

## Critical Review

# Why not? Decrypting social attitudes toward European aquaculture: An updated policy perspective for an old problem

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### Abstract

In some food production systems, sustainability and acceptability are considered umbrella concepts that can be assessed through a combination of criteria and indicators. After a remarkable and somewhat chaotic development in the early 1990s, European aquaculture has been evolving in both scientific and policy domains to improve, and to prove, its sustainability. The updated review of the literature and policy framework presented in this article highlights gaps in European studies, addressing mostly concerns over environmental impacts and food safety and less over economic impacts on other coastal activities or the effects on social values and local traditions. The analysis of the legislative framework demonstrates that the existing legislation adopted at different levels addresses most of the criteria of social acceptability through binding rules and supporting guidelines. Nonetheless, some elements of social concerns, such as the impact of escapes or the degradation of the landscape, remain unaddressed. Several actions are proposed that should be implemented by all actors involved in aquacultural management to improve social attitudes and, thus, the acceptance by the different segments of society. *Integr Environ Assess Manag* 2022;00:1–14. © 2022 The Authors. *Integrated Environmental Assessment and Management* published by Wiley Periodicals LLC on behalf of Society of Environmental Toxicology & Chemistry (SETAC).

**KEYWORDS:** Acceptability; Criteria; Environmental policy; European aquaculture; Social attitudes; Sustainability

### INTRODUCTION

With the adoption of various policies in support of a sustainable blue economy, countries across the globe recognize that the fast growth of new maritime activities was replacing or reducing the space of traditional users (Murray & D'Anna, 2015) and reshaping landscapes and values across coastal areas. Among those emerging economies, modern marine aquaculture has seen a rapid expansion in both developed and developing nations searching to meet the growing demand for food and the need to reduce pressure on wild stocks (Papageorgiou et al., 2021). The importance of sustainable aquaculture is widely recognized in support of food security, local and national economy, and employment (FAO, 2020). However, together with the benefits, such exponential development came, in some cases, at high environmental, social, and economic costs to local populations where it occurs.

In the EU, this sector is not uniformly distributed in terms of species, applied technology, production trend and, currently, it is experiencing stagnation (EU, 2018). Thus, a further expansion presents significant challenges, including the integration with more traditional sectors, growing inputs from (land) farming and urbanization, lack of infrastructure, unclear competences between central and local institutions, and their lack of coordination (O'Hagan et al., 2017).

Although progress has been made to improve the environmental, economic, and social sustainability of the activity as well as its governance, the mistakes made in the past have weakened public trust and are now hampering the development of new projects or expansion of existing ones. Therefore, when establishing scenarios for future development, both the industry and governments must ensure that social attitudes toward the sector and its products are carefully considered if they want to meet their production targets (Cavallo et al., 2021). The concept of sustainability, or sustainable development, has been evolving in both the scientific literature and policy to find the right balance among its components, namely environmental, economic, and social (Purvis et al., 2019). Kleindorfer et al. (2005) redefined those components as People (social), Planet (environment), and Profit (economy), which can be split into

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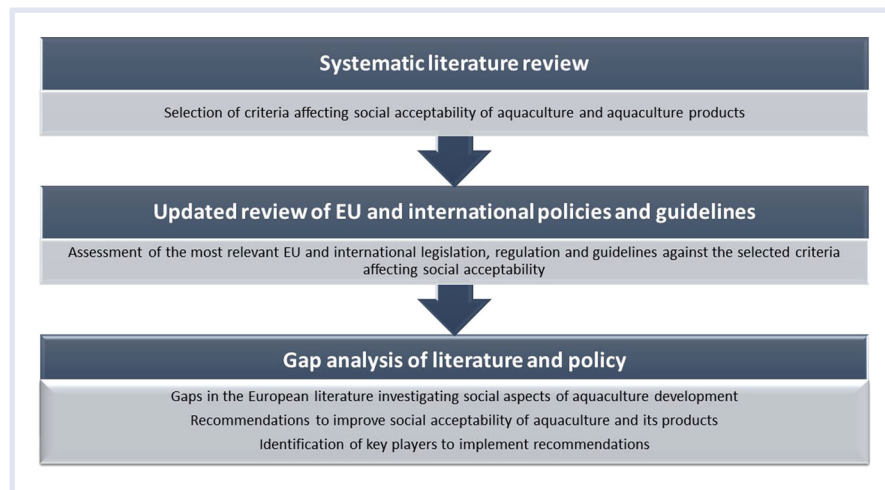


FIGURE 1 The article's overall conceptual framework

multiple subcomponents, for example, cultural and ethical aspects for the People component, ecological processes and water quality for the Planet component. Similarly, although there is not a commonly agreed definition of the concept of social acceptability, it was conceived to describe the outcome of a collective judgment of a project, plan, or policy (Batellier, 2015).

Although the link between sustainability and social acceptability of food industries is widely recognized (van der Voet et al., 2014), sustainable food production does not necessarily ensure acceptability by society. In fact, acceptability depends on perceptions, attitudes, and behaviors that vary among stakeholders or social groups (Aguilar-Manjarrez et al., 2017; Bacher, 2015; Chu et al., 2010), which differ from place to place and evolve over time (Kaiser & Stead, 2002; Massa et al., 2020). Thus, social acceptability needs to be assessed through a wide range of criteria and indicators.

This article presents a comprehensive list of criteria that should be considered to provide an understanding of the social attitudes that can support or hamper the acceptability of aquacultural projects and products. For each of the identified criteria, it presents an updated review of EU and international policies and guidelines that, if properly implemented, could improve perceptions held by the general public, local populations surrounding aquacultural sites, and consumers of aquacultural products in Europe. The article's overall conceptual framework is presented in Figure 1.

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## THE SOCIAL DIMENSION OF AQUACULTURE

Low intensity, or extensive, aquaculture, such as the farming of mollusks and seaweeds, depends on naturally occurring nutrients and plankton and requires less infrastructure,

imposing only minor pressure on the surrounding environment (Edwards, 2015). On the other hand, intensive aquaculture is driven by technology and scientific advances, usually producing carnivorous fish heavily dependent on agro-industrially manufactured feed. This type of aquaculture has developed mostly during the past 40 years (FAO, 2018a), sometimes with little consideration of the potential negative effects on the environment and on the existing socioeconomic context where it was developed (Tičina et al., 2020). Often, attention is given only to practices and ethical concerns that have contributed to the degradation of the image of the sector (Grigorakis, 2010), the perception and misconceptions regarding aquaculture (Bacher, 2015), and to the lack of public trust of institutions (Condie et al., 2022), which result in local forms of opposition. Although both aquacultural producers and public authorities at different levels have adopted different rules and codes to ensure the sustainability of practices and products, the sector is struggling to gain acceptance and to have its multiple benefits recognized. As part of the notion of sustainable development, aquaculture is currently receiving much consideration by national governments and stakeholders regarding the overall benefits it provides (FAO, 2020).

The evolution of social perception and public attitudes toward aquaculture has been assessed by scholars since the early 1990s (Bailey et al., 1996; McCunn, 1989; Weeks, 1992) to identify the elements of sustainable development that both business and competent authorities should consider to gain societal approval.

### The 10 pillars of acceptability

Sustainability and therefore the acceptability of management decisions are umbrella concepts and can be assessed through the combination of multiple criteria (van der Voet et al., 2014). Based on a systematic review of the literature published during the past 30 years, this section presents a comprehensive list of criteria that may be used to understand the evolution of public attitudes toward aquaculture.

Literature searches were conducted on such databases as Google Scholar and Scopus, using keywords such as social acceptability, social license, aquaculture, social perception, attitudes, and synonyms. Once an exhaustive list of criteria has been identified, another search was made by each criterion, for example, aquaculture and impact on landscape, aquaculture and competition for space, and so forth. Finally, the selection of the references to be included in this

contribution was made giving primary consideration to EU studies that provide examples of rejection and support for each criterion.

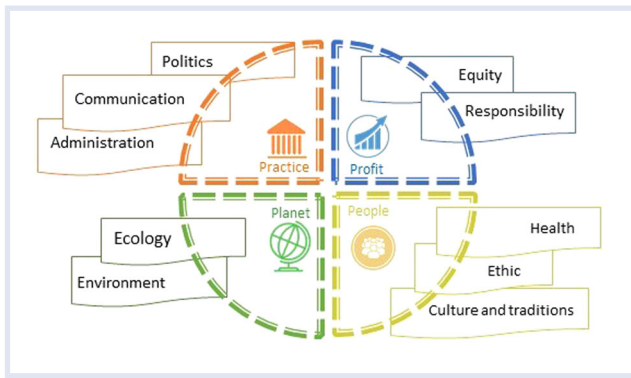
Relevant criteria have been classified into 10 pillars of acceptability (Table 1; adapted from the 10-tenets proposed by Barnard & Elliott, 2015).

The 10 pillars have been grouped into the dimensions of sustainability proposed by Kleindorfer et al. (2005), namely

**TABLE 1** Review of the main drivers of social perception and attitudes of aquacultural project development and products (C, consumers; L, local communities; S, society in general)

Criteria	Pillar	Source
Land and seascape (L)	Environment, culture and traditions	Cavallo et al. (2020); Dalton et al. (2017); Kaiser and Stead (2002); Katranidis et al. (2003); Murray and D'Anna (2015); Shafer et al. (2010)
Detract from the identity of place (L)	Culture and traditions	Mazur and Curtis (2008); Murray and D'Anna (2015); Shafer et al. (2010)
Use of antibiotics, pesticides, GMOs, antiparasitic, artificial colorings (C)	Health, ethic, responsibility	Burbridge et al. (2001); Burgess and Tansey (2005); Hojier et al. (2006); Kruse (2006); Leiss and Nicol (2006); Amberg and Hall (2008); Verbeke et al. (2007); Whitmarsh and Palmieri (2009); Schlag (2010); FAO (2016a); Kaiser (2012)
Odors from waste; noise from farm operations (L)	Health, responsibility	Cavallo et al. (2020); Gourguet et al. (2018); Murray and D'Anna (2015); Schlag (2010)
Organic, nutrients, plastic, and chemicals inputs (S)	Environment, ecology, health, responsibility	Burbridge et al. (2001); Burgess and Tansey (2005); Carballeira Braña et al. (2021); Chu et al. (2010); FAO (2016a); Freeman et al. (2012); Hites et al. (2004); Jacobs (2000); Katranidis et al. (2003); Kruse (2006); Mazur and Curtis (2006, 2008); Murray and D'Anna (2015); Primavera (2006); Schlag (2010); Verbeke et al. (2007); Whitmarsh and Wattage (2006)
Interaction with wild predators (S)	Ecology, ethic	Kaiser and Stead (2002); Schlag (2010)
Escapes (S)	Ecology, ethic, responsibility, culture and traditions	Arechavala-Lopez et al. (2018); Atalah and Sanchez-Jerez (2020); Izquierdo-Gomez and Sanchez-Jerez (2016); Murray and D'Anna (2015)
Genetic, microbial and parasite contamination of wild stocks (from escapes and not; S)	Environment, health, ethic, responsibility, culture and traditions, communication	Burbridge et al. (2001); Alexander et al. (2016); Atalah and Sanchez-Jerez (2020); Heaslip (2008); Kraly et al. (2022)
Fish welfare (C)	Ethic, communication	Burbridge et al. (2001); Burgess and Tansey (2005); Fisheries and Oceans Canada (2005); Honkanen and Olsen (2009); Kruse (2006); Schlag (2010)
High dependence on wild fish for feeding (S)	Ecology, ethic	Carballeira Braña et al. (2021); Grigorakis (2010)
Competition for space (L)	Culture and traditions, responsibility, politics, administration	Halwart et al. (2007); Hoagland et al. (2003); Katranidis et al. (2003); Nimmo et al. (2011); Tollefson and Scott (2006); Sanchez-Jerez et al. (2016); Cavallo et al. (2020, 2021); Corner et al. (2020); Porporato et al. (2020)
Restrict public access (L)	Culture and traditions	Petersen and Stybel (2022); Shafer et al. (2010)
Employment and labor conditions (S)	Ethic, responsibility, equity	Kaiser and Stead (2002); Katranidis et al. (2003);
Transparency (L)	Administration, communication, politics	Barrington et al. (2010); Buanes et al. (2004); Carvalho (1998); Clarke (1996); Kaiser and Stead (2002); Katranidis et al. (2003); Kelly et al. (2017); Wilson (2001)
Participation (L)	Administration, politics	Mazur and Curtis (2006); Anbleyth-Evans et al. (2020); Dalton et al. (2017); Kraly et al. (2022); Kruse et al. (2015)

Abbreviation: GMOs, genetically modified organisms.



**FIGURE 2** Classification of the 10 pillars of social acceptability of aquaculture into the four dimensions of sustainability, Profit (economy), Planet (environment), People (social), and Practice (institutions)

Profit, Planet, and People, with a new element, Practice, to include those aspects related to institutions and governance found in the literature the review (Figure 2).

**Environment.** The actual or perceived impact of aquaculture on the environment is at the core of social acceptability (Kraly et al., 2022) and should be given primary consideration before, during, and after the development of a project. If not carefully addressed, this can damage the reputation of the entire sector and prevent future development (Bacher, 2015; Ertör & Ortega-Cerdà, 2017). Concerns over the environmental degradation that might result from inadequate monitoring and management also affect consumer preferences (Jacobs, 2000; Whitmarsh & Wattage, 2006). The literature analyzed here demonstrates that most environmental concerns center on the production of carnivorous species, such as salmonids in North America and northern Europe (e.g., Chu et al., 2010; Verbeke et al., 2007; Whitmarsh & Palmieri, 2009, 2011) as well as for other marine species in the Mediterranean and Black Seas (IUCN, 2007; Karakassis, 2001, 2013; Price et al., 2015). Such concerns are related to the risk of introducing non-native species, organic-matter inputs, pathogen transfer, therapeutic, and other products. On the other hand, shellfish and algae farming improves water quality (Theuerkauf et al., 2019) and regulates nutrients and carbon concentration (van der Schatte Olivier et al., 2020).

**Ecology.** Inadequate aquacultural development and irresponsible practices can also threaten the structure and functioning of the surrounding ecosystems, leading to opposition by local users. Most examples come from the Atlantic salmon industry. For instance, growing local concerns are related to the consequences of fish escapes, including predation on wild juvenile salmon (Murray & D'Anna, 2015), sea lice infection transfers to wild stocks (Burbridge et al., 2001), genetic introgression of farmed fish into wild populations (Bolstad et al., 2017), and competition effects with native species (Heaslip, 2008). The interaction of farmed species with wild predators, such as birds, other

fish, and mammals, may provoke the opposition of local environmental groups and conservation initiatives (Kaiser & Stead, 2002; Schlag, 2010). Nonetheless, support from society may come when aquacultural projects are integrated into conservation projects (e.g., Marine Protected Areas) contributing to reduce pressure on wild stocks (Le Gouvello et al., 2017).

**Equity.** Ensuring that communities receive the right economic return from the development of aquacultural projects is crucial to acceptability (Kraly et al., 2022). For instance, coastal municipalities and counties in Norway get a share of salmon companies' revenues through the Aquaculture Fund scheme (Ministry of Trade and Industry, 2021; <https://www.fishfarmermagazine.com/news/councils-to-get-share-of-norways-aquaculture-fund/>). Aquaculture has great potential for creating sustainable jobs and local economic growth, and it is expected to contribute to food security and nutritional needs as components of well-being (FAO, 2010; NACA & FAO, 2000). Moreover, it can help the recovery of local fish stocks (Massa et al., 2021), provide good quality fish and shellfish for local restaurants, and play a role as a tourist attraction (Cavallo et al., 2020; Melikh et al., 2020; O'Connor et al., 1992). Although these benefits have been recognized by some, for others, the prospect of jobs and local seafood supply is not enough to support new development (Katranidis et al., 2003).

**Responsibility.** Responsible aquacultural development is another principle that the industry must comply with to gain social approval. It consists of ensuring that environmental degradation that might derive from aquacultural production does not result in economic losses for other users. For example, extensive finfish farms near traditional harvest areas have threatened local fisheries (Gerwing & McDaniels, 2006) and, consequently, led to the loss of income in remote areas where alternatives are limited (Heaslip, 2008; Walters, 2007). On the other hand, some fish cages in the Mediterranean Sea attract shoals of different species nearby, resulting in increased wild fish abundance (Machias et al., 2004). In areas where tourism relies heavily on aesthetic attractiveness, certain aquacultural models could pose the risk of degradation of the economic value of the seascapes (Bavinck et al., 2017; Cavallo et al., 2020; Nimmo et al., 2011; Outeiro et al., 2018), whereas for others, it represents an attraction that brings added value to local economies, such as the “Ruta de Mejillones” in northwestern Spain (<https://www.crucerosdoulla.com/es/activities/ruta-de-los-mejillones-o-grove>).

**Administration.** The lack of mechanisms of local consultation, formal and informal, and the lack of political will to involve local institutions, stakeholders, and communities are considered major drivers of rejection (Costa-Pierce, 2021; Kraly et al., 2022). The lack of coordination among administrations and the lack of trust in policymakers is also a major impediment to aquacultural development (Chapela, 2015).

In general, aquaculture is managed by different ministries, departments, and agencies responsible for setting rules and ensuring compliance with legislation. However, decisions are usually made at the highest levels with little coordination and consultation with local institutions and third parties (Cavallo et al., 2021; Galparsoro et al., 2020). In Chile, for instance, the industry has grown by 800% since 1990, with private concessions spreading across 80% of the southern coastal zone without any form of local support or consultation (Anbleyth-Evans et al., 2020). Such a lack of participation in the past has degraded public trust of local residents of aquaculture-related government agencies (Dalton et al., 2017; Mazur & Curtis, 2008).

**Communication.** The lack of transparency and effective communication about the industry and its processes is pushing consumers to avoid aquacultural products and local communities to oppose new development (Kaiser & Stead, 2002; Kelly et al., 2017; Marino et al., 2013). Media has contributed to the degradation of the image of the sector, spreading misinformation on the impact of certain practices on the environment and human health (Amberg & Hall, 2008; Mather & Fanning, 2019). When a new aquacultural project is developed, businesses provide information on the environmental impacts to competent authorities, whereas little effort is made to effectively communicate with the general public (Katranidis et al., 2003), leaving space for third parties to spread misleading information (Polanco et al., 2018). Both consumers and local communities have become more exigent and demand that the industry demonstrates the quality and safety of their products (Kelly et al., 2017), the sustainability of the practices, and the benefits it brings in ecological services (Gentry et al., 2020; Suplicy, 2018).

**Politics.** Undeniably politics, or political decisions, play a key role in shaping aquacultural development and how the sector is perceived by marine stakeholders and coastal users. Although political will to support aquaculture is a prerequisite for any development, politics must ensure that local traditional uses, such as small-scale fisheries and traditional aquaculture, are preferred to more lucrative yet less sustainable industries. Some examples come from the development of foreign fish farms in Canada (Gerwing & McDaniels, 2006; Rigby et al., 2017; Walters, 2007), New Zealand (Tollefson & Scott, 2006), Chile (Soto et al., 2001), the Mediterranean Sea (Said & MacMillan, 2019), and tropical areas (Chu, 2006). For instance, Said and MacMillan (2019) illustrate how neoliberal policies in Malta are marginalizing small-scale fishing communities by replacing traditional fishing with the “darlings of the new blue economy,” aquaculture and coastal tourism.

**Health.** Concerns over the impact of aquaculture on human health are related to consumption of farmed species (food safety), to farmers working conditions, and to local coastal users. Perceptions of food safety are linked to intensive finfish farming, mostly salmon, which includes the use of

chemicals, antibiotics, antiparasitics, hormones, and genetically modified organisms (GMOs; Alexander et al., 2016; Burbridge et al., 2001; Heaslip, 2008) that can potentially be transferred to consumers. However, during the past decades, the use of antibacterial drugs for fish farming has been drastically reduced, such as for the Norwegian salmon farming thanks also to vaccines (Midtlyng et al., 2011).

**Ethic.** Consumer preferences are driven increasingly by ethical issues, especially for intensive cage culture of carnivorous fish (Ellingsen et al., 2015; Solgaard & Yang, 2011). If the sector wants to improve the acceptability of farmed products, the industry should not ignore issues such as animal welfare (Alexander et al., 2016; Burbridge et al., 2001; Cotee & Petersan, 2009; Honkanen & Olsen, 2009; Huntingford et al., 2006) and environmental sustainability (Bjørklund et al., 2007; Fernández-Polanco & Luna, 2010, 2012). Some ethical aspects in aquaculture have drawn special attention, including selective breeding, feeding (e.g., the extensive use of environmental resources based on fishmeal and fish oil), acute stress generated by crowded fish cages, and the impact of fish escapes on wild population (Atalah & Sanchez-Jerez, 2020). Moreover, the farming of non-native species and their potential impact on biodiversity (FAO, 2016b); predators such as seals, dolphins, and seabirds attracted to and trapped in aquacultural nets; antipredator measures; animal transportation; and killing procedures (Grigorakis, 2010) are additional ethical aspects. On the other hand, work has been undertaken to explore opportunities, benefits, and synergies between some forms of aquaculture and marine protected areas (Le Gouvello et al., 2017). It remains to be understood how much this would positively influence local public acceptance and consumer preferences.

**Culture and traditions.** When planning for new development or extension of existing aquacultural projects, both the promoter and competent authorities must ensure that cultural values and traditions of vulnerable local groups are not undermined (FAO, 2010; Shafer et al., 2010). These include access to ancestral harvesting territory and resources (Gerwing & McDaniels, 2006), but also the degradation of the landscape that concerns all forms of aquaculture, including shellfish (Dalton et al., 2017; Krause et al., 2020; Murray & D'Anna, 2015). On the other hand, traditional forms of extensive aquaculture done in Mediterranean coastal lagoons (e.g., valliculture in the northern Adriatic) are part of the cultural heritage of the region and contribute to preserving relevant coastal ecosystems (Cataudella et al., 2015).

## SOCIAL ACCEPTABILITY—RULES AND GUIDELINES

The review of the literature reveals that the acceptability of aquacultural projects and products depends on several aspects that, in many cases, are linked to each other and may differ from one form of aquaculture to another (e.g.,

species or farming technologies). For each criterion identified, we present a comprehensive, but not exhaustive, review of legislation with which both promoters and competent authorities must comply to address the social acceptability of the sector as a whole (Table 2).

Such a review is the result of the analysis of aquacultural and environmental policies and national strategies of EU member states for aquaculture. Aquaculture is regulated and monitored through a range of international and national legislations that vary considerably between countries and regions of the world (Holmer et al., 2008). Aquaculture, unlike fisheries, is not an exclusive EU competence, and its sustainable development is supported by nonbinding strategic guidelines that are regularly updated (COM, 2013; COM, 2021; Commission Staff Working Document, 2016). The new EC strategic guidelines for a more sustainable and competitive EU aquaculture for the period 2021–2030 (COM, 2021) have been published recently. Here, member states are required to focus in particular on “fostering social acceptance and improving consumer information on EU aquacultural activities and products.” In addition, the strategy clearly states that competitiveness and development of European aquaculture rely, among other things, on social acceptance that has been indicated as an essential element for its integration into local communities.

There is a substantial and complex legislative framework that ensures the safety of farmed products, especially concerning the use of antibiotics, pesticides, GMOs, anti-parasitics, and so forth, that can be transferred to consumers. Similarly, several pieces of legislations exist, that apply to but are not specific to aquaculture, that prevent or mitigate the effect of the input of chemicals, organic matter, and nutrients on the surrounding environment, namely the Water Framework Directive (WFD 2000/60/EC) and the Marine Strategy Framework Directive (MSFD 56/2008/EC). These directives, in addition to regulating the introduction of contaminants and nutrients in marine and freshwaters, apply the polluter-pay principle and require member states to perform an economic analysis of the cost of water use as well as the cost of its degradation (WFD, Art. 9(1) and MSFD, Recital 27).

The Environmental Impact Assessment Directive (EIA Directive—2011/92/EU), amended in 2014 by Directive 2014/52/EU, is one of the most relevant EU directives aiming at determining and preventing damage to the natural environments for a wide range of activities, including aquaculture. According to this directive, promoters have to perform an assessment of the environmental impact for intensive fish farming. However, no definition of “intensive farming” is provided, leaving room for interpretation; thus, the application of these requirements is established case by case across Europe (Cavallo et al., 2021).

Issues related to animal welfare are also well addressed by EU and international policies and guidelines. Directive 98/58/EC (ETS No. 087) sets rules on animal protection based on the European Convention for the Protection of Animals kept for Farming Purposes.

Aquacultural development in sensitive areas, such as the Natura 2000 sites, is allowed under certain conditions (established under the Habitat and Birds Directives), although “special care should be taken when dealing with vulnerable and protected areas, through sound planning and assessment procedures.” Even in this case, the term “special care” is not accompanied by a definition or a set of environmental limits (FEAP, 2013).

The visual impact of marine farming can be mitigated if the principles of the Florence Convention are applied. This international convention aims to promote landscape protection, management, and planning, including seascape (Art. 3), and requires contracting parties to establish procedures for the participation of the general public and local and regional authorities in the definition and implementation of the landscape policies (Art. 5).

More recently, EU and international policies have asked the parties involved to prevent conflict among marine users and to set plans to integrate the different activities (EU and Non-EU Marine Spatial Planning). Such plans are accompanied by a Strategic Environmental Assessment (SEA Directive—2001/42/EC) and are the results of an extensive public consultation among marine stakeholders. Moreover, the selection of suitable sites for aquacultural development required under the Common Fisheries Policy should also be done in coordination among local authorities and stakeholders. Nonetheless, in Europe such a participative process reveals great differences at the level of spatial scale (from local to national level), type of stakeholders involved, and type of platforms where the consultation should be performed (Cavallo et al., 2021).

Concerning transparency and participation, the international Århus Convention (UNECE, 1998) recognizes that “citizens must have access to information, be entitled to participate in decision-making and have access to justice in environmental matters, acknowledging in this regard that citizens may need assistance to exercise their rights.”

Although concerns over the consequences of the escape of farmed fish on the environment and surrounding economic activities are growing among consumers and locals, currently there is no binding regulation or comprehensive guidelines that set rules and practices to prevent adverse impacts (Arechavala-Lopez et al., 2018). The waste disposal is regulated by, among others, Regulation (EC) No. 1069/2009 that prescribes health rules regarding animal by-products and derived products not intended for human consumption and repealing Regulation (EC) No. 1774/2002 (Animal By-products regulation). Noncompliance with the rules, such as the disposal on land of undersized organic wastes produced by mussel farming, could generate odors that may affect local social acceptability (Gourguet et al., 2018). At an international level, a number of guidelines have been developed to promote best practices for conducting aquaculture in a responsible and sustainable manner that apply to the EU context. First, the Food and Agriculture Organization (FAO) elaborates the Code of Conduct of Responsible Fishery, where several principles

TABLE 2 Most relevant EU and international legislation addressing criteria of social perception of aquacultural products and projects

Criteria ( <i>related pillar</i> )	Related policies, regulations, and guidelines*	Examples of requirements
Land and seascape ( <i>environment, culture and traditions</i> )	Landscape Convention (or Florence Convention, 2000)	Arts. 5 and 6 require parties to establish and implement policies aimed at landscape protection. It applies to both terrestrial and marine landscape.
Detract from the identity of place ( <i>culture and traditions</i> )	UNESCO World Heritage Convention; European Landscape Convention (or Florence Convention, 2000)	The UNESCO Convention identifies and protects natural and cultural heritage tangible and intangible (Art. 2).
Use of antibiotics, pesticides, GMOs, antiparasitic, artificial colorings ( <i>health, ethic, responsibility</i> )	Reg. 1881/2006; Directive 2006/113/EC; Reg. 710/2009; Reg. 2019/6; Reg. 528/2012; Reg. 37/2010; Directive 2009/128/EC (Art. 11); Directive 2000/60/EC; Directive 2008/56/EC; Aquatic Animal Health Code—Section 6 (OIE, 2019); FAO/WHO Codex Alimentarius Commission	Reg. 1881/2006 lays down the maximum quantities for certain contaminants in foodstuffs; Annex I of Directive 2006/113/EC sets requirements for the physical–chemical parameters (oxygen content, temperature, salinity, etc.) and presence of contaminants in the shellfish water; Directive 2008/56/EC, Descriptor 9—requires that contaminants in seafood do not exceed levels established by Community legislation.
Odors from waste; noise from farm operations ( <i>health, responsibility</i> )	Directive 1069/2009/EC; Directive 2002/49/EC	<p>Directive 1069/2009/EC lays down health rules regarding animal by-products and derived products not intended for human consumption and repealing Regulation (EC) No 1774/2002 (Animal By-products Regulation).</p> <p>Directive 2002/49/EC defines a common approach intended to avoid, prevent or reduce the harmful effects owing to exposure to environmental noise.</p>
Organic, nutrients, plastic, and chemical inputs ( <i>environment, ecology, health, responsibility</i> )	Directive 2011/92/EU; Directive 2000/60/EC; Directive 2008/105/EC; Directive 2010/75/EU; Reg. 1907/2006, Directive 2004/35/EC; Directive 2008/56/EC; Basel Convention	<p>According to Annex II of the Directive 2011/92/EU an Environmental Impact Assessment is required for intensive fish farming; Directive 2008/105/EC Annex I provides environmental quality standards for priority substances.</p> <p>Article 9 of Directive 2000/60/EC requires Member States to assess the impacts on the aquatic environment and related cost-recovery from the provision of water services, considering the polluter pays principle.</p> <p>Directive 2008/56/EC requires the achievement of Good Environmental Status for Descriptor 5-eutrophication, 8-contaminants, 10-plastic.</p>
Interaction with wild predators ( <i>ecology, ethic</i> )	Directive 2009/147/EC; Directive 92/43/EEC (22); EU Plan 2008/2177(INI); Bonn Convention; Ramsar Convention	The Birds (Directive 2009/147/EC) and Habitat (Directive 92/43/EEC (22)) directives protect approximately 1500 rare and endangered species from the impact of human activities, including aquaculture; the EU Cormorant Management Plan (2008/2177(INI)) minimizes the increasing impact of cormorants on fish stocks, fisheries, and aquaculture.
Escapes ( <i>ecology, ethic, responsibility, culture and traditions</i> )	Mainly national, that is, Aquaculture and Fisheries (Scotland) Act 2007; Vision: “Zero Escapes” strategy (Norway); ICES Code of Practice for the Introduction and Transfer of Marine Organisms; Code of conduct of the Federation European of Aquaculture Producers	

(Continued)

TABLE 2 (Continued)

Criteria ( <i>related pillar</i> )	Related policies, regulations, and guidelines*	Examples of requirements
Genetic, microbial, and parasite contamination of wild stocks (from escapes and not; <i>environment, health, ethic, responsibility, culture and traditions, communication</i> )	Reg. 708/2007; Directive 2008/56/EC	Reg. 708/2007 Art. 4 Parties must ensure that all appropriate measures are taken to avoid adverse effects to biodiversity that might derive from the introduction of non-native species in aquaculture and from the spreading of these species into the wild.  Directive 2008/56/EC Descriptor 2—non-indigenous species.
Fish welfare ( <i>ethic, communication</i> )	Reg. 710/2009; Directive 2006/88/EC; Directive 98/58/EC; Reg. 1/2005; Aquatic Animal Health Code (OIE, 2019)	Reg. 710/2009 sets rules to minimize pests and parasites and for the reason of high animal welfare and health; Directive 2006/88/EC on animal health requirements for aquacultural animals and products thereof, and on the prevention and control of certain diseases in aquatic animals; Directive 98/58/EC lays down minimum standards for the protection of animals bred or kept for farming purposes.  Aquatic Animal Health Code (OIE, 2019) Section 7—for transportation and killing standards.
High dependence on wild fish for feeding ( <i>ecology, ethic</i> )	Reg. 1379/2013; Reg. 834/2007; Reg. 2371/2002	Reg. 1379/2013 Art. 13 and Reg. 834/2007 Art. 5 requires that raw materials for feeding organic carnivorous fish and crustaceans should preferably be derived from sustainable exploitation of fisheries; Reg. 1774/2002 sets the health rules for material of fish origin that may be used in aquaculture and provides for a ban on the feeding of certain materials derived from farmed fish to farmed fish of the same species.
Competition for space ( <i>culture and traditions, responsibility, politics, administration</i> )	Directive 2014/89/EU; Reg. 1380/2013; EU ICZM; FAO AZAs Guidelines (FAO AZAs Guidelines et al., 2019); GFCM Resolution 36/2012/1	Directive 2014/89/EU aims to reduce conflicts and create synergies between maritime activities, including aquaculture with the establishment of national and subnational spatial plans; Reg. 1380/2013 requires parties to establish national and regional aquacultural strategic plans, including the identification of suitable areas for aquacultural development, which are integrated with the existing uses; GFCM Resolution provides guidelines on the implementation of Allocated Zones for Aquaculture.
Restrict public access ( <i>culture and traditions</i> )	Directive 2014/89/EU	
Employment and labor conditions ( <i>ethic, responsibility, equity</i> )	Directive 2009/128/EC; Directive 98/24/EC; ILO Convention (Work in Fishing No. 188)	Directive 2009/128/EC requires the setting of minimum health and safety requirements at the workplace, covering the risks arising from exposure of workers to pesticides, as well as general and specific preventive measures to reduce those risks.
Transparency ( <i>administration, communication, politics</i> )	Reg. 1379/2013 (products); Reg. 1224/2009	Art. 13 improving quality, knowledge of, and the transparency of, production and the market, as well as carrying out professional and vocational training activities, for example, on quality and traceability matters, on food safety and to encourage research initiatives.

TABLE 2 (Continued)

Criteria (related pillar)	Related policies, regulations, and guidelines*	Examples of requirements
Participation (administration, politics)	Directive 2014/89/EU; Reg. 1380/2013; Directive 2003/35/EC; Århus Convention	Directive 2003/35/EC provides for public participation in the formulation of certain plans and programs relating to the environment (in support to the Århus Convention).

Note: Policies are presented in order of relevance to each criterion.

\*Policy references in order of appearance: Reg. 1881/2006: Contaminants in Foodstuffs; Directive 2006/113/EC: Quality Requirements in Shellfish Waters; Reg. 710/2009: Organic Aquaculture Animal and Seaweed Production; Reg. 2019/6: Veterinary Medical Products; Reg. 528/2012: Biocidal Products; Reg. 37/2010: Pharmacologically Active Substances in Foodstuffs of Animal Origin; Directive 2009/128/EC: Sustainable Use of Pesticides Directive; Directive 2000/60/EC: Water Framework Directive; Directive 2008/56/EC: Marine Strategy Framework Directive; Directive 2002/49/EC: Assessment and Management of Environmental Noise; Directive 2011/92/EU: Environmental Impact Assessment Directive; Directive 2008/105/EC: Directive on Environmental Quality Standards; Directive 2010/75/EU: Industrial Emissions Directive; Reg. 1907/2006: REACH Regulation; Directive 2004/35/EC: Environmental Liability with Regard to the Prevention and Remedying of Environmental Damage; Directive 2009/147/EC: Birds Directive; Directive 92/43/EEC (22): Habitat Directive; EU Plan 2008/2177 (INI): European Cormorant Management Plan to minimize the impact of cormorants on fishing and aquaculture; Reg. 708/2007: Alien and Locally Absent Species in Aquaculture; Directive 2006/88/EC: Aquatic Animal Health Directive; Directive 98/58/EC: Protection of Animals Kept for Farming Purposes; Reg. 1/2005: Protection of Animals During Transport and Related Operations; Reg. 1379/2013: Common Organization of the Markets in Fishery and Aquaculture Products; Reg. 834/2007: Organic Production and Labeling; Reg. 2371/2002: Conservation and Sustainable Exploitation of Fishery Resources; Reg. 1774/2002: Health Rules Concerning Animal By-products Not Intended for Human Consumption; Directive 2014/89/EU: Maritime Spatial Planning Directive; Reg. 1380/2013: EU Common Fisheries Policy; Directive 2009/128/EC: Sustainable Use of Pesticides Directive; Directive 98/24/EC: Protection of the Health and Safety of Workers from the Risks Related to Chemical Agents at Work; Reg. 1224/2009: Establishing a Community Control System for Ensuring Compliance with the Rules of the Common Fishery Policy.

also apply to aquaculture (FAO, 1995). For instance, Article 6 requires:

- Maintaining the nutritional value, quality and safety of aquacultural products during harvesting, processing, and distribution (iv);
- Considering the multiple use of coastal zones and integrating aquaculture into area management, planning, and development (vi);
- Promoting awareness of responsible aquaculture through the education and training of fish farmers and involving them in the policy formulation and implementation process (ix);
- Protecting the rights of fish farmers, as well as those involved in subsistence, small-scale, and artisanal fisheries, to a secure and just livelihood (xi);
- Ensuring that resources are used responsibly and that adverse impacts on the environment are minimized (xii).

At the regional level, the FAO General Fisheries Commission for the Mediterranean and the Black Sea (GFCM), has adopted a series of resolutions and guidelines in support of a responsible (FAO, 2018b) and socially acceptable (FAO, 2019) development of the sector. The principles supporting social acceptability include raising stakeholder involvement in aquacultural development, improving transparency and accountability, and increasing the participation of local communities in the selection of sites for aquacultural development (FAO, 2019).

In addition, the International Union for Conservation of Nature provided guidelines for the sustainable development of Mediterranean aquaculture for an effective implementation of aquacultural practices and environmental protection (IUCN, 2007, 2009).

## CONCLUSION

The review of the literature presented in the first part of this article has shown how perceptions of aquacultural projects and products have evolved during the past 30 years across the globe (Table 1). Four dimensions of sustainable aquaculture have been proposed, namely Profit, Planet, People, and Practice. For each dimension, a list of criteria has been identified and classified into 10 pillars of acceptability. For the scope of this study, all criteria identified in the analysis of the worldwide literature have been selected and included when considered relevant to the EU context. We have included both elements driving rejection but also supporting local aquacultural development.

The analysis demonstrates a gap in European literature investigating social aspects of aquacultural development. In fact, of the 110 papers addressing at least one element of social acceptability, 50 cover the European region; 11 of these were focused on non-EU member states (the UK and Norway). Moreover, social acceptability of aquaculture in Europe is usually assessed as part of consumer perception of environmental and health issues, but less about economic impact, or benefits, for coastal communities. Studies of the effects on social values and institutional and political aspects such as trust and transparency are almost nonexistent.

Some of the studies have tried to identify social attitudes toward aquaculture based on income, education level, gender, length of residency in the area, waterfront proximity and viewscape, and other measures of experience of the industry (see Mazur & Curtis, 2008). The contrasting results obtained by some suggest that making assumptions or predictions of people's behavior should be avoided (Alexander et al., 2016; Murray & D'Anna, 2015). In fact, society's perception of aquaculture is highly site specific; thus, some criteria might not be relevant in certain areas or

to certain types of aquaculture. Nonetheless, none of the 10 pillars should be ignored given the strong relationship among each other, namely environment and ethics or health and responsibility, and they should all be given the same consideration.

Furthermore, this study provides an updated policy review of EU aquaculture to understand how and whether legislation has been evolving to address issues of social acceptability. In 2009, the IUCN published the report of a comprehensive aquacultural policy review and identified more than 300 pieces of legislation regulating the European sector (IUCN, 2009). Here, we have identified more than 40 rules and guidelines through which EU parties address, directly or indirectly, issues of social concern at different levels. Although European aquaculture is a competence of member states, thus regulated by national law, we have found that the EU legislative framework is still extremely fragmented with several pieces of legislation addressing the same issue (e.g., use of chemicals) and other issues not addressed at all (e.g., escapes). In other cases, the regulation exists but it is not always complied with by promoters, as in the case of waste disposal from farming operations that generates unpleasant odors (Table 2).

Although some progress has been observed concerning competition for space and public participation in the adoption of the Maritime Spatial Planning Directive (Directive 2014/89/EU), for issues such as the development of project-sensitive sites, the legislation appears obsolete, with unclear definitions and objectives (Habitat Directive—Directive 92/43/EEC [22]). Nonetheless, in the recently published Strategic Guidelines for a sustainable and competitive EU aquaculture for the period 2021–2030, ensuring a socially acceptable aquaculture is part of the four main objectives, and it also recognizes the interrelationship between competitiveness of the sector, participation, innovation, and acceptability.

We conclude that, although there is a comprehensive EU and international legislative framework that ensures the sustainability of the sector, it alone does not ensure its acceptance by society. In fact, acceptability relies on other principles that are not directly addressed by specific legislation, for instance, trust, transparency, fairness, and inclusion (Boughen et al., 2014; Burse & Whiting, 2015; Ogier & Brooks, 2016). We propose a list of actions that all interested parties, including administrations, the industry, and research institutions should consider to overcome the many challenges facing the EU aquacultural sector in the coming years to ensure that all pillars of acceptability are considered (Table 3). In particular, we suggest that research institutions working on aquaculture should integrate human sciences to capture the complexity of this activity at a local level. It is essential to identify not only changes in the environmental conditions that may derive from aquaculture but also how such changes, actual or perceived, may affect local and consumer well-being, and thus consumer attitudes.

EU funding supporting scientific and technological improvements to the sector could be ineffective if they are not

**TABLE 3** List of possible actions to improve social acceptability of aquaculture

Actions
Strength cooperation research–industry–policy
Technology improvements accompanied by assessment on social perception
EU funding and calls for project should integrate social studies
Avoid all-size-fits-all approach in aquacultural development
Better coordination and cooperation among governing institutions at different level
Promote top–down approach and local initiatives of aquacultural development
Better compliance with existing rules and regulations
Bottom–up consultation process to assess the social carrying capacity of suitable aquacultural sites
Conceive more locally adapted forms of aquacultural development
Equitable and transparent attribution of licenses and subsidies
Build trust with local stakeholders to prevent influence from third parties

accompanied by social studies of the perception of products and production systems.

Administrations at different levels need to clarify their role and coordinate their actions to effectively support the sector while ensuring transparency, and building trust with society and coastal users. Local administrations play a key role in ensuring that the industry complies with the existing environmental legislation and must prioritize locally adapted forms of aquaculture that contribute to satisfying local needs in the first place, including food provision and jobs opportunities. Decision makers, on the other hand, must commit to sustainable aquaculture and support it by an equitable distribution of subsidies and inclusive requirements for licenses. Moreover, they should be able to recognize when some forms of aquaculture are not suitable for a particular territory. To this end, it is crucial to build a common understanding of sustainability especially at the local level where aquaculture takes place. This could be done through the development of a system of sustainability indicators through a participative approach to build trust and local consensus (see also Fezzardi et al., 2013). This would result in awareness-raising and ownership by stakeholders, a better dialogue among actors, improved perception and understanding of local priorities, and thus enhanced acceptability of the sector.

A comprehensive assessment of the benefits and impacts of aquaculture through the proposed list of criteria could avoid third-party influence on public perception based on misleading and false information. Media have a prominent role in ensuring transparency of information, avoiding

alarmism, generalization, and misconception related to out-of-date practices that are no longer used, such as the extensive use of antibiotics and pesticides.

To expand and consolidate, the industry should demonstrate that its development does not harm the environment or activities that depend on it. Such integration should not be limited to communication but rather to creating a long-term relationship with locals to ensure that the benefits it might bring are recognized and shared. To do this, action should be taken at different levels, from the single promoter to the associations, and must be adapted to the local socioeconomic context.

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## CONFLICT OF INTEREST

The authors declare no conflicts of interest.

## DATA AVAILABILITY STATEMENT

This is a review of criteria of social acceptability identified through an analysis of the literature across the globe. No new data are presented.

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