures (southern blue-fin tuna, kingfish) and shellfish farming (mussels, abalone and oysters) were investigated. In Ghana and Kenya, consumers were asked about their perceptions of farmed Nile tilapia and African catfish.

2.3. FACTORS THAT INFLUENCE PERCEPTIONS OF AQUACULTURE

Public perceptions of farmed seafood and of aquaculture as a production technique – and its acceptance or rejection – depend on many factors (Figure 2). The implied factors do not only include objective knowledge, but also preconceived ideas such as attitudes or beliefs about the product and its processes. Exploratory studies have shown that the perception of aquaculture can be influenced by the perceived risks of the activity, such as human health risks (Verbeke *et al.*, 2007a) and environmental impacts (Whitmarsh and Wattage, 2006), socio-economic benefits and costs (Katranidis, Nitsi and Vakrou, 2003; Mazur and Curtis, 2008; Whitmarsh and Palmieri, 2009), the level of trust in the industry and government (Mazur and Curtis, 2006), individual knowledge (EC, 2008; Pieniak, Vanhonacker and Verbeke, 2013; Gempesaw *et al.*, 1995), media representation of aquaculture (Schlag, 2011; Amberg and Hall, 2008), local circumstances (Whitmarsh and Palmieri, 2009; Mazur and Curtis, 2008), demographic characteristics (Claret *et al.*, 2014; Mazur *et al.*, 2004; Verbeke *et al.*, 2007a), seafood consumption rate (Vanhonacker, Pieniak and Verbeke, 2013; Verbeke *et al.*, 2007b) and individual values and experiences (Verbeke *et al.*, 2007a). Moreover, consumer decisions to purchase (farmed) seafood may depend on specific product attributes, including price, perceived product quality, taste, origin, health attributes, food safety, availability, freshness, convenience/ease of preparation, previous experience with seafood, and animal welfare (Luten *et al.*, 2002; Honkanen and Olsen, 2009; Olsen *et al.*, 2007; Cahu, Salen and De Lorgeril, 2004; Githukia *et al.*, 2014; Gempesaw *et al.*, 1995; Verbeke *et al.*, 2007b).

Figure 2. Diagram of factors affecting public perceptions of aquaculture



The importance given to these different factors can be expected to vary, depending on a person's background, interest, level of knowledge and understanding. It is thus not surprising that marked differences have been found in attitudes between a range of

stakeholder groups and the wider public (Mazur and Curtis, 2008; Whitmarsh and Palmieri, 2009). A variety of individuals and groups have an interest in aquaculture, such as seafood consumers, people living close to farms, governments, scientists, retailers, NGOs, seafood processors and other economic or leisure activities in the coastal zone (e.g. capture fishery, tourism). They will all be affected in different ways; consequently, diverse aspects of aquaculture influence their opinions. Even within the same sector, actors may not share the same perceptions (Bacher, Gordoa and Mikkelsen, 2014; Chu *et al.*, 2010). Thus this wide range must be taken into account. The extent to which the preferences of certain interest groups with an influence on aquaculture policy are congruent with those of the wider public requires evaluation (Whitmarsh and Palmieri, 2009). A large discrepancy between expert and lay perceptions can make efficient communication challenging (Schlag, 2010).

2.4. REGIONAL CONTEXT AND DEMOGRAPHIC CHARACTERISTICS

Regional settings and conditions can strongly influence perceptions of aquaculture, including the size and structure of the industry, its economic impact, population densities and resulting pressures on the environment (Mazur and Curtis, 2008). Moreover, the benefits and risks of aquaculture also depend on the farming system and the species cultivated: the great diversity of the global aquaculture industry further diversifies the range of potential perceptions. Several transnational studies have shown that notable knowledge and attitudinal divergences towards aquaculture exist between countries and also within countries (Schlag and Ystgaard, 2013). In Australia and Scotland, respondents in rural areas showed higher levels of support and trust in the industry and lower environmental concerns compared with individuals in urban or economically more-developed regions (Mazur and Curtis, 2008; Whitmarsh and Palmieri, 2009). The authors thus argued that this implies that public attitudes towards the aquaculture industry are a function of the weights people attach to the beneficial effects of the industry (i.e. job creation, economic development) as against the perceived negative environmental effects. In addition, perceptions have been shown to vary due to demographic characteristics such as gender (Claret *et al.*, 2014; Mazur *et al.*, 2004), age (Verbeke *et al.*, 2007a) and education (Mazur *et al.*, 2004; Fernández-Polanco and Luna, 2012). Women respondents in an Australian study were considerably more concerned about potential impacts of aquaculture and less trusting of both the government and the aquaculture industry (Mazur *et al.*, 2004), whereas women consumers in Spain were found to be more open to aquaculture (Claret *et al.*, 2014). A study of Belgian consumers showed that the oldest respondents (over 55 years) hold a stronger belief that wild fish is healthier and has a better taste than farmed fish (Verbeke *et al.*, 2007a). Moreover, people with higher levels of education in Australia were found to be more aware of issues affecting aquaculture and coastal management (Mazur *et al.*, 2004).

2.5. WHAT DOES THE PUBLIC KNOW ABOUT AQUACULTURE?

Understanding what the public knows about the aquaculture sector, what they would like to know and where they get their information is an important prerequisite for improving communication on aquaculture issues. Knowledge about the sector has been found to vary substantially among regions, in relation to different aquaculture practices, socio-demographic characteristics, experiences and interests (Freeman *et al.*, 2012; Verbeke *et al.*, 2007a; Schlag and Ystgaard, 2013; Mazur *et al.*, 2004; EC, 2008). As may be expected, higher awareness of aquaculture was found in areas where respondents report more contact with the industry (Mazur and Curtis, 2008; NZ, 2014) and where fish consumption rates are high (EC, 2008). Nevertheless, results of studies in various countries

suggest that large parts of the general public may be relatively uninformed on a range of aquaculture-related topics (Claret *et al.*, 2014; Schlag and Ystgaard, 2013; Barrington *et al.*, 2010; DFO, 2005; Pieniak, Vanhonacker and Verbeke, 2013). Moreover, exploratory insights from focus-group discussions in Belgium and Canada indicate that aquaculture issues are not at the top of the minds of many consumers (Verbeke *et al.*, 2007a; DFO, 2005), and the majority are not aware of the farmed or wild origin of the seafood they buy (Vanhonacker *et al.*, 2011; Claret *et al.*, 2014).

Despite this relatively low awareness of aquaculture, when confronted with the topic, consumers hold quite specific, though often differentiated, opinions about farmed seafood (Verbeke and Brunsø, 2005). Respondents with previous exposure to the sector showed higher awareness of aquaculture's socio-economic benefits, whereas those with less direct exposure demonstrated greater concern for environmental impacts (Mazur and Curtis, 2008). Individuals unfamiliar with aquaculture were more likely to consider farmed products as 'unnatural' and to project negative images drawn from intensive terrestrial livestock production systems onto fish farming (Verbeke *et al.*, 2007a). In general, the perceptions of people with little knowledge of aquaculture are more affected by new information (Robertson, Carlsen and Bright, 2002) and can thus be more easily influenced by manipulated or skewed data (NZ, 2014). Moreover, evidence suggests that consumers' perceptions may be based more on beliefs and emotions than on objective knowledge (Verbeke *et al.*, 2007a; Schlag and Ystgaard, 2013). Thus providing transparent and fact-based information on aquaculture to the general public may not be enough to improve public awareness.

2.6. USE AND TRUST OF INFORMATION SOURCES

The public uses a wide range of information sources about aquaculture, with different degrees of credibility (Pieniak *et al.*, 2007). The results of several studies indicated that information transmitted through personal contact, such as friends and family, the fishmonger, retail sellers or visiting an aquaculture farm, were considered important and trusted (Pieniak *et al.*, 2007; EC, 2008; NZ, 2014). In addition, food labels were found to be an effective way to inform the public about basic product attributes, such as expiry date, nutritional values, price and species weight, from which consumers felt they were able to derive clear quality expectations (Pieniak and Verbeke, 2008). When asked about additional information cues, respondents of a cross-country study in Europe displayed the highest interest in quality and/or food safety labels (Pieniak and Verbeke, 2008; EC, 2008). The Internet, television, radio, advertising and written media also play an important role in consumer information, but they are considered less-trusted sources (Pieniak *et al.*, 2007; EC, 2008). Thus several studies indicate that the most common information sources are not necessarily more trusted. On the contrary, they often receive lower credibility ratings (e.g. media, government), while sources used less frequently receive higher credibility ratings (e.g. scientific reports, health professionals, consumer associations) (Mazur *et al.*, 2004; Pieniak *et al.*, 2007). It seems that consumers mainly use the information most available to them, but do not actively seek out information from more-credible sources unless they have a special interest in the issue (Mazur *et al.*, 2004). In addition, it was shown that the food-buying decision process is in most cases a routine one, characterized by habit and limited information-seeking (Honkanen, Olsen and Verplanken, 2005). These findings emphasize the importance of more-active involvement by health professionals, consumer associations and scientists in the dissemination of information on farmed seafood.

Apart from investigating the knowledge level and use of different information sources on aquaculture, it is crucial to understand what kind of information people are demanding. Thus the next sections highlight the major concerns, but also misconceptions associated with aquaculture. Concerns about and perceptions of environmental impacts, health issues and socio-economic effects are to a certain degree interrelated. However, in the interests of clarity, the present report has separated them into three sections: the environment and animal welfare, food safety and quality, and socio-economic issues.

2.7. ENVIRONMENTAL AND ANIMAL WELFARE CONCERNS

Given that aquaculture takes place in coastal ecosystems and freshwater habitats, which are often under pressure from multiple human impacts, it is not surprising that the sector raises environmental concerns. Thus the challenge in natural resource management is to strike a balance between conservation and economic development, taking into account diverse opinions and interests so as to achieve equitable outcomes (Mazur and Curtis, 2008). Environmental damage is not only a consequence of aquaculture, but also represents a significant constraint, owing to the sector's fundamental dependence on good environmental conditions and hence a shared interest in their maintenance (Young, Brugere and Muir, 1999). This is often overlooked. Nevertheless, inadequate management of aquaculture development and irresponsible practices can damage the environment and also the sector's reputation. Potential impacts have been widely studied in the literature and include: discharge of various effluents (e.g. waste feed, faeces, pesticides and medications) (Primavera, 2006); effects on biodiversity (Beveridge, Ross and Kelly, 1994); negative interactions with wild fish populations (Diamant *et al.*, 2000; Heggberget *et al.*, 1993); use of fishery resources as feed inputs (Naylor *et al.*, 2009); and animal welfare issues (Ashley, 2007). The type and scale of such environmental effects from aquaculture production depend greatly on the farming method, level of production and characteristics of the area. Most environmental concerns centre on the production of carnivorous species, such as shrimp and salmonids, but catfish production in the Mekong Delta has also come under scrutiny. The rapid growth of pangasius and shrimp production in Southeast Asia and trade of these with developed countries have provoked criticism of the industry's environmental, social and safety credentials (Little *et al.*, 2012). Most potential environmental effects are not directly visible to the public eye. Nonetheless, these issues gain attention in the public sphere through NGO campaigns and negative media reports containing easily memorized visual messages of impact (Young, Brugere and Muir, 1999).

Consumer surveys have shown that evidence is mixed on whether people perceive aquaculture as giving rise to environmental and animal welfare problems, and it differs among countries and regions. In Europe, the focus on environmental risks associated with fish consumption is most pronounced in the northern and western countries, such as Belgium, Denmark, Finland, France, Germany, Ireland, the Netherlands, Norway, Sweden and the United Kingdom (EC, 2008). In Norway, the public was found to be especially aware of environmental topics, owing to the particular importance of the aquaculture industry to their country (Schlag and Ystgaard, 2013). Interestingly, in Germany, overfishing raises more sustainability concerns than does fish farming. Thus farmed fish benefits from a more-positive image than wild fish (Schlag and Ystgaard, 2013; EC, 2008). Consumers in southern, central and eastern Europe are uncertain about environmental issues related to both fishing and fish farming, but prefer to consume wild seafood (Schlag and Ystgaard, 2013). Similarly, Japanese consumers in Tokyo show a clear preference for wild fish, and are largely unaware of the current status of the world's fish stocks and of

sustainability issues associated with aquaculture (Onozaka *et al.*, 2010). Nevertheless, when provided with information on the problems of overfishing, respondents showed a willingness to pay a price premium for ecolabelled seafood (Uchida *et al.*, 2014). A public survey in Australia found that respondents recognized the challenge of balancing economic and environmental priorities relating to aquaculture, but they were divided on whether the sector was sufficiently concerned about environmental management. Overall, people were more concerned about environmental risks associated with sea-cage fish farming than with the shellfish subsector (Mazur *et al.*, 2004). For the Canadian public, food safety and environmental safety are highly interrelated, and they perceived a wide range of risks, including disease, damage to the coastal ecosystem, escaped fish and the food fed to fish (DFO, 2005). Despite negative perceptions of the current state of the industry, aquaculture was seen to have tremendous potential, as long as strict regulations are in place to enforce food and environmental safety standards.

The concept of animal welfare in relation to aquaculture is still very underdeveloped in most regions and does not arouse concerns among the majority of consumers (Honkanen and Olsen, 2009). Nevertheless, the growing attention to fish welfare, especially in northern European countries (Solgaard and Yang, 2011; Ellingsen *et al.*, 2015) should not be ignored by the aquaculture sector, especially as animal welfare seems to be used by consumers as an indicator for other more-sought-after product attributes, such as safety and impact on health (Harper and Makatouni, 2002).

To date, information on how environmental concerns affect decision-making on seafood consumption is limited. A national consumer study in the United States found that 47 percent of participants had a negative view of farm-raised seafood, due to concerns associated with product quality, food safety and the environment. Yet this negative perception doesn't seem to translate into purchasing behaviour, as a mere 5 percent of survey respondents indicated that they buy only wild seafood (<http://gaalliance.org/blog/2015/03/17/gaa-fishin-company-survey-finds-u-s-consumers-still-largely-unfamiliar-with-aquaculture/>, accessed 18.06.2015). Similarly, despite a somewhat negative perception of aquaculture, the majority of European consumers do not seem to differentiate between farmed and wild products when purchasing seafood (EC, 2008). The results from a study in Belgium suggest that consumer rejection of farmed fish was associated with a lower perceived quality of the product, rather than grounded in sustainability concerns (Verbeke *et al.*, 2007b). These findings suggest that other product attributes, such as quality, price, taste and convenience, are more-important purchasing criteria, whereas sustainability attributes are only taken into account by a limited number of consumers (Verbeke *et al.*, 2007b). The willingness of some consumers to pay a higher price for aquaculture products that have been produced more sustainably (Uchida *et al.*, 2014; Whitmarsh and Wattage, 2006), suggests that the pattern of consumption may at least in part be determined by people's environmental preferences. Yet consumers may not always behave the way they indicate in scientific surveys. The results of a European-wide study imply that sustainability labels currently do not play a major role in consumer food choices. Even though consumers indicate concern, in most cases this does not trigger a change in behaviour towards purchasing more-sustainable products (Grunert, Hieke and Wills, 2014).

The debate about aquaculture's environmental effects indicates that the potential risks are given much more attention than the potential environmental benefits. However, in the context of growing concerns about capture fisheries and ocean pollution, people may

increasingly start to see the advantages of aquaculture. In Germany, the public has already made a change, preferring farmed over wild-caught fish, as it is believed to reduce pressure on wild fish stocks (Schlag and Ystgaard, 2013).

2.8. PERCEPTIONS OF FOOD SAFETY AND THE QUALITY OF AQUACULTURE PRODUCTS

Fish products have a very positive image worldwide in terms of health, and the increasing trend of eating more healthy diets is positive for the fish sector. The unique lipid composition of fish, including long-chain polyunsaturated fatty acids (LC-PUFAs), and the rich nutrient content can provide protection against a wide range of health issues (Larsen, Eilertsen, and Elvevoll, 2011). Nevertheless, the dietary recommendation to eat two portions of fish a week, of which one should be oily, is not met by many consumers. One barrier for not eating more fish is the concern about safety. Reports about fish contamination with methyl mercury, polychlorinated biphenyls (PCBs), dioxins, pesticides and other environmental contaminants have negatively affected the positive image of fish (Verbeke *et al.*, 2005). Similarly, concerns about human health risks associated with aquaculture have been heightened by the results of a controversial study published in the journal *Science* (Hites *et al.*, 2004). The authors reported significantly elevated levels of chemical contaminants in farmed compared with wild salmon. Although the recorded levels of contamination were well within international food standards (EFSA, 2005), the study received widespread coverage in the media (Chatterton, 2004). Such mass-media information on the pollution and contamination of fish can have an impact on consumer perceptions of and attitudes towards (farmed) fish consumption. At the same time, it can interfere with communication of the health aspects of fish, making it difficult for consumers to balance eventual risks with potential health benefits (Verbeke *et al.*, 2005). It is now accepted that for the majority of wild-caught and farmed species, neither the risks of mercury nor organic pollutants outweigh the health benefits of seafood consumption (FAO/WHO, 2011; USDA, 2015). However, once the public is alarmed by a potential risk, it may be difficult to reverse this effect.

In spite of the overall positive image of farmed and wild fish (EC, 2008), a range of European consumer studies showed that wild fish was preferred to farmed fish in terms of health, nutritional value (Claret *et al.*, 2014), taste (Verbeke *et al.*, 2007a) and quality (Verbeke *et al.*, 2007a; Kole, 2003; Claret *et al.*, 2014). Similarly, in Canada, wild salmon is generally perceived as healthier, with more vivid and authentic colour, better taste and texture, less fat, better appearance and, overall, seen as better and more natural (DFO, 2005). This perception of wild fish being more 'natural' was also found among European consumers (Claret *et al.*, 2014; Verbeke *et al.*, 2007a) and seems to idealize the naturalness of conventional fishing and contrast it with modern aquacultural methods (Schlag and Ystgaard, 2013).

The scarce information available from developing countries shows that consumers in Ghana (Darko, 2011) and Kenya (Githukia *et al.*, 2014) prefer wild tilapia and catfish to farmed fish, primarily due to issues of availability, healthiness and taste. Consumers in Kenya, especially, stated a dislike for the 'mud taste' of farmed tilapia, and some consumers reported health concerns because they shared the perception that cultured fish were produced with genetically modified feed ingredients or chemicals such as growth hormones and pesticides (Githukia *et al.*, 2014). Similarly, anecdotal information from Egypt suggests that, as a consequence of public concern about contaminants in farmed tilapia, wild tilapia and/or frozen imported fish are preferred (Eltholth *et al.*, 2015). Thus the perception that

farmed fish is less healthy and less nutritious seems to stem primarily from the belief that they have higher levels of medicinal or growth promotion residues (Verbeke *et al.*, 2007a). This shows that consumers are largely unaware that antibiotic use has significantly decreased in many production systems (Pieniak, Vanhonacker and Verbeke, 2013), and that aquaculture has various potential advantages with respect to managing, controlling and guaranteeing the quality, safety, healthiness and even taste of farmed fish (Verbeke *et al.*, 2007a).

However, there may be a change in perception underway, because some consumers regard farmed fish as less affected than wild fish by marine pollution and heavy metals (DFO, 2005; Claret *et al.*, 2014). Hence, consumers seem to face a trade-off between health additive residues (e.g. antibiotics), which are believed to be more present in farmed fish, and heavy metals, which are believed to be less present in farmed fish (Verbeke *et al.*, 2007a). Nevertheless, in Spain it was found that fish selection depends more on quality and/or price attributes than on safety-related aspects, as consumers already assume safety (Fernández-Polanco and Luna, 2012). In the absence of such confidence in food safety controls and regulatory systems, the safety and quality of food become the most important aspects associated with fish. In China, safety and quality rather than price were considered the most important factors influencing the consumption of fish products (Zhang, 2002). Consequently, consumers were willing to pay a modest price premium for food products that underwent more-rigorous food-safety inspection (Wang *et al.*, 2009).

2.9. PERCEIVED SOCIO-ECONOMIC RISKS AND BENEFITS

Aquaculture operates in the public space and interacts with a wide range of other resource users and the local community. Thus varied perceptions exist of the socio-economic benefits and risks of aquaculture development. Evidence from the few available surveys of attitudes on socio-economic issues suggests that the strongest acceptance of aquaculture is generally found when local communities benefit directly from the industry (Katranidis, Nitsi and Vakrou, 2003; Whitmarsh and Palmieri, 2009; Mazur and Curtis, 2008). In developing countries, especially, small-scale aquaculture development can contribute significantly to local communities as a supplier of healthy animal protein to improve the nutrition of poor people (Irz *et al.*, 2007; Ahmed and Lorica, 2002). In addition, aquaculture growth can increase the supply of fish in domestic markets, thus making it more affordable (Irz *et al.*, 2007). Similarly, in Canada and Europe, consumer studies found that farmed seafood (especially salmon) is generally seen as cheaper and available year-round, compared with wild-caught fish, enabling people to eat fish more regularly (DFO, 2005; Claret *et al.*, 2014; Amberg and Hall, 2008; Vanhonacker, Pieniak and Verbeke, 2013). Moreover, insights from focus-group discussions in seven European countries show that the public recognizes the economic benefits of fish farming, such as higher employment rates, better income and economic development in rural areas (Schlag and Ystgaard, 2013). This perception was especially present in Norway, where respondents believe that small coastal communities will be more likely to survive due to the presence of the fish-farming industry.

In Australia, Greece and Scotland, public perceptions of aquaculture development were much more positive in areas where unemployment rates are higher and job density lower, compared with more-economically developed regions (Katranidis, Nitsi and Vakrou, 2003; Whitmarsh and Palmieri, 2009; Mazur and Curtis, 2008). A survey of rural communities in Chile and Ireland found that the majority of people recognized that unemployment and emigration levels would be much higher without the aquaculture industry (Barrett, Caniggia

and Read, 2002; White and Costelloe, 1999). Evidence from the Philippines shows that aquaculture represents an important source of employment in coastal areas through direct and indirect demand for relatively unskilled labour. Thus the surveyed communities perceived aquaculture development very positively, owing to the sector's contribution to poverty alleviation (Irz *et al.*, 2007). On the other hand, concerns exist regarding the potential exploitation of workers in developing nations by international aquaculture corporations (Schlag and Ystgaard, 2013). However, research supporting or disproving these claims is limited. Hishamunda *et al.* (2014) point out that large-scale aquaculture companies are often the only employer in rural regions, and workers may thus be under pressure to accept lower wages and reduced working conditions. Yet the conclusions of an assessment of employment conditions in the aquaculture sector were generally positive. Evidence from various case studies suggests that the labour force, in general, has benefited from aquaculture, and that wages were higher than the minimum wage and usually above salaries in alternative sectors (Hishamunda *et al.*, 2014).

The increased production and scale of farms, export-oriented production and concentration of ownership have been linked to a decrease in the sector's contribution to local economies and its connection to local communities (Tiller, Brekken and Bailey, 2012). This may lead to an uneven distribution of burdens and benefits, with a potential to cause conflict and generate rejection and mistrust. In the South Evoikos Gulf in Greece, for instance, fishers and local communities expected a greater contribution to local development from fish farms (Mente *et al.*, 2007). Similarly, in Norway, the aquaculture industry has been criticized for paying only a very small direct tax in some municipalities (Tiller, Brekken and Bailey, 2012). Further conflict may arise through access to and use of common resources or damage caused to the ecosystem. The shrimp industry, in particular, has been blamed for having a range of detrimental environmental side effects on traditional farmers and the wider society, such as salinization of soil and groundwater, pollution of waterways and destruction of mangrove habitats (Ridler and Hishamunda, 2001).

In many European coastal areas, fishers claim that aquaculture is affecting them by restricting their fishing grounds and through negative environmental effects (e.g. Mente *et al.*, 2007; Ertör and Ortega-Cerdà, 2015), giving rise to compensation demands for external costs (Liu, Olaussen and Skonhoft, 2011). In general, the tourism sector in many European countries also perceives aquaculture as a risk, owing to competition for space, navigational conflicts and the visual impact of farms (Ertör and Ortega-Cerdà, 2015). Similarly, in Canada and the United States, complex user conflicts for limited coastal space have significantly slowed the expansion of marine aquaculture (Knapp, 2012; Masser and Bridger, 2007). The strongest opponents to aquaculture in those countries include environmental NGOs, the ecotourism industry and the commercial fishing sector (Noakes *et al.*, 2003). In addition, indigenous peoples (First Nations) in British Columbia, Canada, argue that fish-farm siting and environmental impacts interfere with their traditional way of life (Gerwing and McDaniels, 2006). These concerns resemble the views in some southern European countries, where the expansion of aquaculture is perceived as a risk to traditional livelihoods and long-established fishing methods (Schlag and Ystgaard, 2013; Mente *et al.*, 2007). Conflicts associated with aquaculture development can also arise through lack of a transparent and participatory decision-making procedure (Ertör and Ortega-Cerdà, 2015). This was the cause of conflicts in Finland, Greece, Scotland and Spain, where some aquaculture stakeholders – including summerhouse residents, local fishers, the tourism sector and the local population – felt excluded from the consultation process (Ertör and Ortega-Cerdà, 2015; Varjopuro *et al.*, 2000).

3. RECOMMENDATIONS FOR IMPROVING THE PUBLIC UNDERSTANDING OF AQUACULTURE

Chapter 2 demonstrated the wide range of perceptions of aquaculture and its products and the differing levels of knowledge about the industry, even within countries and regions. Strategies to improve public understanding and acceptance will thus have to be adapted to site-specific circumstances. The present chapter offers general recommendations on improving public understanding and acceptance (especially in western countries), but it is beyond the scope of this report to provide specific solutions for diverse situations. To face the various challenges and help the topic receive the attention it deserves, the report emphasizes the importance of better coordination within the aquaculture industry. Moreover, it discusses how the industry could better communicate its progress, and which roles diverse stakeholders could play in this process, including FAO, retailers, governments, consumer groups, educators, the media and aquaculture associations. Table 1, at the end of this chapter, provides a summary of the recommendations.

3.1. RECOMMENDATION 1: ADDRESS IMPORTANT SOCIAL AND ENVIRONMENTAL ISSUES TO IMPROVE THE INDUSTRY AND ITS REPUTATION

Even though there are misperceptions and a lack of awareness of the current workings of the aquaculture sector – and the progress it has already made in a relatively short time – many social and environmental issues are still to be resolved by the industry. This means that it is not only facing a communication problem. If it is to grow sustainably, the industry must continue to address the externalities it causes with a view to improving its reputation. Modern aquaculture has expanded greatly in merely a few decades, and the beginnings of this growth were not always carried out with great professionalism. As with any other sector, there are very responsible actors, but also companies that focus on short-term profits at the cost of sustainability, negatively affecting the reputation of the whole industry. The aquaculture industry now must prove that it has learned from its mistakes, and it must commit to environmentally and socially sustainable development.

To achieve change at greater speed and scale, it makes sense that aquaculture subsectors work together to address the challenges they share. In this sense, producer organizations can play an important role in unifying the industry and in promoting sustainable production methods. The Global Salmon Initiative (GSI) is an example of how farming companies all over the world are cooperating to share their best practices, technology and know-how so as to improve the sector's sustainable performance (www.globalsalmoninitiative.org/, accessed 17.06.2015). The idea behind this initiative is that, to become more sustainable, it is not enough to have one or two best-performing companies; the whole sector must be included. As salmon aquaculture is among the most criticized and controversial of food-production systems, this subsector can be a good example of how a food-/protein-producing industry can progress towards sustainability in a relatively short time. If it achieves its goals, it may act as a role model for other aquaculture subsectors, and the idea may even be adopted by other food industries. Yet big changes are not possible without capital, and some aquaculture subsectors that could benefit from such an initiative (e.g. shrimp or pangasius) may not be sufficiently consolidated to form collaborations large enough to have real impact. Thus, in partnership with GSI, FAO is planning initiatives to make aquaculture expertise available in developing countries in support of the expansion of sustainable aquaculture. This and other initiatives can speed up the sustainability of aquaculture and simultaneously improve the sector's image.

In addition, FAO is playing an important role by promoting the Code of Conduct for Responsible Fisheries (CCRF), which provides guidance in the development of sustainable aquaculture and highlights its importance in feeding the growing world population. Moreover, it should continue to stress the value of good management practices in aquaculture, one of the most-effective measures for reducing environmental impacts and costs. To be socially and environmentally more sustainable, the aquaculture industry must be supported by a good governance framework. This includes more harmonization and simplification of policies, and better communication and coordination among national and local authorities (GFCM, 2013). In addition, among specialized research bodies, enhanced coordination, knowledge- and data-sharing are needed to reduce environmental risks. Closer science/industry collaboration can assure better access of producers to the newest developments on the most pressing topics (e.g. disease, feed sources). Government bodies can support the industry by focusing research on environmental efficiency. They can also encourage aquaculture operations to be community-minded, and can determine fair prices for leasing areas and fair negotiations, which will indirectly help improve aquaculture's reputation. In addition, a variety of public- (e.g. regulations, standards, taxation and subsidy policies) and private-sector-led initiatives (e.g. certification, purchasing standards) can offer farmers incentives to practice more-sustainable aquaculture (Waite *et al.*, 2014).

Private certification schemes and standards may complement state regulations, encouraging further improvements in environmental performance. However, the contribution of certification to increased sustainability in aquaculture is limited, as much of the potentially certifiable aquaculture production is currently produced and sold in countries with little demand for certification, for example China (Bush *et al.*, 2013). Consumers in these emerging middle-class markets focus more on food safety, whereas sustainability or social qualities remain niche concerns (Xu *et al.*, 2012). Similarly, despite the higher concern for sustainability in western countries, sustainability labels currently do not play a major role in consumer food choices (Grunert, Hieke and Wills, 2014). The high number of certification programmes can lead to consumer confusion and inefficiencies. Moreover, private certification schemes can be expensive for producers, who may not receive an economic benefit from certifying their products. Thus certification schemes are only part of the solution, and their future success will depend on the extent to which general consumer concern about sustainability can be turned into a change in consumption (Grunert, Hieke and Wills, 2014). Business-to-business certification may be more effective in improving the social and environmental impact of aquaculture (e.g. GLOBALG.A.P., which has great impact among retailers).

Most investigations of the sustainability of aquaculture have focused mainly on environmental challenges, rather than on social issues. Similarly, the information provided on company websites or in (voluntary) sustainability reports is still excessively oriented towards environmental impact and the efficient use of resources. Yet socio-economic aspects are crucial to public support of the aquaculture industry. As seen in Chapter 2, the strongest acceptance of aquaculture is generally found when local communities benefit directly from the industry (Katranidis, Nitsi and Vakrou, 2003). Thus it can be argued that the potential of more-responsible companies to attract better and more-motivated workers and to have positive relationships with local communities – and therefore greater social acceptance – can be important reasons to address those issues. Moreover, demonstrating positive social impact is increasingly a prerequisite for aquaculture certification. At the moment, however, information is lacking in many countries on employment numbers,

incomes, hiring in the local community and gender inclusion. This prevents estimation of the socio-economic importance and thus the social license of the industry in a given region (Hishamunda *et al.*, 2014).

Working towards a more-responsible aquaculture industry is not only crucial, due to environmental and social reasons, but sustainable enterprise can positively impact the financial performance of a company. In aquaculture, many factors, such as disease, feed quantity, the occupational and health safety of workers and social acceptance are directly linked to potential costs. Thus the financial benefits of sustainability have to be promoted better by aquaculture associations through the dissemination of success stories.

3.2. RECOMMENDATION 2: GUARANTEE FULL TRANSPARENCY OF THE SOCIAL AND ENVIRONMENTAL PERFORMANCE INDICATORS AND REGULATIONS THAT CONTROL THE PRODUCTION OF FARMED SEAFOOD (AQUACULTURE PRODUCERS AND GOVERNMENTS)

Aquaculture producer organizations, FAO and governments could play important roles here. This recommendation stems from social perception studies, which clearly demonstrated the need for more-credible and transparent information to build public trust in the sector. It is not enough that the industry assure its sustainability – companies have to back up their claims with proof. One way to assess sustainability is via certification of compliance with certain standards. Another way of demonstrating transparency is to report and publicly disclose relevant information on company websites. However, the transparent disclosure of information will only have relevance if it offers a level of resolution that is meaningful to those groups that have an interest in the data (Sustainable Fisheries Partnership, 2011). Different issues affect different aquaculture subsectors, and producers' perceptions of the most important aspects may not be congruent with the perceptions of other stakeholders. So it is important that the industry think about what is important to it and which information is relevant to its stakeholders. Sustainability reports should include regularly updated, precise technical data on key performance indicators (e.g. performance and records on environmental, social, economic and labour issues), published in English. Apart from technical information, a section should be included that focuses more on the interests and level of understanding of the general public. It was clear in Chapter 2 that the public wants to be informed of the positive aspects, but also of the problems, including mistakes made in the past. Thus, by voluntarily reporting this information, the aquaculture industry can demonstrate to society what has been done so far to tackle the social, environmental and economic challenges and to communicate planned actions to address issues that cannot be resolved within a short time frame. Moreover, by having key performance indicators addressed and monitored, the rate of improvement and transformation that the industry has been/is going through to become more sustainable can be directly measured. This can help build public trust and support. At the same time, a strong commitment to public disclosure can be a very effective way of addressing critics, by showing them what is actually being done.

Transparent disclosure on aquaculture production is not only important to the public. The whole aquaculture value chain seeks this information to better understand risks and fulfil commitments to sustainability and transparency (Sustainable Fisheries Partnership, 2011). Many key performance indicators (e.g. feed use, disease) are directly linked to business success. Thus investors place great importance on transparent disclosure of information, as the data allow them to identify the strengths and weaknesses of a company. Similarly,

transparent information on aquaculture production can inform retailers of potential problems (e.g. disease incidents), which helps them predict the availability of supplies and minimize risk. Some leading aquaculture companies have already voluntarily provided information on their websites. However, great differences are found among companies, sectors and countries. In the case of the salmon industry, 14 companies that represent 50 percent of total farmed salmon production worldwide have agreed on a set of indicators and this year published their first joint sustainability report (www.globalsalmoninitiative.org/sustainability-report/, accessed 11.06.2015). The hope is that this reporting system will improve over time and can serve as an example for other aquaculture subsectors. Ultimately, such data would allow direct comparison of key sustainability indicators of diverse food-production sectors.

If the aquaculture industry wants to be considered a leading player in sustainable food production, it must increase the quality and quantity of data disclosure (Sustainable Fisheries Partnership, 2011). A strong commitment to high standards of transparency of some companies within a sector may automatically put pressure on other aquaculture producers to become more responsible, thereby improving the sustainability of the industry as a whole. This process could be advanced if FAO, with the help of other key stakeholders, would develop global guidelines for best practice in disclosing social, environmental and economic data. The various aquaculture subsectors could then develop their reporting strategy based on these commonly agreed standards. Such a global approach could substantially improve social acceptance of the industry and build confidence and trust throughout the value chain (Sustainable Fisheries Partnership, 2011). Regional or national aquaculture organizations can also play an important role in countries or sectors with no previous reporting experience. The associations can help set up an efficient reporting system and make public disclosure of relevant data compulsory for all members. At the same time, the benefits of transparency, as well as the potential consequences of not being transparent, must be communicated to producers (e.g. positive or negative media attention, greater or lower public acceptance, and an increase or decrease in sales and prices).

Not only should the aquaculture industry disclose more information to the public; governments, as well, must become more transparent. The results of public surveys suggest that civil society has a varying degree of trust in governmental decisions related to aquaculture (DFO, 2005; Mazur and Curtis, 2006). Thus the public needs to be reassured by governments that strict aquaculture regulations are in place. At the same time, governments and the industry must discuss problems and their solutions openly, rather than hiding the issues. Most people know and accept that every industry has associated risks; however, they expect that an industry is only allowed to operate if the potential risks are at an acceptable level and appropriately mitigated. Public confidence in government aquaculture-related decisions could be improved in part by regularly publishing readily accessible information on current industry performance regarding social and environmental impacts. As shown in Section 2.9, many conflicts associated with aquaculture development arise when transparent and participatory decision-making is lacking and some aquaculture stakeholders are excluded from the consultation process. Thus understanding community views and engaging in meaningful and interactive dialogue with diverse stakeholder groups is an essential part of preventing conflict and building a more-socially acceptable aquaculture industry (Mazur and Curtis, 2008). Especially when developing new aquaculture installations, a participatory and integrative approach should be used to inform the public early on in the process – also in relation to special planning and the creation of zones with multiple and diverse economic activities. The siting of aquaculture installations is at the

heart of many conflicts, and poorly sited or planned aquaculture may result in low social acceptability. To enhance the integration of aquaculture with other activities, coastal zones allocated for aquaculture should be introduced. Moreover, credible cost-benefit analysis should be conducted to inform the public of the advantages of aquaculture before the installation of a new farm (Hishamunda, Poulain and Ridler, 2009).

In addition, governments must strictly enforce the correct labelling of seafood products to guarantee transparency. As shown in Section 2.6, food labels are an important source of information for consumers; yet, much mislabelling or incomplete information still exists. The provision of correct information at the point of sale is important to the consumer, but also to producers. If traceability is not guaranteed, the consumer cannot identify aquaculture products or choose between imported and locally produced seafood.

3.3. RECOMMENDATION 3: COLLABORATE WITH OTHER STAKEHOLDERS TO COMMUNICATE MORE EFFECTIVELY AND TO IMPROVE PUBLIC UNDERSTANDING OF AQUACULTURE

Even though the aquaculture industry has achieved important objectives aiming at greater social and environmental sustainability, there is no guarantee that these efforts will translate into a better reputation. One problem is that, until recently, the industry did not have a proactive communication strategy, but was rather defensive or reactive. Good communication is critical in addressing negative attitudes or misperceptions, as it will demonstrate openness and is less likely to encourage unwanted or undue attention from the media and groups opposed to the industry (Chatterton, 2004). Thus, in addition to public disclosure of relevant information on its environmental and social performance, the industry must become more adept at increasing public awareness and understanding of aquaculture through open dialogue. The great diversity of the aquaculture industry and the wide range of perceptions suggest that the optimal mechanisms for communication cannot be generically prescribed; each approach will need to be specific to the situation in question (Young, Brugere and Muir, 1999).

As shown in Chapter 2, some communities, groups and individuals will be more informed and/or more critical of certain aquaculture industries and government practices than others. Moreover, it is important to acknowledge that significant differences exist in how people communicate and perceive risks. Consequently, information will need to be communicated differently for policy-makers, aquaculture stakeholders and consumers (Mazur *et al.*, 2004). To date, the debate about aquaculture has focused mainly on risks, often lacking a balanced evaluation of costs and benefits (Luoma and Löfstedt, 2007). In order to offer more-balanced information, both scientific risks and benefits need to be acknowledged and presented in ways that are understandable to various audiences. As seen in Section 2.6, not all sources of information are viewed as having equal reliability, yet perceptions of credibility and trust are critical to effective communication among government, industry and members of the public (Mazur *et al.*, 2004). Thus, taking into account the importance of the facilitator when it comes to communication, the aquaculture industry should collaborate with a range of different partners – such as FAO, retailers, governments, educators, scientists, health professionals and consumer organizations – in order to communicate more effectively the risks and benefits of aquaculture.

At the same time, the aquaculture industry should consider partnering with potential opponents, such as environmental advocacy groups. Negative campaigns on aquaculture led

by NGOs have the potential to significantly influence public opinion, consumer behaviour and the activities of policy-makers and regulatory agencies (Tiersch and Hargreaves, 2002). The industry should take a proactive approach and begin a more-fact-based and constructive discussion of environmental stewardship and best-management practices with those NGOs that have legitimate concerns. Initiatives such as the aquaculture dialogues organized by the World Wildlife Fund (WWF) can break down barriers between stakeholders and build a framework for discussion, which is crucial in addressing misconceptions. Moreover, influential NGOs can be important partners of the aquaculture sector in improving its performance and translating that into reputation.

In addition, the capability of the industry to effectively use the media to communicate success stories and promptly respond to criticism is becoming increasingly important. To date, the main media focus lies on aquaculture's challenges and problems at the expense of its benefits. So it is easy to understand why the industry and its diverse applications might elicit public concern (Schlag, 2011). The aquaculture industry must increase the presence of balanced information – to communicate sectoral improvements and highlight aquaculture's benefits. Initiatives could include hiring communication experts for regular media briefings to develop relationships with journalists likely to cover aquaculture topics in a given area (Chatterton, 2004). Moreover, depending on the message and the target population, different media and information sources may be used. The use of social network sites and blogs can help in direct communication with the public and may be especially interesting in reaching younger consumers.

The following sections highlight information that should be communicated better, and the roles various stakeholders could play in this process.

3.4. RECOMMENDATION 4: COMMUNICATE THE HEALTH BENEFITS OF FARMED SEAFOOD

Chapter 2 showed that one of the main concerns shared by consumers in many regions is that farmed seafood may be less healthy than wild products. This is not too surprising, because negative health effects have been widely publicized in the media and consumers have received a lot of contradictory information. Moreover, healthiness and nutritional value are also scientifically contentious topics, as these values depend largely on farming conditions (Verbeke *et al.*, 2007a). Concerns seem to be mainly associated with the potential use of substances, such as growth hormones, antibiotics, pesticides and artificial colouring, during the rearing of farmed fish. A lot of uncertainty in developed countries is associated, in particular, with farmed seafood produced in and imported from developing countries. Thus it is important to inform the public that strict food-safety controls, improvements in farming practices and the ban of harmful substances are significantly limiting the risk of providing unhealthy farmed products to the market (Little *et al.*, 2012). This is particularly true for the export market, where quality- and safety-control mechanisms are very rigid, strictly limiting bad products from entering the market. Moreover, it is scientifically accepted that, if raised under appropriate conditions, the nutritional content of farmed fish is at least as beneficial as that of wild fish, particularly in terms of the prevention of cardiovascular diseases (Cahu, Salen and De Lorgeril, 2004). In addition, the regulated conditions in aquaculture production permit controlling for toxic contaminants and pathogens throughout the production process, offering potential advantages over wild fish.

To communicate these benefits effectively, broader campaigns are needed in collaboration with health professionals, government agencies, retailers and FAO. A European-wide study showed that consumers place a high level of trust in retailers, with a tendency to transfer the responsibility of certain consumption decisions to them (EC, 2008). Thus aquaculture associations could collaborate with distributors' and fishmongers' organizations to design and implement informational tools on farmed products (e.g. flyers, tastings, recipes, etc.). In addition, sales personal should be trained to provide updated information to consumers on the current production of farmed seafood. Similarly to retailers, consumer groups and health professionals are also in direct contact with the public and can thus be important partners in communication. Even though the public assigns high credibility to consumer groups and health experts, people do not use them as frequently as other information sources (e.g. media). This highlights the importance of a more-proactive involvement of these professionals in private or public aquaculture campaigns. Such initiatives may include discussing the health benefits of (farmed) fish in the media, dissemination of information on media websites and the provision of informational brochures.

3.5. RECOMMENDATION 5: PROMOTE AQUACULTURE'S CONTRIBUTION TO FOOD SECURITY AND NUTRITION

Consumer groups and health professionals, together with FAO, are important actors in disseminating information on the negative impacts on human health of the global transition towards diets high in processed foods, refined sugars, refined fats, oils and meats. It is important to communicate the health benefits of farmed and wild seafood compared with other animal proteins. In fact, farmed fish should be compared with farmed meats to show the marked nutritional advantage of aquaculture products through their high levels of essential nutrients, some of which are hardly found in non-aquatic foods. This unique nutrient and lipid composition makes fish a key element in food security and nutrition strategies. Despite being a major source of animal protein for humans, a recent study by Béné *et al.* (2015) found that, to date, only limited attention has been given to the potential contribution of fish in fighting malnutrition and hunger in many countries. Thus policy-makers and food-security experts must become better informed on the importance of fish in making the food system more nutrition sensitive and on the critical role aquaculture is likely to play in meeting future demand for fish. In this respect, FAO can play a major role in raising awareness of the importance of aquaculture at the decision-making level.

3.6. RECOMMENDATION 6: PUT THE ENVIRONMENTAL COSTS OF AQUACULTURE INTO PERSPECTIVE, COMPARED WITH OTHER (FOOD) SECTORS

The way we produce our food is having an increasingly strong global impact on both the environment and human health (Tilman and Clark, 2014). Thus a more-encompassing approach needs to be taken, similar to that for health aspects, in order to evaluate the effects of different diets on environmental sustainability. As shown in Section 2.7, one of the main concerns associated with aquaculture is the potential effect of farms on the surrounding environment. Yet, if the aquaculture industry is compared with other food sectors, the results reveal that the cultivation of seafood represents more-efficient protein production and resource use than most terrestrial livestock systems (Bartley *et al.*, 2007). Compared with pork, poultry and beef, fish in aquaculture systems are more-efficient converters of feed into protein (Hasan and Halwart, 2009), provide greater energy and protein retention, higher edible yields (Torrissen *et al.*, 2011) and a lower carbon footprint (Hall *et al.*, 2011). Putting aquaculture in perspective with other animal production systems could challenge

negative perceptions about aquaculture's environmental sustainability. Thus a holistic approach to determining the environmental costs of all food-producing sectors is needed (Bartley *et al.*, 2007). As long as such a balanced picture of environmental costs is absent, policy does not reflect realities, which can lead to the over- or underregulation of certain sectors. Future work in this field would certainly help increase the sustainability of food production and would assist policy-makers and consumers in making more-informed choices (Bartley *et al.*, 2007). Ultimately, the goal should be to evaluate the environmental costs of all development sectors, e.g. tourism, municipal development and capture fisheries. In this context, FAO could provide leadership by encouraging governments to think and act holistically and to carefully balance the full range of environmental costs of the different activities. Moreover, it has been suggested that FAO disseminate information on the known impacts of all food-production systems and facilitate access to methods, information, analyses and policy that would help minimize adverse impacts (Bartley *et al.*, 2007).

3.7. RECOMMENDATION 7: IMPROVE COORDINATION WITHIN THE AQUACULTURE INDUSTRY TO RENDER COMMUNICATION STRATEGIES MORE EFFECTIVE

Aquaculture is a rather fragmented industry, with a diverse range of activities divided in subsectors. Despite its variety, aquaculture is often perceived as one industry, resulting in the transfer of negative perceptions from one farming sector to another. Thus it makes sense for the different subsectors to work together on communication to have real impact and achieve a greater political hearing. Even though many fora, producer organizations and platforms exist where aquaculture producers meet, more communication and cooperation among these entities is needed. Aquaculture associations are often relatively small, with limited budgets, which makes it difficult to launch effective promotional initiatives. Increased synergy and coordination among aquaculture subsectors and members of the whole value chain could lead to more-coherent communication strategies with a greater effect. More communication within and among sectors will also allow sharing of experiences in communication initiatives and identification of the most promising elements in existing campaigns.

To improve public awareness and understanding of aquaculture, both local and global actions are required. A coordinated initiative could be the creation of a common marketing fund – an approach that has worked well in the Norwegian salmon industry. In addition, a good strategy may be to combine a generic marketing campaign that promotes the benefits of aquaculture in general with more-specific initiatives to raise the visibility of certain products and farming systems by using the most unique and robust message for each (e.g. shellfish: extensive, integrated or intensive aquaculture) (European Union aquaculture campaigns). The European Union's "Farmed in the EU" campaign represents such an approach, which emphasizes the local origin, freshness and healthiness of farmed seafood in general (<http://ec.europa.eu/fisheries/inseparable/en/farmed-eu>, accessed 25.06.2015).

A common tool to improve the reputation of aquaculture is the development of certification assuring the healthfulness, safety and/or sustainability of farmed products. As seen in Section 2.6, consumers display a high interest in quality and/or food safety labels. Yet the high proliferation of labels can also bear risks, and synergetic efforts at regional, national and international levels are needed to reduce the number of certifications and to better distribute the tasks of regulation, education, information and promotion among public and private bodies.

Apart from marketing certain products, an extensive global aquaculture communication campaign could be launched. It should communicate an objective view of aquaculture, highlighting the importance of a sustainable aquaculture industry in feeding the growing world population. To give it credibility, the initiative should be planned in close cooperation with FAO and other intergovernmental organizations, the public sector and other key aquaculture stakeholders. Such a campaign could foster a positive shift towards greater acceptance of the aquaculture industry and increased belief in its sustainability. As an important part of such an initiative, FAO – due to its high credibility – should provide more-easily accessible and understandable information on aquaculture for the wider public. Moreover, it could declare an International Year of Aquaculture, which would be an unprecedented opportunity to increase public awareness and understanding of this activity.

On a smaller scale, local initiatives can also contribute to a better public understanding of the aquaculture industry. As shown in Section 2.6, previous experiences, such as farm visits and/or social links with the industry, increase trust and support for the activity (Mazur *et al.*, 2004). Companies could collaborate to organize aquaculture events in their region, seafood degustation and visits to farms to demonstrate the cultivation process. Another approach would be to give public talks in the local community and to regularly publish a newsletter with the latest information on farm activities. Such initiatives could also be planned as part of an International Aquaculture Day, a day on which aquaculture farms around the world engage with the public to promote the sector.

Better cooperation within the aquaculture industry can also help strengthen its presence in policy and consumer lobbies. More communication campaigns are needed that specifically target politicians – calling for support and providing balanced information. Moreover, the industry needs to be represented in existing platforms, such as the Consumer Goods Forum and The Sustainability Consortium, in order to promote itself and demonstrate to retailers that aquaculture is dealing with sustainability issues. By collaborating more closely, the aquaculture industry can better publicize the potential of aquaculture to create jobs, supply protein and foster economic development. Moreover, the global trend towards increased exploitation and integrated management of aquatic resources, linked to the European Commission's Blue Growth initiative, is a good way to promote aquaculture as part of a larger context.

3.8. RECOMMENDATION 8: INVEST IN AQUACULTURE EDUCATION

As was shown in Chapter 2, there is a view in Western countries that wild fish is more 'natural' than farmed fish (DFO, 2005; Verbeke *et al.*, 2007a; Claret *et al.*, 2014). Schlag and Ystgaard (2013) argue that this perception seems to idealize the naturalness of conventional fishing and contrast it with modern aquaculture methods. Wild fish and traditional fishing methods are familiar to consumers, while farmed fish and fish farming are still unfamiliar and novel, heightening risk perceptions. Similarly, the public tends to have a romantic notion of livestock farming, because children grow up playing with farm animals and people have become accustomed to seeing farms and pastures. In contrast, the public is not used to seeing aquaculture cages taking up public space in the sea. As mentioned in Section 2.5, these findings suggest that consumer perceptions of farmed fish and aquaculture, itself, may be based more on beliefs and emotions than on objective knowledge (Verbeke *et al.*, 2007a; Schlag and Ystgaard, 2013). Thus efforts to provide fact-based information to consumers and the general public may not be enough to improve public awareness or to change consumption behaviours (Verbeke *et al.*, 2007a).

To increase public understanding of aquaculture and to normalize the aquaculture sector, information on the farming of aquatic animals and plants should be included in the scholastic curriculum. Just as children are taught the workings of modern farming and agriculture, explanation of the functioning of fish farms is needed. By educating children about aquaculture early on, the activity becomes familiar and will eventually gain more trust in the society. Governments and the industry should cooperate with teachers and organize interactive school visits to an aquaculture farm in the region. As mentioned previously, the school project “Farmed in the EU” – designed to raise awareness of the aquaculture sector among Europe’s teenagers (12-18 years old) – is a good example of such an initiative. The project brings students closer to fish farming, so they can explore its role in food production and in preserving the environment and its effects on the local community (http://ec.europa.eu/fisheries/inseparable/en/farmed-eu#quicktabs-farming_in_the_eu_en=5, accessed 24.06.2015).

Such an initiative can also teach children about the importance of healthy eating and the consumption of sustainable seafood, which can then be shared with their families and hopefully influence their eating habits. This is important, because young people, especially, perceive fish as a ‘difficult product’ – difficult to buy, to preserve and to cook. Eating fish indeed requires some planning (longer distances to buy good fish, a short preservation time and the required preparation skills). Children, in particular, who are not educated to eat fish, should be informed of the health and environmental benefits of seafood consumption.

Learning about aquaculture at school also demonstrates to the young generation the business and career opportunities aquaculture offers, and they may be more likely to consider working in this sector. The future success of a sustainable aquaculture sector will depend on access to educated/skilled employees, and strategic research and development. A study in Australia showed that farm owners often held a relatively negative view of academia (Awal *et al.*, 2012), and were quite critical of aquaculture graduates. This underlines the importance of better cooperation between the industry and tertiary institutions to ensure that training is relevant and useful to aquaculture enterprises. In addition, where this is not the case, the industry should allow greater access to on-farm training and education to guarantee that graduates have a chance to experience the commercial reality of the industry and gain the appropriate practical skills and knowledge.

Table 1. Summary of recommendations for improving public understanding of aquaculture

	Address important issues	Increase transparency	Improve communication
Aquaculture industry	<ul style="list-style-type: none"> • Cooperate with other companies to work on most-pressing issues • Focus and report more on social sustainability • Collaborate more-closely with scientists to access newest knowledge and innovation 	<ul style="list-style-type: none"> • Disclose relevant information on social, environmental and economic key parameters • Talk openly about issues and how they can be addressed 	<ul style="list-style-type: none"> • Collaborate with NGOs to translate performance into a better reputation • Use different media more effectively to inform and respond to criticism • Create a common marketing fund • Strengthen the sector’s presence in policy and consumer lobbies
Aquaculture associations	<ul style="list-style-type: none"> • Unify the subsectors and promote good management practices • Promote the financial benefits of acting sustainably 	<ul style="list-style-type: none"> • Organize effective reporting systems to support producers • Promote the benefits of being more transparent to aquaculturists 	<ul style="list-style-type: none"> • Develop more-coordinated and proactive initiatives to promote the benefits of aquaculture • Launch a global aquaculture communication campaign with credible partners • Establish an International Aquaculture Day
Governmental bodies	<ul style="list-style-type: none"> • Establish a good aquaculture framework • Harmonize policies and communicate better among agencies • Focus research on environmental efficiency of aquaculture • Provide incentives to farmers to act more responsibly 	<ul style="list-style-type: none"> • Regularly publish information on aquaculture planning and development • Render decision-making transparent and participatory • Conduct credible cost-benefit analysis • Strictly enforce correct seafood labelling rules 	<ul style="list-style-type: none"> • Better regulate the use of private certifications to reduce confusion among consumers • Distribute the tasks of regulation, education, information and promotion among public and private bodies
FAO	<ul style="list-style-type: none"> • Communicate best aquaculture practices (CCRF) • Promote knowledge and technology transfer to developing countries 	<ul style="list-style-type: none"> • Develop global guidelines on transparent reporting in aquaculture • Provide more-easily accessible and understandable information on aquaculture for the wider public 	<ul style="list-style-type: none"> • Launch the International Year of Aquaculture • Raise awareness of the importance of aquaculture to the supply of essential nutrients, employment and economic development • Disseminate information on the known impacts of all food-production systems and encourage governments to think and act more holistically
Retailers	<ul style="list-style-type: none"> • Work with governments and the industry to reduce the number of certifications 	<ul style="list-style-type: none"> • Demand greater transparency from producers 	<ul style="list-style-type: none"> • Train sales personnel to better inform consumers of the benefits of farmed seafood products

	Address important issues	Increase transparency	Improve communication
Scientists	<ul style="list-style-type: none"> • Enhance coordination, knowledge and data-sharing among institutions 		<ul style="list-style-type: none"> • Increase research and understanding of the environmental costs of the various (food) sectors
Educators	<ul style="list-style-type: none"> • Communicate the importance of sustainable seafood consumption 		<ul style="list-style-type: none"> • Include information on the aquaculture industry in the scholastic curriculum
Consumer groups and health experts			<ul style="list-style-type: none"> • Communicate the health benefits of farmed fish compared with other animal protein sources

4. CONCLUSIONS

The report's findings show that public perceptions of aquaculture vary greatly between countries and even within regions. Different stakeholders perceive different risks and benefits depending on aquaculture's effects on them. At the same time, large parts of the general public are relatively uninformed on a range of aquaculture-related topics. Thus – apart from objective knowledge – personal experiences, preconceived ideas and the demographic and regional context strongly influence perceptions of aquaculture. The strongest consumer concerns regard the health and safety aspects of farmed products. Evidence is mixed on whether people perceive aquaculture as causing environmental and animal welfare problems, and it differs among countries and regions. Interestingly, when purchasing fish, the majority of consumers are not aware of the farmed or wild origin of the seafood they buy. This suggests that other factors, such as quality, price, taste and convenience, seem to play more-important roles, whereas sustainability aspects are only taken into account by a limited number of consumers. While the public in general recognizes the socio-economic benefits of aquaculture, especially in communities where aquaculture contributes to more employment, food security and economic development, the presence of farms can lead to conflicts over resource use with other activities of the coastal zone. Overall, the public debate on aquaculture has focused mainly on risks, often lacking a balanced evaluation of costs and benefits.

The aquaculture industry needs a more-open, broader dialogue that will increase transparency in the sector and improve public awareness. It is important to shape the debate on aquaculture more actively, because a lack of information leaves room for speculation. If it is to communicate the benefits of aquaculture more effectively, the industry must collaborate more with other stakeholder groups viewed as credible by the public. Moreover, greater synergy and cooperation are needed among the various subsectors of aquaculture, so as to speak with one voice and achieve a greater political hearing. While important social and environmental issues are still to be addressed, it is important to put aquaculture in a wider perspective by comparing its costs and benefits with other animal production systems. To date, a holistic view – taking into account a balanced evaluation of aquaculture's risks and benefits – has been lacking, impeding the development of policies that reflect production realities. In the future, food-production systems must become even more efficient to produce more with fewer resources to feed a growing world population. Thus it is crucial to communicate better the important role that farmed fish will play in the future, as one of the most-efficient converters of feed into high-quality food.

More social science research on aquaculture is needed, particularly to better understand the influence on public perceptions. Future studies should combine qualitative and quantitative methods to obtain a more-in-depth view of different perspectives and how they are formed.

Moreover, socio-economic data is generally lacking in many countries, such as employment numbers, incomes, hiring in the local community and gender inclusion, which prevents estimation of the socio-economic importance of the industry in each region. Similarly, only very few attitudinal surveys on socio-economic issues are available.

As already mentioned in Chapter 2, studies investigating public perceptions of aquaculture are almost completely absent in developing countries. This can partly be explained by the fact that countries highly dependent on aquaculture's contribution to food security and poverty alleviation do not have the luxury of being concerned about the activity's

sustainability. Moreover, in some regions, such as Asia, aquaculture has been present for many centuries and is a well-established and accepted activity. Yet there is some evidence that better education and higher incomes in emerging economies (e.g. in China) are leading to increased public awareness of environmental issues and fish product safety – potentially increasing public mistrust. Thus the industry and governments in these regions would benefit from social research to better inform their decisions on aquaculture planning and management.

During the last three-to-four decades, the aquaculture sector has grown from an annual production of 4.7 million tonnes in 1980 to 70.5 million tonnes in 2013. Annual consumption of seafood from aquaculture for direct human consumption overtook that from capture fisheries in 2014. But with a growing world population, the annual supply from the aquaculture sector must reach 62 percent in 2030 to maintain the current consumption levels per capita. And with increasing consumption, the figure will be much higher. This presents tremendous challenges to the sector, to policy-makers and to the aquaculture community at large. Improving perceptions of the sector will be instrumental if the goal is to be achieved.

5. REFERENCES

- Ahmed, M. & Lorica, M.H.** 2002. Improving developing country food security through aquaculture development: lessons from Asia. *Food Policy*, 27(2): 125–141.
- Altintzoglou, T., Verbeke, W., Vanhonacker, F. & Lutén, J.** 2010. The image of fish from aquaculture among Europeans: impact of exposure to balanced information. *Journal of Aquatic Food Product Technology*, 19(2): 103–119.
- Amberg, S.M. & Hall, T.E.** 2008. Communicating risks and benefits of aquaculture: a content analysis of US newsprint representations of farmed salmon. *Journal of the World Aquaculture Society*, 39(2): 143–157.
- Ashley, P.J.** 2007. Fish welfare: current issues in aquaculture. *Applied Animal Behaviour Science*, 104(3): 199–235.
- Awal, S., Christie, A., Watson, M. & Hannadige, A.G.** 2012. Perception of aquaculture education to support further growth of aquaculture industry in Victoria, Australia. *Journal of Agricultural Education and Extension*, 18(3): 269–284.
- Bacher, K., Gordo, A. & Mikkelsen, E.** 2014. Stakeholders' perceptions of marine fish farming in Catalonia (Spain): a Q-methodology approach. *Aquaculture*, 424: 78–85.
- Barrett, G., Caniggia, M.I. & Read, L.** 2002. "There are more vets than doctors in Chiloé": social and community impact of the globalization of aquaculture in Chile. *World Development*, 30(11): 1951–1965.
- Barrington, K., Ridler, N., Chopin, T., Robinson, S. & Robinson, B.** 2010. Social aspects of the sustainability of integrated multi-trophic aquaculture. *Aquaculture International*, 18(2): 201–211.
- Bartley, D.M., Brugère, C., Soto, D., Gerber, P. & Harvey, B., eds.** 2007. *Comparative assessment of the environmental costs of aquaculture and other food production sectors: methods for meaningful comparisons*. FAO/WFT [World Fisheries Trust] Expert Workshop, 24–28 April 2006, Vancouver, Canada. FAO Fisheries Proceedings No. 10. Rome, FAO.
- Béné, C., Barange, M., Subasinghe, R., Pinstrup-Andersen, P., Merino, G., Hemre, G.-I. & Williams, M.** 2015. Feeding 9 billion by 2050: putting fish back on the menu. *Food Security*, 7(2): 261–274.
- Beveridge, M.C., Ross, L.G. & Kelly, L.A.** 1994. Aquaculture and biodiversity. *Ambio* 23(8): 497–502.
- Burbridge, P., Hendrick, V., Roth, E. & Rosenthal, H.** 2001. Social and economic policy issues relevant to marine aquaculture. *Journal of Applied Ichthyology*, 17(4): 194–206.
- Bush, S.R., Belton, B., Hall, D., Vandergeest, P., Murray, F.J., Ponte, S., Oosterveer, P., Islam, M.S., Mol, A.P. & Hatanaka, M.** 2013. Certify sustainable aquaculture. *Science*, 341(6150): 1067–1068.
- Cahu, C., Salen, P. & De Lorgeril, M.** 2004. Farmed and wild fish in the prevention of cardiovascular diseases: assessing possible differences in lipid nutritional values. *Nutrition, Metabolism and Cardiovascular Diseases*, 14(1): 34–41.
- Chatterton, J.** 2004. Framing the fish farmers: the impact of activists on media and public opinion about the aquaculture industry. In B.L. Crowley & G. Johnson, eds. *How to farm the seas*. Halifax, Nova Scotia, Atlantic Institute for Market Studies.
- Chu, J., Anderson, J.L., Asche, F. & Tudur, L.** 2010. Stakeholders' perceptions of aquaculture and implications for its future: a comparison of the U.S.A. and Norway. *Marine Resources & Economics*, 25(1): 61–76.
- Claret, A., Guerrero, L., Ginés, R., Grau, A., Hernández, M.D., Aguirre, E., Peleteiro, J.B., Fernández-Pato, C. & Rodríguez-Rodríguez, C.** 2014. Consumer beliefs regarding farmed versus wild fish. *Appetite*, 79: 25–31.

- Darko, F.A.** 2011. *Consumer preference for farmed fish in Ghana and Kenya: opportunities for domestic demand-driven aquaculture*. Purdue University, West Lafayette, IN, USA. (MA thesis)
- De Silva, S.S. & Davy, F.B.** 2010. Aquaculture successes in Asia: contributing to sustained development and poverty alleviation. In S.S. De Silva & F.B. Davy, eds. *Success stories in Asian aquaculture*. Dordrecht, Netherlands, Springer Netherlands.
- DFO.** 2005. *Qualitative research exploring Canadians' perceptions, attitudes and concerns toward aquaculture*. Paper prepared for the Department of Fisheries and Oceans (Canada), Strategic Communications Branch, Ottawa, Canada. Ottawa, Department of Fisheries and Oceans.
- Diamant, A., Banet, A., Ucko, M., Colorni, A., Knibb, W. & Kvitt, H.** 2000. Mycobacteriosis in wild rabbitfish *Siganus rivulatus* associated with cage farming in the Gulf of Eilat, Red Sea. *Diseases of Aquatic Organisms*, 39(3): 211–219.
- EC.** 2008. Image survey on the perception of fishery and aquaculture products. In: *Study 1 in the course of the framework contract lot 3: studies concerning the implementation of the European Fisheries Fund*. Brussels, European Commission [online]. http://ec.europa.eu/fisheries/documentation/studies/image_survey/index_en.htm
- EFSA.** 2005. *Opinion of the scientific panel on contaminants in the food chain on a request from the European parliament related to the safety assessment of wild and farmed fish*. Parma, Italy, European Food Safety Authority [online]. www.efsa.europa.eu/sites/default/files/scientific_output/files/main_documents/contam_opinion_ej236_swaff_v2_en1%2C3.pdf
- Ellingsen, K., Grimsrud, K., Nielsen, H.M., Mejdell, C., Olesen, I., Honkanen, P., Navrud, S., Gamborg, C. & Sandøe, P.** 2015. Who cares about fish welfare? A Norwegian study. *British Food Journal*, 117(1): 257–273.
- Eltholth, M., Fornace, K., Grace, D., Rushton, J. & Häslér, B.** 2015. Characterisation of production, marketing and consumption patterns of farmed tilapia in the Nile Delta of Egypt. *Food Policy*, 51: 131–143.
- Ertör, I. & Ortega-Cerdà, M.** 2015. Political lessons from early warnings: marine finfish aquaculture conflicts in Europe. *Marine Policy*, 51: 202–210.
- FAO.** 2014. *The state of world fisheries and aquaculture 2014*. Rome.
- FAO/WHO** [World Health Organization]. 2011. *Report of the Joint FAO/WHO Expert Consultation on the Risks and Benefits of Fish Consumption*. Rome/ Geneva. 50 pp.
- Fernández-Polanco, J. & Luna, L.** 2010. Analysis of perceptions of quality of wild and cultured seabream in Spain. *Aquaculture Economics & Management*, 14(1): 43–62.
- Fernández-Polanco, J. & Luna, L.** 2012. Factors affecting consumers' beliefs about aquaculture. *Aquaculture Economics & Management*, 16(1): 22–39.
- Freeman, S., Vigoda-Gadot, E., Sterr, H., Schultz, M., Korchenkov, I., Krost, P. & Angel, D.** 2012. Public attitudes towards marine aquaculture: a comparative analysis of Germany and Israel. *Environmental Science & Policy*, 22: 60–72.
- Gempesaw, C.M., Bacon, R., Wessells, C.R. & Manalo, A.** 1995. Consumer perceptions of aquaculture products. *American Journal of Agricultural Economics*, 77(5): 1306–1312.
- Gerwing, K. & McDaniels, T.** 2006. Listening to the salmon people: coastal First Nations' objectives regarding salmon aquaculture in British Columbia. *Society and Natural Resources*, 19(3): 259–273.

- GFCM** [General Fisheries Commission for the Mediterranean]. 2013. Indicators for sustainable aquaculture in Mediterranean and Black Sea countries: guide for the use of indicators to monitor sustainable development of aquaculture. In D. Fezzardi, F. Massa, P. Ávila-Zaragoza, F. Rad, G.Z. Yücel-Gier, H. Deniz, M. Hadj Ali Salem, H. Auadh Hamza & S. Ben Salem, eds. *Studies and reviews*. Rome, FAO.
- Githukia, C.M., Obiero, K.O., Manyala, J.O., Ngugi, C.C. & Quagraine, K.K.** 2014. Consumer perceptions and preferences of wild and farmed Nile tilapia (*Oreochromis niloticus* L.) and African catfish (*Clarias gariepinus* Burchell 1822) in urban centres in Kenya. *International Journal*, 2(7): 694–705.
- Grunert, K.G., Hieke, S. & Wills, J.** 2014. Sustainability labels on food products: consumer motivation, understanding and use. *Food Policy*, 44: 177–189.
- Hall, S.J., Delaporte, A., Phillips, M.J., Beveridge, M. & O’Keefe, M.** 2011. *Blue frontiers: managing the environmental costs of aquaculture*. Penang, Malaysia, The WorldFish Center.
- Harper, G.C. & Makatouni, A.** 2002. Consumer perception of organic food production and farm animal welfare. *British Food Journal*, 104(3/4/5): 287–299.
- Hasan, M.R. & Halwart, M.** 2009. Fish as feed inputs for aquaculture: practices, sustainability and implications. In M.R. Hasan & M. Halwart, eds. *Fish as feed inputs for aquaculture: practices, sustainability and implications*. FAO Fisheries and Aquaculture Technical Paper No. 518. Rome, FAO.
- Hegggerget, T.G., Johnsen, B.O., Hindar, K., Jonsson, B., Hansen, L.P., Hvidsten, N.A. & Jensen, A.J.** 1993. Interactions between wild and cultured Atlantic salmon: a review of the Norwegian experience. *Fisheries Research*, 18(1–2): 123–146.
- Hishamunda, N., Poulain, F. & Ridler, N.** 2009. *Prospective analysis of aquaculture development: the Delphi method*. FAO Fisheries and Aquaculture Technical Paper No. 521. Rome, FAO.
- Hishamunda, N., Bueno, P., Menezes, A.M., Ridler, N., Wattage, P. & Martone, E.** 2014. *Improving governance in aquaculture employment: a global assessment*. FAO Fisheries and Aquaculture Technical Paper No. 575. Rome, FAO.
- Hites, R.A., Foran, J.A., Carpenter, D.O., Hamilton, M.C., Knuth, B.A. & Schwager, S.J.** 2004. Global assessment of organic contaminants in farmed salmon. *Science*, 303(5655): 226–229.
- Honkanen, P. & Olsen, S.O.** 2009. Environmental and animal welfare issues in food choice: the case of farmed fish. *British Food Journal*, 111(3): 293–309.
- Honkanen, P., Olsen, S.O. & Verplanken, B.** 2005. Intention to consume seafood: the importance of habit. *Appetite*, 45(2): 161–168.
- Irz, X., Stevenson, J.R., Tanoy, A., Villarante, P. & Morissens, P.** 2007. The equity and poverty impacts of aquaculture: insights from the Philippines. *Development Policy Review*, 25(4): 495–516.
- Kaiser, M. & Stead, S.M.** 2002. Uncertainties and values in European aquaculture: communication, management and policy issues in times of “changing public perceptions”. *Aquaculture International*, 10(6): 469–490.
- Katranidis, S., Nitsi, E. & Vakrou, A.** 2003. Social acceptability of aquaculture development in coastal areas: the case of two Greek islands. *Coastal Management*, 31(1): 37–53.
- Knapp, G.** 2012. The political economics of United States marine aquaculture. *Bulletin of Fisheries Research Agency*, 35: 51–63.

- Kole, A.P.W.** 2003. Consumer opinions towards farmed fish, accounting for relevance and individual knowledge. In J.B. Luten, J. Oehlenschläger & G. Ólafsdóttir, eds. *Quality of fish from catch to consumer: labelling, monitoring and traceability*, pp. 393–400. Wageningen, Netherlands, Wageningen Academic Publishers.
- Larsen, R., Eilertsen, K.-E. & Elvevoll, E.O.** 2011. Health benefits of marine foods and ingredients. *Biotechnology Advances*, 29(5): 508–518.
- Little, D.C., Bush, S.R., Belton, B., Phuong, N.T., Young, J.A. & Murray, F.J.** 2012. Whitefish wars: pangasius, politics and consumer confusion in Europe. *Marine Policy*, 36(3): 738–745.
- Liu, Y., Olaussen, J.O. & Skonhoft, A.** 2011. Wild and farmed salmon in Norway: a review. *Marine Policy*, 35(3): 413–418.
- Luoma, S.N. & Löfstedt, R.E.** 2007. Contaminated salmon and the public's trust. *Environmental Science & Technology*, 41(6): 1811–1814.
- Luten, J., Kole, A., Schelvis, R., Veldman, M., Heide, M., Carlehoeg, M. & Akse, L.** 2002. Evaluation of wild cod versus wild caught, farmed raised cod from Norway by Dutch consumers. *Okonomisk Fiskeriforskning*, 12 (2002), ISSN 0803-6799: 44–60.
- Masser, M.P. & Bridger, C.J.** 2007. A review of cage aquaculture: North America. In M. Halwart, D. Soto & J.R. Arthur, eds. *Cage aquaculture: regional reviews and global overview*. FAO Fisheries Technical Paper No. 498. Rome, FAO.
- Mazur, N.A. & Curtis, A.L.** 2006. Risk perceptions, aquaculture, and issues of trust: lessons from Australia. *Society & Natural Resources*, 19(9): 791–808.
- Mazur, N.A. & Curtis, A.L.** 2008. Understanding community perceptions of aquaculture: lessons from Australia. *Aquaculture International*, 16(6): 601–621.
- Mazur, N., Aslin, H., Curtis, A., Byron, I. & Magpantay, C.** 2004. *Community perceptions of aquaculture: report on the Eyre Peninsula*. Canberra, Australia, Bureau of Rural Sciences Canberra.
- Mente, E., Pantazis, P., Neofitou, C., Aifanti, S., Santos, M.B., Oxouzi, E., Bagiatis, V., Papapanagiotou, E., Kourkouta, V. & Soutsas, K.** 2007. Socioeconomic interactions of fisheries and aquaculture in Greece: a case study of South Evoikos Gulf. *Aquaculture Economics and Management*, 11(3): 313–334.
- Naylor, R.L., Hardy, R.W., Bureau, D.P., Chiu, A., Elliott, M., Farrell, A.P., Forster, I., Gatlin, D.M., Goldburg, R.J., Hua, K. & Nichols, P.D.** 2009. Feeding aquaculture in an era of finite resources. *Proceedings of the National Academy of Sciences*, 106(36): 15103–15110.
- Noakes, D., Fang, L., Hipel, K. & Kilgour, D.** 2003. An examination of the salmon aquaculture conflict in British Columbia using the graph model for conflict resolution. *Fisheries Management and Ecology*, 10(3): 123–137.
- NZ.** 2014. *Public perceptions of New Zealand's aquaculture industry*. Wellington, Ministry for Primary Industries, Government of New Zealand (also available at www.fish.govt.nz/NR/rdonlyres/A9048808-E118-40C7-A10F-1B8268F01559/0/publicperceptionsofaquacultureFINAL14082014.pdf).
- Olsen, S.O., Scholderer, J., Brunsø, K. & Verbeke, W.** 2007. Exploring the relationship between convenience and fish consumption: a cross-cultural study. *Appetite*, 49(1): 84–91.
- Onozaka, Y., Uchida, H., Morita, T. & Managi, S.** 2010. Uninformed or uninterested? Surveys examine Japanese consumers' interest in sustainable seafood. *Global Aquaculture Advocate*, 1(1): 58–60.
- Pieniak, Z. & Verbeke, W.** 2008. Consumer interest and marketing potential of information on fish labels. *Health*, 5: 1–62.

- Pieniak, Z., Vanhonacker, F. & Verbeke, W.** 2013. Consumer knowledge and use of information about fish and aquaculture. *Food Policy*, 40: 25–30.
- Pieniak, Z., Verbeke, W., Scholderer, J., Brunso, K. & Olsen, S.O.** 2007. European consumers' use of and trust in information sources about fish. *Food Quality and Preference*, 18(8): 1050–1063.
- Primavera, J.H.** 2006. Overcoming the impacts of aquaculture on the coastal zone. *Ocean & Coastal Management*, 49(9–10): 531–545.
- Ridler, N. & Hishamunda, N.** 2001. *Promotion of sustainable commercial aquaculture in sub-Saharan Africa*. FAO Fisheries Technical Paper No. 408/1. Rome, FAO.
- Robertson, R.A., Carlsen, E.L. & Bright, A.** 2002. Effect of information on attitudes towards offshore marine finfish aquaculture development in northern New England. *Aquaculture Economics & Management*, 6(1-2): 117–126.
- Rudell, P.N. & Miller, M.L.** 2012. Human perceptions and attitudes regarding geoduck aquaculture in Puget Sound, Washington: a Q-method approach. *Journal of Shellfish Research*, 31(1): 342–343.
- Schlag, A.K.** 2010. Aquaculture: an emerging issue for public concern. *Journal of Risk Research*, 13(7): 829–844.
- Schlag, A.K.** 2011. Aquaculture in Europe: media representations as a proxy for public opinion. *International Journal of Fisheries and Aquaculture*, 3(7): 158–165.
- Schlag, A.K. & Ystgaard, K.** 2013. Europeans and aquaculture: perceived differences between wild and farmed fish. *British Food Journal*, 115(2): 209–222.
- Shafer, C.S., Inglis, G.J. & Martin, V.** 2010. Examining residents' proximity, recreational use, and perceptions regarding proposed aquaculture development. *Coastal Management*, 38(5): 559–574.
- Shindler, B.A., Wilton, J. & Wright, A.** 2002. *A social assessment of ecosystem health: public perspectives on Pacific Northwest forests*. Corvallis, Oregon, Department of Forest Resources, Oregon State University.
- Solgaard, H.S. & Yang, Y.K.** 2011. Consumers' perception of farmed fish and willingness to pay for fish welfare. *British Food Journal*, 113(8-9): 997–1010.
- Sustainable Fisheries Partnership.** 2011. *Public access to environmental information around salmon aquaculture*. Sustainable Fisheries Partnership Discussion Paper. Honolulu, HI, USA (also available at <http://cmsdevelopment.sustainablefish.org.s3.amazonaws.com/2011/11/01/SFP%20Discussion%20Paper%20-%20Salmon%20Aquaculture%20and%20Environmental%20Data-aeaa1cc6.pdf>).
- Tiersch, T.R. & Hargreaves, J.A.** 2002. Contending with criticism: sensible responses in an age of advocacy. In R.R. Stickney & J.P. McVey, eds. *Responsible marine aquaculture*. New York, USA, CAB International.
- Tiller, R., Brekken, T. & Bailey, J.** 2012. Norwegian aquaculture expansion and integrated coastal zone management (ICZM): simmering conflicts and competing claims. *Marine Policy*, 36(5): 1086–1095.
- Tilman, D. & Clark, M.** 2014. Global diets link environmental sustainability and human health. *Nature*, 515(7528): 518–522.
- Torrissen, O., Olsen, R.E., Toresen, R., Hemre, G.I., Tacon, A.G., Asche, F., Hardy, R.W. & Lall, S.** 2011. Atlantic salmon (*Salmo salar*): the “super-chicken” of the sea? *Reviews in Fisheries Science*, 19(3): 257–278.
- Uchida, H., Onozaka, Y., Morita, T. & Managi, S.** 2014. Demand for ecolabeled seafood in the Japanese market: a conjoint analysis of the impact of information and interaction with other labels. *Food Policy*, 44: 68–76.

- USDA [US Department of Agriculture]. 2015. Scientific Report of the 2015 Dietary Guidelines Advisory Committee. In: *Advisory report to the Secretary of Health and Human Services and the Secretary of Agriculture*. Washington, DC (also available at www.health.gov/dietaryguidelines/2015-scientific-report/PDFs/Scientific-Report-of-the-2015-Dietary-Guidelines-Advisory-Committee.pdf).
- Vanhonacker, F., Pieniak, Z. & Verbeke, W.** 2013. European consumer image of farmed fish, wild fish, seabass and seabream. *Aquaculture International*, 21(5): 1017–1033.
- Vanhonacker, F., Altintzoglou, T., Lutén, J. & Verbeke, W.** 2011. Does fish origin matter to European consumers? Insights from a consumer survey in Belgium, Norway and Spain. *British Food Journal*, 113(4-5): 535–549.
- Varjopuro, R., Sahivirta, E., Mäkinen, T. & Helminen, H.** 2000. Regulation and monitoring of marine aquaculture in Finland. *Journal of Applied Ichthyology*, 16(4-5): 148–156.
- Verbeke, W. & Brunso, K.** 2005. Consumer awareness, perceptions and behaviour towards farmed versus wild fish. In K.J. Thomson & L. Vanzi, eds. *The economics of aquaculture with respect to fisheries*. 95th EAAE Seminar, Civitavecchia, Italy. The Hague, Netherlands, European Association of Agricultural Economists.
- Verbeke, W., Sioen, I., Pieniak, Z., Van Camp, J. & De Henauw, S.** 2005. Consumer perception versus scientific evidence about health benefits and safety risks from fish consumption. *Public Health Nutrition*, 8(04): 422–429.
- Verbeke, W., Sioen, I., Brunso, K., De Henauw, S. & Van Camp, J.** 2007a. Consumer perception versus scientific evidence of farmed and wild fish: exploratory insights from Belgium. *Aquaculture International*, 15(2): 121–136.
- Verbeke, W., Vanhonacker, F., Sioen, I., Van Camp, J. & De Henauw, S.** 2007b. Perceived importance of sustainability and ethics related to fish: a consumer behavior perspective. *AMBIO: A Journal of the Human Environment*, 36(7): 580–585.
- Waite, R., Beveridge, M., Brummett, R., Castine, S., Chaiyawannakarn, N., Kaushik, S., Mungkung, R., Nawapakpilai, S. & Phillips, M.** 2014. In: *Improving productivity and environmental performance of aquaculture*. Working paper. Washington, DC, World Resources Institute (also available at http://www.wri.org/sites/default/files/wrr_installment_5_improving_productivity_environmental_performance_aquaculture.pdf).
- Wang, F., Zhang, J., Mu, W., Fu, Z. & Zhang, X.** 2009. Consumers' perception toward quality and safety of fishery products, Beijing, China. *Food Control*, 20(10): 918–922.
- White, F. & Costelloe, J.** 1999. *Socio-economic evaluation of the impact of the aquaculture industry in counties Donegal, Galway, Kerry and Cork*. Marine Resource Series, No. 7. Dublin, Marine Institute.
- Whitmarsh, D. & Palmieri, M.G.** 2009. Social acceptability of marine aquaculture: the use of survey-based methods for eliciting public and stakeholder preferences. *Marine Policy*, 33(3): 452–457.
- Whitmarsh, D. & Wattage, P.** 2006. Public attitudes towards the environmental impact of salmon aquaculture in Scotland. *European Environment*, 16(2): 108–121.
- Xu, P., Zeng, Y., Fong, Q., Lone, T. & Liu, Y.** 2012. Chinese consumers' willingness to pay for green- and eco-labeled seafood. *Food Control*, 28(1): 74–82.
- Yeung, R.M.W. & Morris, J.** 2001. Food safety risk: consumer perception and purchase behaviour. *British Food Journal*, 103(3): 170–187.
- Young, J.A., Brugere, C. & Muir, J.F.** 1999. Green grow the fishes-oh? Environmental attributes in marketing aquaculture products. *Aquaculture Economics and Management*, 3(1): 7–17.

Zhang, X.-G. 2003. Consumption trends and habits for aquatic products in China. In M. Eleftheriou & A. Eleftheriou, eds. *Proceedings of the ASEM [Asia-Europe Meeting] workshop Aquachallenge, Beijing, 27-30 April 2002. Aquaculture challenges in Asia after the Bangkok Declaration on Sustainable Aquaculture*, pp. 137–142. Brussels, European Commission.

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