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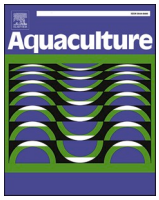

Social licence to operate: Insights from a combined citizen-stakeholder survey of fish farming in the Finnish Baltic Sea

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ABSTRACT

How aquaculture is situated in the social fabric of a nation, or a smaller geographical area, is to an important degree shaped by the citizenry's connections and acquaintances with the industry and its impacts. In Finland, marine fish farming is articulated through a strict environmental regulation apparatus whose requirements the industry seeks to meet via techno-scientific development. This setting contributes to a rather narrowly framed societal dialogue with limited connection to what constitutes the industry's social licence to operate – That is, the enduring community approval of its operations. With the aim of contributing to a broadening dialogue, we conducted simultaneous stakeholder and citizen surveys to explore experts' and coastal dwellers' perceptions of fish farming, its impacts, and the industry's future prospects. Four postures towards the fish farming industry emerged from the data, reflecting divergent views on its social licence to operate. While an important segment of the coastal population is unfamiliar with the industry, there are clear divisions and similarities between a majority that supports increasing fish farming and an important minority critical of the industry and its impacts. There is a risk that the currently techno-scientific or even legalistic nature of both the fish farming governance approach and the debate about the industry's impacts and contributions will overlook the very idea of a social licence to operate. This raises important questions about the extent to which companies and the authorities actually engage with coastal communities

1. Introduction

In recent decades, the global aquaculture industry has grown to become a business complex steered through environmental and social change. In this, the industry not only depends on formal environmental permits from the authorities but also on a 'social licence to operate' (SLO), as coined in 1997 by Jim Cooney, a Canadian expert on the mining industries' social and environmental performance (Cooney, 2017). Moffat et al. (2016) define SLO as an enduring acceptance or approval of an operation or project by local communities and stakeholders. While this informal 'licence' is not a legal requirement for the operation of industries, it is crucial for companies to achieve and maintain, as it reflects the trust, legitimacy, and consent granted by the public. SLO is therefore a demonstration of companies' ability to align their operations with stakeholders' and communities' varying norms, values, and expectations (Sinner et al., 2020), involving contextual daily operations (Prno, 2013), especially in terms of open and reciprocal relationships with local stakeholders (Leena et al., 2019; Moffat and Zhang, 2014; Boutilier and Thomson, 2011).

Various segments of the local and national populations frequently hold very different views or have distinct levels of knowledge of aquaculture, its impacts, and its role in wider food production systems (Thomas et al., 2018). In Finland, stakeholder-commissioned consumer surveys have shown that there is a high level of willingness to increase consumption of domestically produced fish as food among the population,[1] and the consumption of domestically produced farmed fish has constantly increased since the mid-2010s (Luonnonvarakeskus, 2023). Moreover, the Finnish government has expressed a consistent political will to increase supply (Finnish Government, 2014, 2019, 2022, 2023) to respond to various concerns, including the negative trade balance of

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[1] There are no published data about this, but e.g. the Pro Fish Association, a non-profit organisation whose members are organisations of the fisheries industry, professional fishermen, fish farmers, fish processors, and fishmongers, commissioned consumer surveys on Finnish fish consumption in 2013, 2016, 2019, and 2021. In these surveys, between 72 % and 80 % of Finns were willing to increase their fish consumption.

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fish products, the national self-sufficiency and security of food supply, healthier diets, and, more broadly, the invigoration of coastal livelihoods and associated industries (Finnish Government, 2014).

However, the political will to increase Finnish farmed fish[2] production (Finnish Government, 2014, 2019, 2022, 2023) often clashes with national commitments to improve the Baltic Sea's ecological status (Hyytiäinen et al., 2024; Tynkkynen, 2017), a goal that also has wide support among the citizenry (Nieminen et al., 2019). Moreover, the implementation of the strategies and commitments emanating from these potentially conflicting objectives falls within the jurisdictions of various sectoral authorities with distinct functions in fish farming decision making (Ringbom et al., 2023; Soininen et al., 2019). Competing perceptions about the legal interpretation of facts may therefore easily overshadow the dialogue on the societal goals that guide – or should guide – fish farming decision making, reflecting the views of distinct sectoral authorities (Tynkkynen, 2015; Peuhkuri, 2001).

The situation has set a dominant role for the environmental permit processes and their technical facts-based evidentiary reasoning (Soininen et al., 2023), contributing to a rather narrowly framed societal dialogue about the industry and its future prospects. This illustrates the convolution of the ends and means of maritime strategies, governance, and policy (Carter, 2018; Krause et al., 2015), hindering the quest for definitive and objective final solutions for aquaculture conflicts, leading to 'wicked' problems (see Churchman, 1967; Rittel and Webber, 1973) that cannot be solved or even successfully managed through technical, juridical, or scientific approaches alone (Ringbom et al., 2023). For long-term governance and management solutions to emerge, questions about the division of responsibilities and burdens (Fleming et al., 2023), as well as the socioeconomic and political weight of farmed fish production in relation to its environmental impacts, need to be addressed; and these questions cannot be answered purely based on science and technology (Peuhkuri, 2001).

In this article, we set out to broaden the discussion framework on the sustainability of fish farming by merging the Finnish Baltic coastal context with a set of core environmental concerns, including citizens' changing dietary habits. Recognising that there are distinctive and even conflicting perceptions of and postures towards fish farming, its impacts, and its future prospects, we conducted simultaneous stakeholder and citizen surveys to explore:

What kind of postures can be found towards fish farming?

a. What kind of knowledge and views characterise the postures?
b. What kind of personal background details are associated with the postures?

Based on the survey, we identify the similarities and differences of the distinct postures towards fish farming and aim to offer insights into what constitutes the fish farming industry's 'social licence to operate'. After the introduction, we present a description and background for Finnish fish farming on the Baltic Sea coast, followed by a methodological chapter with a description of the survey, samples, and statistical analyses. In the results section, we present four distinct postures towards fish farming, the different 'views' of fish farming that characterise the four postures, and the associated background variables. We then discuss the SLO of the fish farming industry as a general environmental discourse, as a reflection of life histories and in dietary choices, as community engagement, and as the industry's image. The paper ends with a conclusion.

[2] In Finland, the aquaculture industry concentrates on the farming of finfish, and as fish farming is the primary activity within the broader scope of Finnish aquaculture, we also use it as a synonym for aquaculture in this article.

2. Contextual background

2.1. Background

Fish farming has a long history in Finland, where the extensive coastline provides favourable conditions for producing fish. While the rainbow trout *(Oncorhynchus mykiss)* was introduced in Finland as a new food alternative as early as 1897 (Saarni et al., 2003), commercial fish farming began half-a-century later in the late 1950s. During the 1960s, experiments were initiated to raise rainbow trout in net cages, and as fish farming became industrialised, the 1970s saw annual production volumes growing from 1000 to 4500 t, with fish farming becoming a promising source of livelihood and a profitable industry (Saarni et al., 2003). In the 1980s, production grew rapidly, and Finland became one of Europe's leading producers of large salmonids. In the early 1990s, approximately 20,000 t of farmed rainbow trout were produced annually (Saarni et al., 2003).

Finland's accession to global markets and stricter environmental regulation, both mainly resulting from Finland joining the European Union (EU) in 1995 (Setälä et al., 2018; Saarni et al., 2003), were the first major challenge to the industry and resulted in production declining to about 17,000 t in 1995, and yet further to its lowest in 2011, at approximately 11,000 t (Kankainen et al., 2023). In 2020, approximately 12,000 t of rainbow trout were produced in marine facilities, predominantly located in the inner archipelago (Fig. 1), on average about 6 km from the mainland but often near island shoreline, in depths between 5 and 20 m. The facilities mostly produce less than 100 t of fish annually, but the largest ones produce up to 1000 t (unpublished). Just over 3000 t were produced in inland waters. The value of domestic farmed fish food is approximately €50–70 million annually. More than 90 % of domestic production is rainbow trout, in addition to some European whitefish and small quantities of Arctic char, pikeperch, brown trout, and sturgeon (Setälä et al., 2019).

When the first fish farms were established, few locals expected that a new industry, creating jobs and boosting the local economy, could pose a threat to marine environments. Over the last 50 years, what began in the late 1970s as summer residents' criticism of unwelcome changes in water environments and researchers' observations of eutrophication has evolved into the fish farming industry's greatest challenge – the (lack of) public approval haunting environmental permitting policy (Peuhkuri, 2001).

2.2. Impacts of fish farming

Fish farming involves environmental impacts that are at the core of the industry's SLO processes. While Finnish fish farms have also become the subject of broader debates on the sustainability of coastal food production and use of maritime space (Sandell, 2022), the main concern in practice has always been their contribution to the eutrophication of the Baltic Sea's coastal waters (Saikku and Asmala, 2010). This phenomenon is driven by elevated nutrient levels that can lead to harmful algal blooms, oxygen depletion, and other negative effects on aquatic ecosystems (Murray et al., 2019; Bonsdorff et al., 1997). In the case of fish farms, the primary source of the nutrients delivered to the aquatic environment is fish feed: The metabolic waste products and, under very specific conditions, uneaten feed that are released into the environment convert fish farming facilities into a series of point sources of phosphorus and nitrogen in coastal waters (Soininen et al., 2019; Helminen and Honkanen, 2002).

Over the decades, the industry has improved its environmental performance through significant technological development – for example, through the use of low-discharge fish feeds (Dalsgaard et al., 2023; Vielma et al., 2000), selective fish breeding (Kause et al., 2022), spatial location management of fish farms (e.g. Setälä et al., 2018) and expanding production in recirculating aquaculture systems (RAS) capable of reducing nutrient discharges (Kujala et al., 2020). The levels

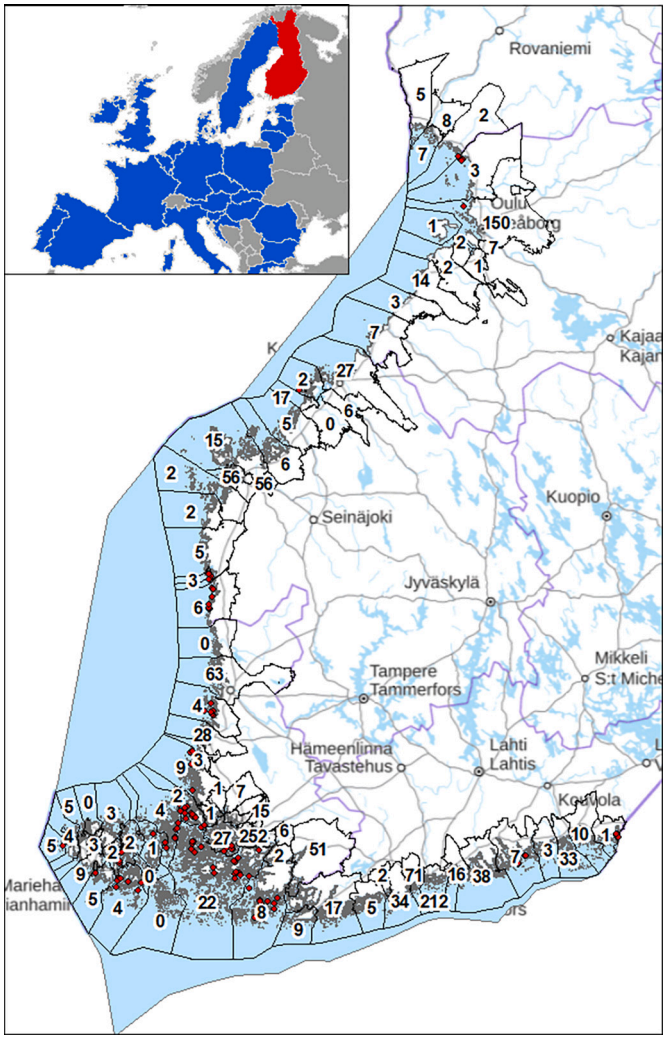

Fig. 1. The Baltic Sea coast of Finland and the Åland Islands. The numbers represent the sample size in each of the coastal municipalities (the sum 1477 is less than the total sample size of 1510 because some respondents resided in inland municipalities). The red dots depict the location of coastal fish farming facilities in 2020. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

of phosphorus and nitrogen in feeds have been reduced to meet the minimum requirements of fish of different sizes (Dalsgaard et al., 2023). Another discussion in Finland is the use of the 'Baltic Sea feed', a feed that is partly made of herring and sprat harvested in the Baltic Sea. The net overall effect of this nutrient recycling and at different spatial scales remains the subject of debate, however. The difficulty lies in the interpretation of net ecological effects, considering all the relevant factors, including where fish forage, and fishing occurs, and whether the feed industry's demand actually increases the catch of herring and sprat, or merely allocates part of the catch to feed that is then reintroduced to the Baltic Sea (Setälä et al., 2018).

The Finnish nutrient input from fish farming to the Baltic Sea is currently about 1 to 2 % of the total nutrient input from the national territory (Fleming et al., 2023). However, a conflict remains, reflecting not only present socioecological trade-offs (Soininen et al., 2019) but also past legacies, including the image of fish farming as a polluting industry, based on its undeniable historical record (Salmi et al., 2004; Peuhkuri, 2002; Bonsdorff et al., 1997).

2.3. Policy context

The aquaculture industry is immersed in a series of societal debates related to apparent trade-offs between different food-producing livelihoods, environmental protection, and the use of marine space (Belton et al., 2020). Nevertheless, farmed fish production remains globally hailed as one of the most promising branches of food production in the face of climate change (MacLeod et al., 2020; Silvenius et al., 2022) and biodiversity decline (Costello et al., 2020). Fish consumption is also generally recommended as a healthy dietary choice, particularly because of the Omega-3 fatty acids fish contains (Pieniak et al., 2010), contributing to a decreased burden of diseases in society (e.g. cardiovascular disease, see Ronto et al., 2018). The Finnish Institute for Health and Welfare (2022) recommends that Finns should eat 300–450 g of fish a week (2–3 meals) and the Finnish Food Authority's (n.d.) recommendation is similar, at least 300 g (2 meals). However, Finns consumed over 4.5 kg of domestic fish and over 8.5 kg of imported fish per person in 2020 (Luonnonvarakeskus, 2023), meaning only about 250 g (1.5 meals) per week. The most important domestic species in terms of consumption was farmed rainbow trout (1.4 k per person), while up to 3.4 k of imported farmed salmon was consumed per person.

The European Blue Growth Strategy (European Commission, 2017) strongly supports the growth of marine and maritime activities, including aquaculture and fisheries. The Finnish fish farming industry's primary focus is on coastal and offshore fish production, and in terms of public policy, the strategic goal of expanding Finnish marine fish farming responds to various concerns, including the negative trade balance of fish products, the national self-sufficiency and security of food supply, and, more broadly, the invigoration of coastal livelihoods and associated industries (Finnish Government, 2014). Reflecting the Blue Growth principles, the Finnish National Aquaculture Strategy also proposes to expand fish farming in mainland Finland through 'sustainable growth', aiming to increase production even fivefold by 2035 (Finnish Government, 2021, 2022).[3] However, the expressed political will to increase fish consumption and farmed fish production (Finnish Government, 2021) leaves unanswered the questions about how much, through which means, and where this fish should be farmed – all important aspects for establishing the SLO for Finnish fish farms.

Receiving an environmental permit for new or existing fish farming operations is a complex process in Finland. Central to the process are the necessary permits granted by the Regional State Administrative Agency in accordance with the Environmental Protection Act and the Water Act. It may also require an Environmental Impact Assessment (EIAs), which helps further ensure that any significant environmental effects are identified and mitigated. The process is time-consuming and expensive, which is why many fish farming companies may prefer to avoid the EIA, although it may be crucial in helping Finland balance its goal of expanding fish farming with its strong commitment to environmental protection and engaging public participation in the process. The Centre for Economic Development, Transport and the Environment (ELY) decides whether an EIA is required based on the scale and location of the project. For larger farms (1000 t), EIAs are mandatory. The EIA evaluates the potential environmental impacts, including water quality degradation, the impact on local wildlife and fish populations, effects on local communities, heritage, and noise and visual consequences.

After receving the environmental permit, the ELY Centre is responsible for monitoring a fish farm's environmental permit granted by the Regional State Administrative Agency. The municipal environmental protection authority acts as a local supervisor and reports any breaches. The Centre for Economic Development, Transport and the Environment

[3] This excludes the self-governing province of the Åland Islands, which has some environmental and livelihood-related legislation of its own. In this article, we mainly focus on fish farming in mainland Finland, although the survey also includes data from Åland.

must notify the authority of deficiencies for possible measures. Monitoring is aided by annual reports and emission and impact monitoring reports (Environmental Protection Act, 527/2014).

In Finland, fish farming is governed by a combination of national laws and European Union regulations. Key national legislation includes the Environmental Protection Act (527/2014), which requires permits for aquaculture operations to minimise their environmental impact, especially on water quality, and the Water Act (587/2011), which regulates water use. At the European level, the Water Framework Directive (WFD) sets ecological and chemical water quality standards that aim to achieve a 'good status' for all European coastal waters by 2027 (European Commission, 2014). Fish farming must adhere to these standards to reduce pollution and protect aquatic ecosystems. Moreover, the Marine Strategy Framework Directive (MSFD) further regulates activities in marine environments, including aquaculture in coastal and offshore areas, having similar goals to the WFD (European Commission, 2008). The combined Finnish and European environmental commitments entail a series of regulatory limitations to the installation of new fish farming facilities. The European Court of Justice has added another layer of complexity to the legal regulation with the so-called Weser case (Paloniitty, 2016), concerning how the WFD's environmental objectives are to be interpreted and applied in the environmental permit processes (Belinskij, 2022; Soininen et al., 2019).

Long-standing tensions and conflicts remain between the fish farming industry and other stakeholders with a critical stance towards its impacts on Baltic ecosystems and the socially important sea- and leisure-scapes of the Finnish Baltic Sea coastline (Svels and Åkerlund, 2018). This is similar to other aquaculture conflicts in Europe and elsewhere, where complex sets of claims and social purposes become central, increasing interest in aquaculture while raising operators' and public industries' SLO perspectives (Olsen et al., 2024; Olsen et al., 2023; Alexander, 2022; Chávez et al., 2019; Flaherty et al., 2019; Ertör and Ortega-Cerdà, 2015).

3. Materials and methods

3.1. Surveyed population and samples

The survey aimed to capture opinions about and distinct postures towards fish farming among the population living in the Finnish coastal areas of the Baltic Sea and on the Åland Islands, where marine fish farms have been or are present. The study was a combined citizen and stakeholder survey conducted in early 2021, and the data were collected by the market research company Taloustutkimus Oy, although it was initialised and planned by the authors. Our main interest was in identifying distinctive ways of thinking (shared response patterns based on many questions) among citizens and stakeholders rather than individual respondents' responses to specific questions.

A total of 1650 citizens and stakeholders were surveyed in the twofold study, including a citizen survey for residents of coastal and archipelago municipalities (n = 1510) and a stakeholder survey for authorities, experts, and others related to the field of fish farming (n = 140). The citizen survey consisted of two survey samples: an online panel; and a 'push-to-web' survey. The online panel survey was addressed to Finnish-speaking Taloustutkimus online panellists residing in Finnish coastal municipalities (see the map in Fig. 1). Respondents in the 'push-to-web' survey were selected from the Finnish Population Information System to represent the Swedish-speaking residents in coastal municipalities, the residents of the Åland Islands, and second-home owners in coastal municipalities. This was to help reveal any additional views on the topic by these specific groups. The overall sample is therefore not fully representative of the study area's population. All respondents were between 18 and 79 years of age. A total of 1207 (80 %) respondents were Finnish speakers, and 303 (20 %) were Swedish speakers. Of the respondents, 712 (47 %) were female, and 798 (53 %) male. The stakeholder survey sample was compiled of fisheries sector authority representatives and experts (n = 140), as presented in more detail in Table 2.

The questionnaire was the same for citizens and stakeholders, with the exception of several additional expert questions for stakeholders. The response time was approximately 20 min. In both the online and 'push-to-web' surveys, respondents received a letter containing guidance on how to respond, an internet link, and a QR code for the form, with a unique login code. Stakeholder respondents were contacted directly via email. The responses were stored on the Taloustutkimus server during the collection phase and then analysed by the authors. The survey questionnaire included the 35 main claims (Annex 1) and eight (8) background questions (Annex 2), including questions about personal history and diets, addressed to all respondents. Of the 35 claims, a total of 14 claims were general in scope, while the remaining 21 were specifically about fish farming.

3.2. Statistical analyses

Clusters (groups) of surveyed respondents were identified using a self-organising map (SOM, Kohonen, 1982, 2001). In general, SOM is a dimensionality reduction method for grouping, profiling, and visualising high-dimensional data. For example, previous studies have evaluated questionnaire and survey data using SOM in food safety (Trafialek et al., 2015), social wellbeing (Lagus et al., 2013), health services (Garavaglia, 2000), and clinical treatments and hospitalisation (Martin Guerrero et al., 2012; Voutilainen et al., 2014).

In this study, SOM was used to patternise responses to 35 claims by 1510 citizen survey respondents (samples) with a two-dimensional map, which were then clustered. This two-stage procedure, first using SOM to reduce dimensions to two that are then clustered – for example, using the k-means algorithm in the second stage (Kohonen, 2014), has been found to perform well compared with direct clustering of the data (Vesanto and Alhoniemi, 2000). The map size (the number of nodes in the x and y dimensions) and the number of clusters were evaluated using the Davies Bouldin (DB) validity index (Davies and Bouldin, 1979) as a performance criterion. In parameter optimisation, a grid search was used until the minimum of the DB index was found, using the elbow criterion. The SOM map size was restricted to roughly follow the map size rule (of thumb) of Vesanto and Alhoniemi (2000); N(nodes) = 5 x sqrt (Nrows). In the pre-processing phase, the responses were normalised with a zeroed mean and a variance of one. The learning rate function was the inverse of time, which guarantees that all samples have a roughly equal influence on the results. After training the SOM using citizen responses, the same model was applied to cluster stakeholders according to their responses to the same 35 claims. Analyses were performed using RapidMiner software (version Studio Enterprise 10.0.000., https://rapidminer.com).

4. Results

4.1. Four postures towards fish farming

The clustering of respondents was made using only the citizen survey responses to the 35 claims. This revealed four clusters (groups) of citizens with distinct postures towards fish farming on the Finnish Baltic Sea coast. There were three clusters whose respondents tended to support the establishment of more fish farms, most notably the *Expanders* (Cluster 3) and *Pragmatists* clusters (Cluster 0), and to a somewhat lesser degree the *Unfamilars* (Cluster 1). The *Reducers* cluster (Cluster 2), meanwhile, tended to support the view that there should be less fish farming in the future. Below, we describe the typical characteristics of the responses in the four clusters (Fig. 2).

Expanders tended to support the idea of more fish farming at all geographical levels (national, home region, and home municipality), with a notably decreasing trend from national to home municipality level. Their concern about the sustainability of natural resource use in

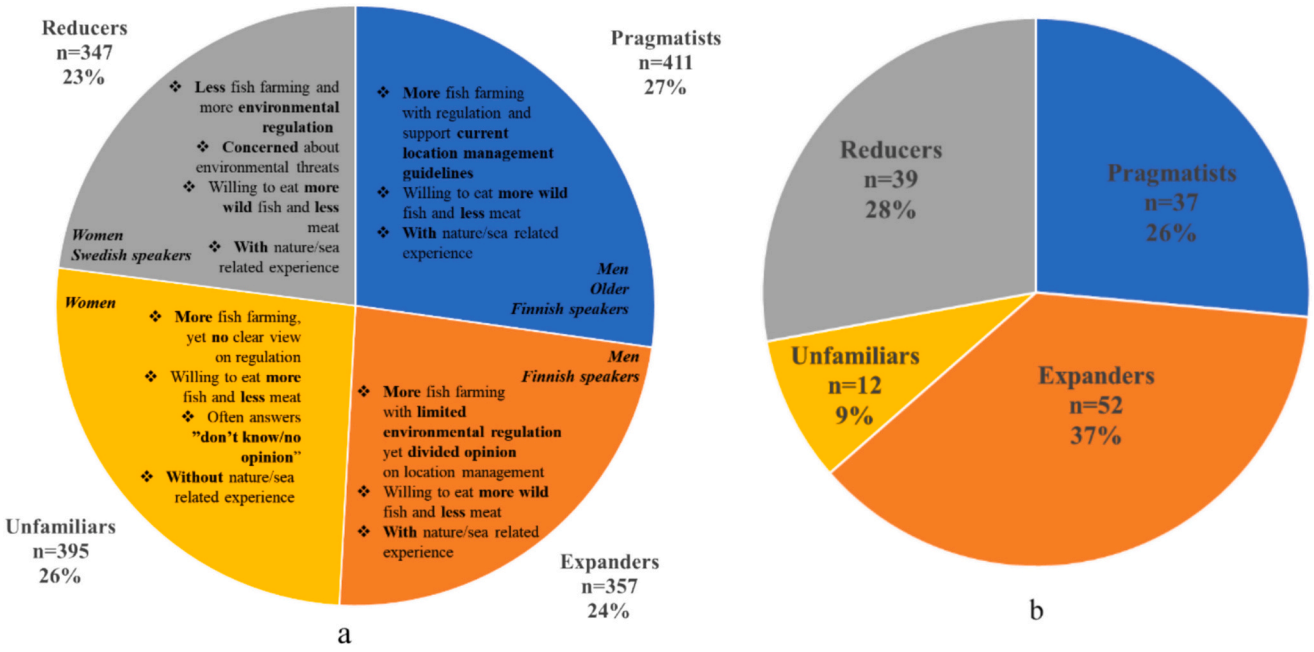

Fig. 2. Four clusters. (a) The main characteristics of the clusters, and the distribution of citizen respondents in the clusters. (b) The distribution of the stakeholder respondents in the clusters.

Finland and the state of Finnish nature was less conspicuous than the *Pragmatists* and *Reducers*. *Expanders* saw fish farming as a locally important employer and a desirable way to replace fish imports and supply stable or increasing domestic fish consumption. They did not see fish farming as negatively affecting the leisure potential of the coastal and archipelago areas or to decrease the value of second homes. They did not support making the environmental regulation of fish farming stricter, and their views about the preferable ways to locate fish farming facilities and assess their environmental impacts varied more than those in the *Pragmatists* cluster.

Pragmatists tended to support the expansion of fish farming at all geographical levels, but the strength of this willingness decreased from national to home municipality level. *Pragmatists* generally saw fish farming as a locally important employer and as a desirable way to replace fish imports, but they also expressed a stronger concern about the sustainability of natural resource use in Finland and about the current state and the future of the Baltic Sea and its waters. While *Pragmatists* were unwilling to allow any food producing sector to increase its nutrient load to the Baltic Sea, they saw the expansion of fish farming as possible through efficient regulation and following the guidelines of the location management currently applied.

Unfamiliars did not have strong opinions about fish farming, and/or they knew little about it. Nevertheless, they were also supportive of the expansion of fish farming at all levels from national to local, with only a slightly decreasing tendency of willingness towards the home municipality level. Yet this support was weaker than in the case of the *Pragmatists* and *Expanders*. *Unfamiliars* tended to think that no food producing sector should be allowed to increase its nutrient load to the Baltic Sea, but these respondents did not express clear preferences between different location management or impact assessment options for fish farms but instead had no opinion at all.

Reducers tended to prefer less fish farming at all geographical levels from national to home region and home municipality, and this tendency was similar across all three levels. *Reducers* showed a clear concern about the sustainability of natural resource use in Finland, and in particular, about the state of the Baltic Sea. They also tended to think that fish farming had a negative impact on coastal second-home value and on the leisure-time potential of coastal areas in general. *Reducers* supported tighter regulation of fish farming, and they did not consider fish farming a desirable way to replace fish imports.

As Fig. 2 shows, each cluster represented about a quarter of citizen survey respondents, but stakeholder respondents were notably less frequently *Unfamiliars*, and significantly more frequently *Expanders* than citizen respondents. The *Reducers* cluster was also more frequently represented by stakeholder than citizen respondents. Table 1 presents the types of engagement of stakeholder respondents per cluster.

Below, we present a detailed analysis of the four clusters, revealing distinct postures towards the Finnish fish farming industry and its socioenvironmental context. We present the results based on specific sets of claims in the survey questionnaire (Annex 1). These sets included, first, general environmental claims and second, specifically fish farming-related claims. Below, we present the citizen survey results first, and then the stakeholder survey results in those aspects in which they notably diverge from the citizen survey results.

4.1.1. The postures' general views on the environment

4.1.1.1. Citizen survey. This set included 14 claims that intended to shed light on respondents' general views on the environment (Annexes 3 and 6). These claims were relatively easy to answer for most citizen respondents, with an 'I do not know' response rate of 8 %. For the four clusters separately, only 4 % of *Pragmatists'* responses were 'I do not know', and this rate was almost equally low for both *Expanders* (5 %) and *Reducers* (7 %). In contrast, the *Unfamiliars'* 'I do not know' response rate was 16 %.

In the citizen survey, *Reducers* and *Expanders* differed in how they perceived the sustainability of the current use of natural resources in Finland. *Reducers* were divided between those who had no opinion, and those that at least partly agreed with the claim that the use of nature was currently unsustainable, whereas *Expanders* were divided between those with no opinion and those partly disagreeing with this claim, on average neither agreeing nor disagreeing (Annex 3: C1_1). This was also the case about the claim regarding human impacts on the resilience of nature (C1_4). Concerning these two claims, *Pragmatists* and the *Unfamiliars* were also inclined to view natural resource use as unsustainable and adversely impacting nature's resilience, contrasting with *Expander's* views.

Table 1
Number of stakeholder respondents per cluster and type of engagement. CEDTEs are the Centres for Economic Development, Transport and the Environment.

	Expanders	Pragmatists	Reducers	Unfamiliars	Total
Research organisations	17	11	9	2	**39**
CEDTEs	7	3	7	3	**20**
Municipal councils	6	6	2	3	**17**
Municipal administrations	4	3	6	2	**15**
Non-governmental organisations	3	5	4	0	**12**
Regional administrations	3	3	3	1	**10**
Other	4	1	4	1	**10**
Advocacy organisations	4	1	0	0	**5**
Ministries	1	1	2	0	**4**
Spatial planning	0	2	0	0	**2**
Regional state administrative agencies	1	1	0	0	**2**
Multiple	1	0	1	0	**2**
Entrepreneurs	1	0	1	0	**2**
Total	**52**	**37**	**39**	**12**	**140**

All the clusters of citizen respondents, including the clusters that held the most positive views about the expansion of fish farming, tended to agree at least to some degree with the claim that no field of food production ought to increase its eutrophicating nutrient discharge to the Baltic Sea from the current levels (Annex 3: C3_3). This may reflect the responses to the claim about the current state of the eutrophication process: most respondents in the *Pragmatists*, *Reducers*, and *Unfamiliars* clusters disagreed at least to some degree with the claim that the worst had been already left behind (C3_5); only *Expanders* were somewhat more optimistic about this development.

Concerning possible approaches to improved sustainability, *Expanders* more frequently supported voluntary action by consumers and companies, whereas *Reducers* believed more in tightening environmental legislation (C1_6). It was noteworthy that all clusters tended to agree relatively strongly with the claim that the present state of nature in Finland in general did not negatively affect their preferred forms of nature-related recreation activities (C1_2).

4.1.1.2. Stakeholder survey. There were some notable ways in which stakeholder respondents differed from those of citizen respondents. In particular, stakeholder *Reducers* had less trust in the effectiveness of legislation in protecting the environment (C3_1) than the other stakeholder clusters and were particularly less willing to allow any food producing sector to increase its nutrient discharge from the current level (C3_3). They also predominantly believed that the worst was yet to come in eutrophication development (C3_5). Stakeholders in the *Reducers* cluster also agreed least with the claim that technological development would ultimately solve the sustainability problems at hand (C1_5).

Stakeholder *Reducers* and to a lesser degree *Pragmatists* were less willing to refrain from nature conservation to keep supplying resources domestically (C1_3), and *Reducers* clearly supported regulation compared to voluntary action by consumers and companies, which was strongly supported by *Expanders* (C1_6).

4.1.2. The postures' specific views about fish farming

4.1.2.1. Citizen survey. Compared to the above general claims, citizen respondents found this set of 18 claims about fish farming more difficult to answer (Annexes 3, 5, and 7). The overall 'I do not know' response rates were 27 %, and in particular, *Unfamiliars* presented no opinion on 45 % of claims. For *Reducers*, the 'I do not know' response rate was 24 %, for *Expanders*, 13 %, and for *Pragmatists* 12 %. There was a tendency among citizen *Reducers* to support stricter environmental regulation to govern fish farming (C2_6), while the opposite was the case for *Expanders*. *Pragmatists* and *Unfamiliars* were in between. A possible solution, allocating new facilities in the open sea (C2_9), was at least slightly supported by all clusters, and in particular, by *Pragmatists*. The RAS approach was also supported by all clusters (C5_8).

Claims C4_1–4 had a different scale of response, seen as clearer differences between citizen respondent clusters. The first three claims were about the desirable locations of fish farming facilities in relation to surface water currents, sea openness, and the state of eutrophication. The *Pragmatists* cluster had clear views on all these claims: they strongly supported locating fish farming in open water areas characterised by strong surface currents and a low level of eutrophication. Whereas responses in the *Reducers* and *Expanders* clusters were divided between the alternatives to these three claims, the typical response in the *Unfamiliars* cluster was 'I do not know'. Responses to the fourth claim, which was about a preferred approach to monitoring of impacts, revealed a similar pattern, as respondents in the *Pragmatists* cluster typically preferred the modelling of impacts at wider geographical scales, while in the *Reducers* and *Expanders* clusters, the response was more divided. The *Reducers* cluster was slightly inclined towards modelling, and the *Expanders* cluster towards actual monitoring of impacts in the vicinity of fish farms. Again, *Unfamiliars* typically responded 'I do not know'.

As a clear tendency, citizen *Reducers* saw that fish farming had a negative impact on the value of second homes (C2_8) and on coastal areas as sites of recreation (C2_5), while respondents in the *Expanders* cluster did not see the situation in this way. Respondents in the *Pragmatists* and *Expanders* clusters tended to agree with the claim about the desirability of imports substitution through expansion of domestic fish farming (C2_7), while respondents in the other two clusters were uncertain about this claim *(Unfamiliars)* or disagreed *(Reducers)* with it.

When asked directly to express their willingness to either increase fish farming from the present level, decrease it, or maintain it as it was, citizen respondents in the four clusters had somewhat different views on the desirability of fish farming in future (Fig. 3; Table 2). This question was the last in the questionnaire, and it was responded to separately at three different geographical levels: the Finnish Baltic coast; the respondent's home region; and the respondent's home municipality. The great majority of *Expanders* and *Pragmatists* expressed an opinion on these claims (the 'I do not know' response rates were only 9 % and 11 % respectively), while *Reducers* (22 %) and *Unfamiliars* (43 %) more frequently expressed no opinion. *Expanders* expressed the strongest willingness to increase fish farming at all levels, and *Pragmatists* tended to clearly support increasing fish farming. *Unfamiliars* also appeared more supportive than restrictive regarding the expansion of fish farming, but the tendency was weaker than in the two above clusters. *Reducers* was the only cluster whose respondents clearly expressed a willingness to decrease fish farming from the current situation. This willingness was similar at all geographical levels.

4.1.2.2. Stakeholder survey. Among stakeholder respondents, *Pragmatists* in particular, *Expanders* slightly less, had clearly defined views on suitable location management. *Pragmatists* would locate fish farms in open (C4_2) and clear (C4_3) water areas with strong surface currents (C4_1) and would prefer to evaluate farms' environmental impacts by modelling (C4_4). *Expanders*' views were similar, though with slightly

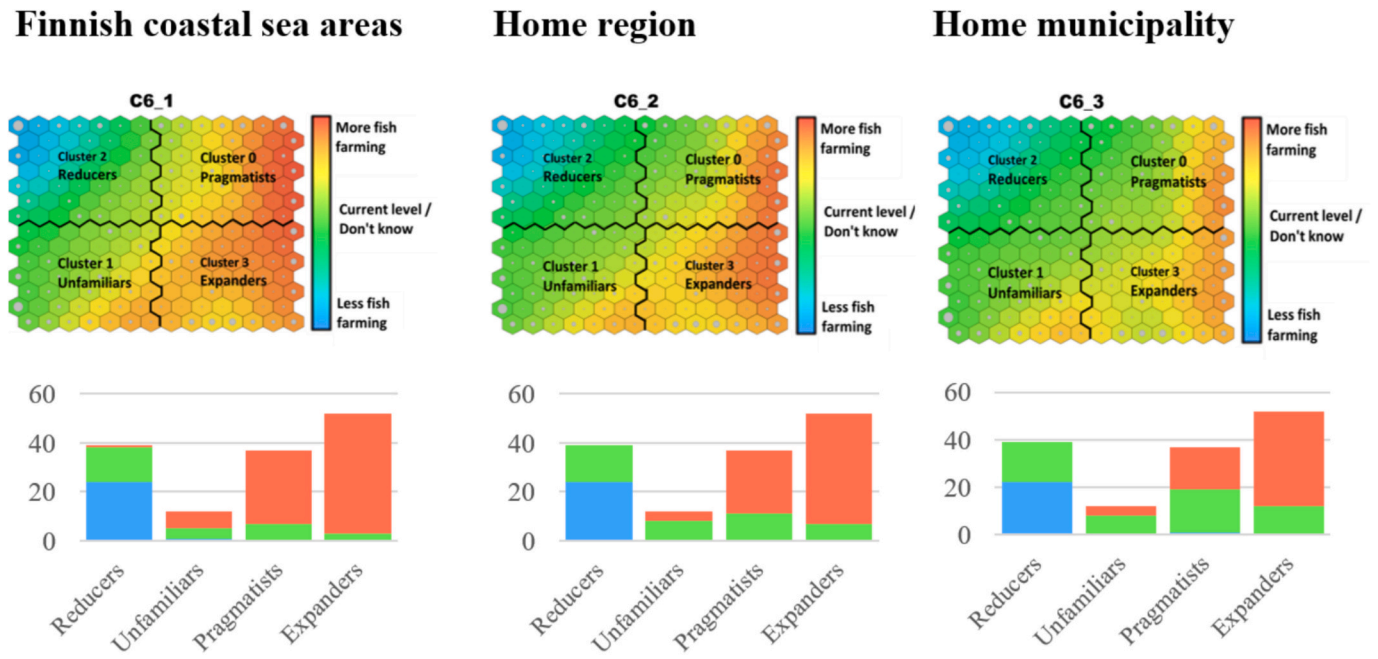

Fig. 3. SOM presentation of citizen respondents' and bar chart of stakeholders' views on the desirability of new fish farms on the Finnish Baltic coast (left), in their home regions (centre), and in their home municipalities (right). The scale from blue through green, yellow and red depicts a shift from views that see new fish farms as undesirable (blue) to desirable (red). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 2
Per cluster average of citizen survey responses per claim and the rate (%) of 'I do not know (IDNK)' responses over the set of three direct claims about the future of fish farming.

Cluster	Expanders	Pragmatists	Reducers	Unfamiliars	All
C6_1	2.72	2.62	1.62	2.24	2.31
C6_2	2.68	2.42	1.57	2.21	2.23
C6_3	2.53	2.33	1.56	2.18	2.16
IDNK%	9 %	11 %	22 %	43 %	21 %

more variation. *Reducers*, and particularly *Unfamiliars*, responded more often that they did not know – or perhaps in the case of the former, did not want to choose between options they found similarly undesirable. Stakeholder respondents in the *Reducers* cluster strongly supported stricter regulation (C2_6) and did not see fish farming as a desirable way to replace fish imports (C2_7).

In this set of claims, five additional claims addressed only stakeholder respondents (Annex 4). These claims were more technical in nature, addressing the environmental impacts of fish farming and associated governance and management alternatives. In particular, stakeholder *Expanders* saw that the nutrient discharge from fish farms was seen more negatively in decision making than that from other sectors (C2_12). *Expanders* were also the most positive about nutrient recycling (C2_10) and compensations (C2_14) as a means to achieve reduced net discharge. They were also the most reluctant to limit fish farming in waterbodies whose ecological status is not good or excellent (C2_11), and the most willing to introduce waterbody level discharge thresholds (C2_11).

Stakeholder respondents in the *Reducers* cluster were particularly more worried about the possible negative effects of fish farming on coastal recreation and second homes than *Expanders* (C2_5 and C2_8). They did not see fish farming as a desirable way to replace fish imports (C2_7).

In the case of the questions about the willingness to increase or decrease farmed fish production, the responses among stakeholder clusters were similar to those in the citizen survey, with *Pragmatists*, and particularly *Expanders*, supporting more fish farming in future across all geographical levels, but with a clearly decreasing tendency of support from the home region to the home municipality level. Stakeholder *Reducers* would either decrease fish farming or leave it as it currently was. In Annex 3, we present all the figures, and in Annexes 6 and 7 all the tables of the analysis.

4.2. *Background variables associated with the four postures*

While the four clusters were identified based on only the 35 claims (Annex 1), several background questions and variables were not part of the clustering analysis (Annex 2). These included questions about age, gender, language, life history, and diets. The results below concern both citizen and stakeholder respondents.

It is noteworthy that respondents in the *Pragmatists* and *Reducers* clusters differed in relation to age, gender, and response language (Fig. 4). In particular, the incidence of *Pragmatists* tended to be higher in older than younger generations, while the other clusters' distribution was more constant across different ages. Furthermore, the incidence of *Pragmatists* and *Expanders* was slightly higher among men, and Finnish-speaking respondents than among women and Swedish-speaking respondents. In particular, the *Reducers* cluster had a high incidence among women and Swedish-speaking respondents.

Whether respondents lived in population centres (urban or rural) or in the sparsely populated countryside was not clearly associated with their postures towards fish farming (Fig. 5). However, the presence of fish farming in respondents' municipality of residence[4] was associated with an increased incidence of *Expanders* and a decreased incidence of *Reducers*.

Respondents' life histories (childhood memories and experiences of coastal areas, nature-related leisure activities, and the ownership of or access to coastal second homes) were also associated with their views on fish farming (Fig. 6). In relation to the other clusters, *Unfamiliars* reported having important childhood memories and experiences of the

[4] The information about the presence of fish farming in the different municipalities was retrieved from the YLVA environmental protection information facility for 2020.

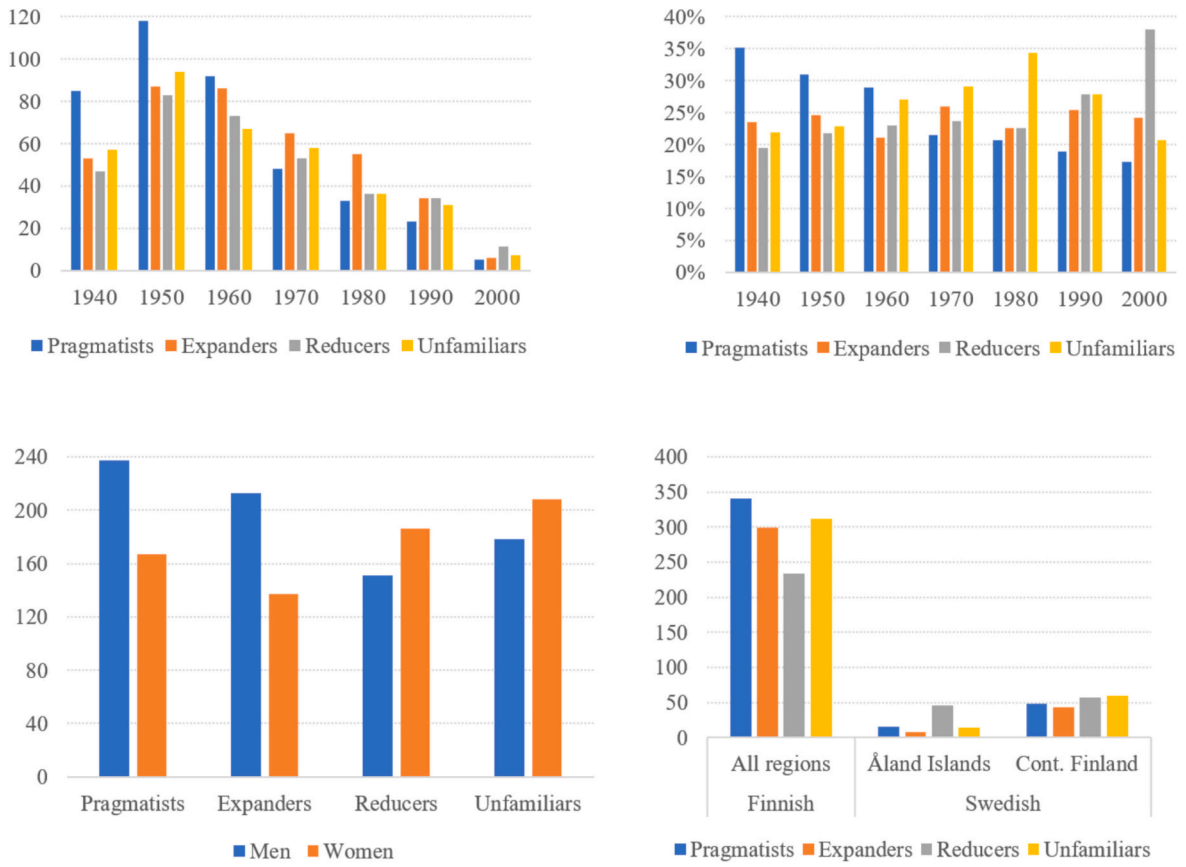

Fig. 4. The distribution of respondents in the four clusters based on age (% and n per decade of birth), gender (men 53 % / women 47 %), and response language (Finnish 80 % / Swedish 20 %).

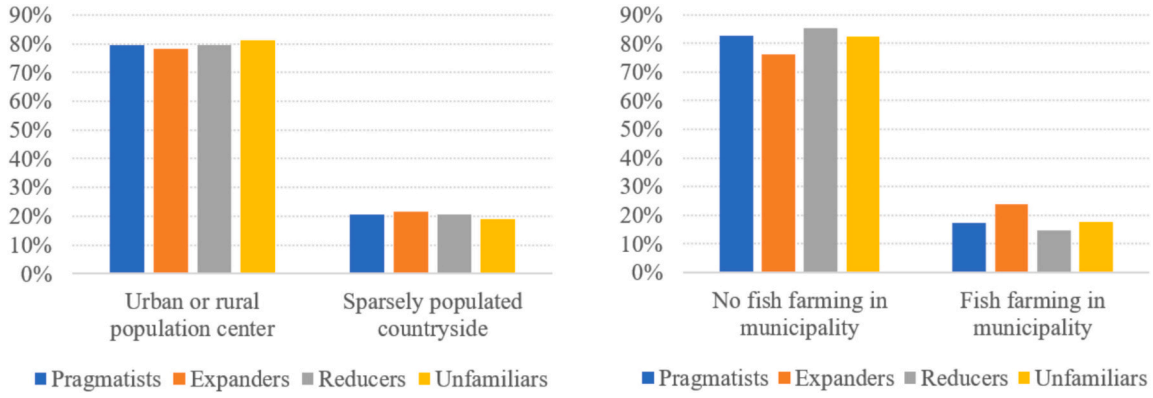

Fig. 5. The distribution of respondents in the four clusters based on their residence (urban or rural population centre 80 % / Sparsely populated countryside 20 %) and incidence of fish farming in the home municipality (no fish farming 82 %; fish farming 18 %).

sea, coast, or archipelago significantly less (more commonly responded 'no' than 'yes'), whereas respondents in the other clusters most commonly reported having these experiences or memories. The same pattern was observed regarding nature-related leisure-time activities, which only about half of *Unfamiliars* reported having, while their incidence in other clusters was much higher. The incidence of second homes was lowest in the case of *Unfamiliars* and highest among *Pragmatists* and *Reducers*. Overall, while about 80 % of respondents reported having at least one of the above life-history items, *Unfamiliars* was the cluster with significantly more respondents lacking all three items.

Respondents' dietary views were also associated with their views on fish farming – that is, the specific clusters to which they belonged – and the willingness to change diets was associated with specific clusters (Fig. 7). While respondents in all clusters were at least somewhat willing to *decrease* their consumption of red meat from domestic animals (beef and pork) and dairy products, all clusters were also willing to *increase* their consumption of fish. Willingness to increase fish consumption was generally lower, though also positive, among *Reducers*, which was also the only cluster whose respondents expressed a willingness to decrease the consumption of Finnish farmed fish. Indeed, they were willing to decrease the consumption of all types of proteins from domestic animals but increase the consumption of game meat and (wild) fish.

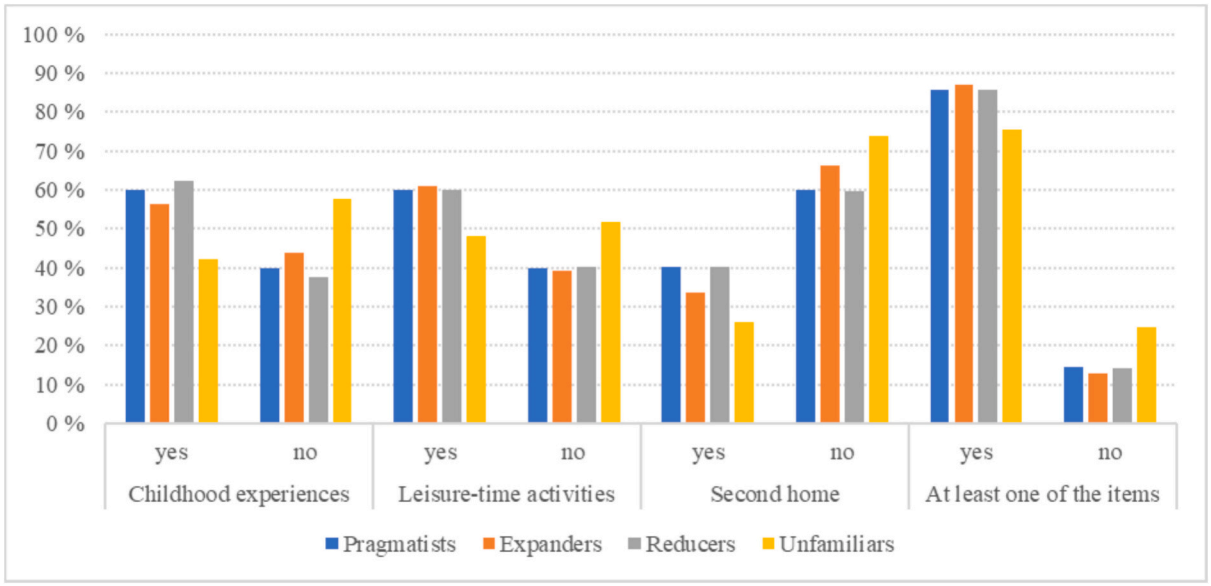

Fig. 6. The distribution of respondents in the four clusters based on life-history items (childhood experiences 55 % / no experiences 45 %; leisure-time activities 57 % / no leisure-time activities 43 %; second home 35 % / no second home 65 %; at least one of the above 83 % / none of the above 17 %).

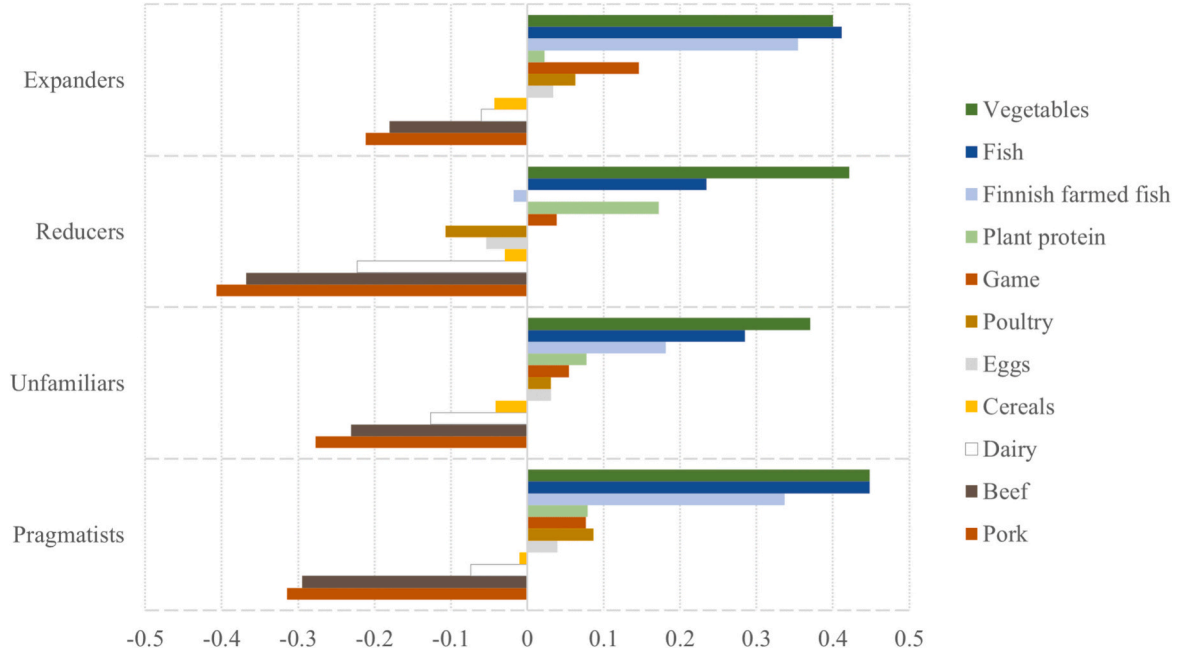

Fig. 7. Willingness to change diets. The column length depicts the cluster's respondents' average willingness to decrease (below zero) or increase (above zero) the consumption of meat, fish, milk and eggs. The responses: start eating, will eat more = 1; will eat less, will stop eating = −1; no change = 0. The further from zero the column reaches either up or down means stronger average willingness to change diet accordingly.

5. Discussion

5.1. Social licence to operate

The concept of a *social licence to operate* (SLO) has become increasingly central in the aquaculture industry as the sector continues to expand to meet global demand for seafood in the context of growing sustainability claims (European Commission, 2017). Unlike the formal environmental permits needed for aquaculture operations, SLO represents a continuous and open-ended process of approval and acceptance granted by local communities, stakeholders, and the broader public (Whitmore et al., 2025; Cooney, 2017; Moffat et al., 2016). In the context of aquaculture, achieving and maintaining SLO requires companies to align their practices with the diverse and often shifting norms, values, and expectations of the communities with which they engage, and which they affect.

Our results highlight four themes linked to Finnish fish farming companies' SLO. Below, we examine how SLO can be discussed, first, as a general environmental discourse, second, as a reflection of life histories and dietary choices, third, as community engagement, and fourth, as the fish farming industry's image. In relation to these themes, there were different views and significant knowledge gaps among segments of the population. In particular, this was the case in the claims specifically about fish farming. In our samples, citizen and stakeholder respondents

also differed in their views, the latter quite expectedly, with higher certainty about their views. Stakeholders' better familiarity with the topic, however, did not fade out some of the controversies, as seen below.

5.2. SLO as a general environmental discourse

Public opinion and stakeholder views reflect the complex socio-ecological realities of the aquaculture industry, from local to national level and beyond. Perceptions of the impacts of fish farming and the associated views on its desirability and future prospects have been studied in many contexts. The industry's perceived environmental impacts form a critical factor affecting public opinion on fish farming (Aanesen et al., 2023; Olsen et al., 2023), and there are often important differences in the views that are dominant among the general public on one hand and among specific stakeholder clusters and the media on the other (Whitmarsh and Palmieri, 2009; Olsen, 2022).

In our citizen survey, respondents in the different clusters had relatively similar views about the *state of the environment*. On one hand, the largest differences were between *Expanders*, who were less worried about human impacts on nature in general and believed that the ecological state of the Finnish coastal waters was improving, and on the other hand, *Reducers*, who believed that humans negatively impacted nature and its resilience, and that the state of the Finnish coastal waters was continuing to deteriorate. The views of *Pragmatists* and *Unfamiliars* were mainly between these positions.

Respondents in the *Expanders* and *Pragmatists* clusters tended to represent views favourable to the expansion of fish farming, either associated with less *environmental concern* or with more emphasis on *better regulation*. *Reducers* were more concerned about the state of the environment, and they tended to support the contraction of the industry, whereas *Unfamiliars* were less certain, although their views were positive rather than negative regarding the increase of fish farming. All clusters represented a view that no food-producing sector should increase its nutrient discharge level, and while this tendency was strongest among *Reducers*, followed by *Pragmatists*, also *Unfamiliars* and *Expanders* at least somewhat agreed with this claim.

In response to the changing environmental discourse, the Finnish fish farming sector is increasingly recognising a new reality concerning the SLO for fish farming enterprises, as evidenced by the WWF (Worldwide Fund) including rainbow trout on its Green List in 2014 (Ovaska et al., 2017; WWF, 2017). The first Aquaculture Stewardship Council (ASC) certificates were granted in 2022[5] alongside the emergence of the first sustainability report in 2023.[6] Notably, across the four clusters, there was also a tendency to believe that Finns would consume more fish in future. This means the fish farming industry faces a dilemma if it wants to capture a share of a potentially expanding market while adhering to good environmental standards.

5.3. SLO as a reflection of life histories and dietary choices

All clusters in the study expressed a willingness to increase their fish consumption; and, with the exception of *Reducers*, all clusters also showed a willingness to consume more Finnish farmed fish, albeit to a lesser extent than for fish overall. It is also noteworthy that the majority of respondents regarded fish farmed in Finland as free of environmental toxins. Based on these results, there is a strong reason for the fish farming industry to embed SLO within the general public, as three quarters of respondents are open to increasing their consumption of Finnish farmed fish, while only a quarter is inclined to consume less.

Willingness to increase fish consumption is not the same as *actually* increasing it. The availability of suitable fish products and their price influence the level at which consumer desires become reality. Consumer choice is the result of a complex combination of cues (signals) related to intrinsic and extrinsic characteristics of fish itself as a product and raw material (Saidi et al., 2022; Jennings et al., 2016). As intrinsic cues, consumers emphasise attributes related to the quality of fish and its convenience as a raw material (freshness, large boneless, pre-processed) and health benefits (low in fat, good fat). Paredes et al. (2021) found that taste was the main reason to consume fish – but also not to consume it – and more important than health reasons, for example. Extrinsic cues include price and those related to production methods (e.g. caught or farmed fish). Wild fish is often preferred to farmed fish, but farmed salmonids especially offer many intrinsic and extrinsic characteristics, making it a consumer-friendly choice.

At the level of individuals, the consumption of fish varies over time, across generations, and across socioeconomic groups (Gustavsen et al., 2014). In our study, we explored three key factors influencing respondents' dietary choices: environmental; ethical; and health concerns. Our results indicate that while the individual reasons for specific choice to consume fish may be more complex, the expressed preference for increased fish consumption (Fig. 7) at least may be more related to health than the environment. Among all protein sources, those that are generally considered healthier (plant protein, fish, and poultry) are more highly ranked than those considered less healthy (dairy, beef, pork). The willingness to increase game meat is an anomaly in this pattern, potentially explained by ethical, environmental, and health-related reasons (Corradini et al., 2022; Hölker et al., 2019). The *Reducers* cluster especially consistently expressed willingness to consume less animal protein resulting from industrial production and would instead choose to eat more wild fish and game meat, both of which include species that can be considered better alternatives from ecological or ethical perspectives (Matilainen et al., 2024; WWF, 2017). However, the direct question about whether animal wellbeing was a more important factor for a consumption decision than the environmental impact of production proved challenging to answer. Notably, a third of stakeholders were unable to form an opinion on this matter. The preferences for dietary choices shown in this study (Fig. 7) point to the need for further studies on the reasons for changing dietary choices and consumption of a given protein source, including farmed fish.

Consumer life histories and situations such as habits, experiences, age, gender, income, and health also have an important effect. Nature connectedness and early childhood experiences of outdoor life are linked to adulthood wellbeing and consumer choices (Alexander et al., 1977; Kaplan, 1984; Alexander, 2002; Lewicka, 2011), unfolding how understanding of society links to earlier childhood encounters. In our survey, the results show that respondents who were more familiar with the coastal milieu appeared to have a better-founded stance (both positive and negative) towards fish farming than those with less contextual involvement and experience. The incidence of the *Pragmatist* posture decreased constantly from older to younger generations, while *Expanders* were uniformly present in the different generations. The incidence of the *Unfamiliar* posture became increasingly evident towards Generation X respondents (early-to-mid 1960s to the early 1980s) in contrast to *Reducers* who began to emerge with the beginning of Generation Z (mid-to-late 1990s until the early 2010s), despite the limited data available for result analysis (see Fig. 3). Grénman et al. (2023a) show that consumers in Generation Z both support access to healthy food and are highly environmentally and socially conscious (Chaturvedi et al., 2020; Grénman et al., 2023b).

While respondents' residency in either an urban or a rural environment was not notably associated with the prevalence of the postures, those municipalities where fish farming was present exhibited a marginally higher presence of *Expanders* (Fig. 5). Conversely, second-home owners were less likely to belong to the *Expanders* or *Unfamiliars*

[5] Fifax becomes the first farm in Finland to achieve ASC certification – ASC International. https://asc-aqua.org/news/fifax-becomes-the-first-farm-in-finland-to-achieve-asc-certification/. Viewed 17.1.2025.

[6] Sustainability Report Nordic Trout 2022 https://nordictrout.com/en/our-responsibility/responsibility-report/. Viewed 17.12025.

clusters. In general, if the respondent had none of the life-history items studied (childhood memories and experiences from coastal areas, nature-related leisure activities, and ownership of or access to coastal second homes), they were more likely to belong to the *Unfamiliars* cluster.

5.4. SLO as community engagement

A literature and policy framework review of European aquaculture shows that most studies address concerns about environmental impacts and food safety, while the economic impacts of fish farming on other coastal activities or its effects on social values and local traditions (Cavallo et al., 2023; Bergh et al., 2023) has been less emphasised. There is significant variation in how SLO is understood across and within organisations, which can lead to misconceptions about its meaning (Stronge et al., 2024). In their study, Stronge et al. (2024) discovered that relying solely on one-way communication strategies could create a false sense of security regarding social licence, as evidenced by the challenges faced in the aquaculture sector. Genuine engagement with local communities and other stakeholders requires a shift to more interactive approaches, such as community workshops and panels, to build trust and understanding. Organisations must adapt their strategies in response to evolving stakeholder expectations to maintain constructive relationships with communities, hence emphasising the importance of effective stakeholder engagement for social licence.

Citizen and stakeholder views on fish farming also reflect how 'impartial, evidence-based, transparent, and independently reviewed' the science advice supporting the sector's decision-making is (Godwin et al., 2023). This is particularly crucial for the legitimacy of governance in the context of a shift to impact-based regulation in which the interpretation of legislation depends on (natural) scientific knowledge on the status of the environment (Soininen et al., 2023). In this context, the European and Finnish policy have arguably failed to contribute to increased fish supply for human food in Finland.

The EIA process highlights the importance of community involvement, but while public participation is required, it may not always be effectively implemented. Finnish EIA legislation ensures that local communities, stakeholders, and others can review and comment on projects through hearings, consultations, and meetings. Notifications are made via media and online platforms, allowing residents and clusters to provide feedback on proposed projects like fish farms. For several reasons – for example, their small size – many fish farms in Finland are not required to undergo the EIA process; instead, they follow a standard permit procedure, which offers less public participation. In this process, the fish farmer submits the permit application, and the environmental authority announces it. Stakeholders can then provide statements, interested parties can submit objections, and others may express opinions, but no further public participation is required.

In our survey, it seemed that the majority of citizens trusted that environmental damage could be avoided by following environmental legislation but also that companies should emphasise the local people's opinions more. This duality of a legislative process – with the EIA path more time consuming and expensive but including a broader participation of the public, and the alternative non-EIA path more straightforward and noticeably less time-consuming and expensive, but with less public participation – might have a big impact on how SLO is achieved or not. While a hearing and discussion forum exist in the environmental permit process, it is not necessarily enough to enable conditions for SLO to be in place, with the concerned parties heard and their concerns considered.

Our survey highlights that more conflicts between fish farming and other coastal livelihoods may occur. In particular, *Reducers* tend to expect this. However, there is some agreement about *where* fish should be farmed, with a potentially positive contribution to gaining SLO. Agreeing beforehand on locations where fish farming will be allowed, and where the damage they cause to the environment could be efficiently mitigated, would help dialogue between the companies and the public.

Finland currently implements a National Aquaculture Location Management Plan (Setälä et al., 2014, to be updated 2024–25) and a Maritime Spatial Plan (2021) which both have an enabling approach to aquaculture. In particular, the implementation of the spatial location plan aims to mitigate environmental, economic, and social risks (Aguilar-Manjarrez et al., 2017). Both plans intend to decrease conflicts between different uses of the maritime space, guiding the operations of different actors, particularly those of fish farming companies by indicating those areas that have been evaluated as suitable for aquaculture. However, spatial location plans are considered *soft law* in the legal framework, and their impact on the legislative procedure is not clearly defined, which adds insecurity to the environmental permit processes (Eliantonio, 2018).

5.5. SLO as the fish farming industry's image

The fish farming industry in Finland still faces a challenge because of its historical role as contributor to the eutrophication of the Baltic Sea (Salmi et al., 2004; Peuhkuri, 2002; Bonsdorff et al., 1997). The industry's attempt to change this not only involves a process of addressing historical criticisms, but also, with aid from several consecutive governmental strategies, the industry aims to position fish farming as a viable and responsible contributor to both food security and economic development. This would also mean the industry being recognised as an important local contributor to job creation and the production of healthy food. Advances in technology, fodder composition, and management practices within the fish farming sector have been leveraged to communicate the fish farming sector's reduced environmental impact. This strategic emphasis has slowly equipped the industry with an argument to enhance its reputation and public image among local communities and the general public. By showcasing initiatives that aim to minimise pollution and promote sustainability, the industry seeks to foster greater trust and acceptance.

Olsen et al. (2023) show that attitudes towards fish farming may depend on respondents' proximity to the industry, and our study develops this, showing that such proximity to fish farms appears to be a critical factor. All the clusters except *Reducers* were strongly or at least somewhat supportive of more farmed fish being produced at the national level, but the strength of support reduced in respondents' home regions and municipalities. We argue that the observed decline in willingness among all clusters to support the establishment of additional fish farms in their home municipalities has implications for SLO. Most respondents see the present level of eutrophication caused by fish farming as not disproportionately large, but many consider that fish farms have a negative effect on recreation and property value. Fish farming therefore appears to be particularly problematic for respondents at the level of farm locations. Whether this is an example of the 'not-in-my-backyard' (NIMBY) effect might be a subject for further study, but the establishment of new fish farms is most strongly supported at the national level, with a decreasing tendency to welcome new establishments the nearer one gets to respondents' home municipality.

In contrast, respondents living in municipalities with established fish farming operations tended to express a more positive attitude towards fish farms, revealing a higher proportion of *Expanders*, who viewed fish farming as an important local employer. Moreover, through an SLO lens, the fish farming industry may be perceived as more attractive as a whole, rather than when considered from the perspective of individual fish farming enterprises. For genuine SLO to emerge, future fish farming sector actors will need to emphasise broader industry engagement, including much more effective stakeholder involvement.

6. Conclusions

Fish farming, and especially its environmental impacts, is a source of

controversy among the population, as this study shows. While the growth of domestic fish production is believed by many to increase the utilisation of fish resources to create work opportunities and added-value in sparsely populated areas, and to contribute to a lower fish trade deficit, there is a grey area between the political will to increase the production of farmed fish and the interpretation of the environmental regulation. The techno-scientific or even legalistic nature of both fish farming governance and the debate about the industry's positive and negative contributions hinders broader dialogue on its possible futures. Following the sectoral delineations, the authorities' decision making in the permit processes is challenging in relation to legal interpretation on the one hand and sectoral strategies on the other. Finding a holistic solution for the lock-ins requires attention to be paid to the distinct sectoral authorities' perceptions of action and policies, the environmental advocacy organisations' understanding of the state of Baltic ecosystems, and the needs and visions of the Finnish fish farming industry itself and its SLO.

SLO should be understood as an ongoing process instead of focusing solely on the environmental permit process phase. There is a genuine danger that once the permit has been obtained, SLO will be overlooked, raising important questions about the extent of community engagement with the industry and its involvement with citizens and stakeholders. Stakeholders tend to articulate their views on environmental legislation more readily, while citizens face greater challenges in doing so. As shown in this study, the disparity between what stakeholders and citizens know raises questions about how SLO can be achieved and maintained. This could be answered by enhancing the fish farming sector's currently limited two-way communication and education, resulting in improved communication and interaction among the fish farming industry, stakeholders, the authorities, and the public.

CRediT authorship contribution statement

Matti Salo: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Lauri Niskanen:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Kristina Svels:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Pekka Jounela:** Writing – original draft, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Appendix

Annex 1. The questionnaire claims.

Claim #	Claim	General/ specific	Response scale
C1_1	The current kind of natural resources use cannot continue in Finland without nature suffering in the long term.	General	5-step Likert
C1_2	The current state of nature enables me to enjoy the kinds of recreation in nature that are personally important to me.	General	5-step Likert
C1_3	If nature conservation in Finland contributes to decreased availability of domestic raw materials, this means that imports have to increase accordingly.	General	5-step Likert
C1_4	Current human activities diminish the resilience of nature to a degree that threatens the existence of humankind.	General	5-step Likert
C1_5	The problems of natural resources use will be resolved through new technologies.	General	5-step Likert
C1_6	If the use of natural resources is to be more sustainable than currently, it will be better to promote voluntary action by consumers and companies rather than to tighten environmental legislation.	General	5-step Likert
C2_1	Eutrophication caused by the nutrient discharge from fish farming is disproportionately large on Finnish coastal waters than that caused by the discharge from agriculture and forestry.	Specific	5-step Likert
C2_2	Fish farming may be a locally important employer in coastal areas.	Specific	5-step Likert
C2_3	Fish farmed in Finland does not contain concentrations of environmental toxins that would be harmful to human health.	Specific	5-step Likert
C2_4	Activities that decrease the nutrient discharge from fish farming are worth carrying out even if they mean more climate emissions than in the current situation.	Specific	5-step Likert
C2_5	Fish farming negatively affects the coastal and archipelago areas as attractive recreation environments.	Specific	5-step Likert
C2_6	The environmental requirements set for fish farming should be tighter than at present.	Specific	5-step Likert
C2_7	More fish should be farmed on Finnish coastal sea areas if this can contribute to substituting fish imports.	Specific	5-step Likert
C2_8	Fish farming facilities within a visible distance decrease the value of coastal second homes.	Specific	5-step Likert
C2_9	If fish farming technology allows the establishment of facilities in the open sea, farms should be established or relocated there, even if this means higher consumer prices.	Specific	5-step Likert
C3_1	I trust that environmental damage caused by businesses can be avoided by following environmental legislation.	General	5-step Likert
C3_2	The wellbeing of production animals is a more important factor contributing to my food consumption decisions than the amount of environmental impacts of products.	General	5-step Likert
C3_3	No sector of food production should increase its eutrophication causing nutrient discharge to the Baltic Sea from the present level.	General	5-step Likert
C3_4	Companies should place more emphasis on the environmental opinions of local people when making decisions about production.	General	5-step Likert
C3_5	The worst has already been seen in the eutrophication development of Finland's coastal waters.	General	5-step Likert
C4_1	Fish farming should preferably take place… (1) …in water areas with strong surface currents so that the local impacts will be smaller. / (2) …in water areas with weak surface currents so that the local impacts do not spread more widely. / (3) I do not know.	Specific	3 alternatives
C4_2	Fish farming should preferably take place… (1) …in open water areas so that the impacts will be smaller than in locations closer to the shoreline. / (2) …in sheltered water areas where production costs are lower. / (3) I do not know.	Specific	3 alternatives

(*continued on next page*)

(*continued*)

Claim #	Claim	General/ specific	Response scale
C4_3	Fish farming should preferably take place… (1) …in clear waters with low nutrient content in the open sea. / (2) …closer to the coastline in locations that already suffer from additional nutrient load. / (3) I do not know.	Specific	3 alternatives
C4_4	Compared to the present situation, the evaluation of the environmental impacts of fish farming facilities should be based more on… (1) …direct measurements in the vicinity of the facilities. / (2) …impact models covering wider areas. / (3) I do not know.	Specific	3 alternatives
C5_1	The significance of fish farming carried out in Finnish sea areas increases as part of domestic food production in the 2020s.	Specific	5-step Likert
C5_2	Water quality in Finnish coastal areas will become worse than at present during the 2020s.	General	5-step Likert
C5_3	Fish consumption by Finns will decrease during the 2020s.	General	5-step Likert
C5_4	The self-sufficiency of Finnish food consumption will increase during the 2020s.	General	5-step Likert
C5_5	It will be possible to predict and monitor the environmental impacts caused by fish farming so well during the 2020s that it will be possible to reliably evaluate the industry's sustainability.	Specific	5-step Likert
C5_6	Conflicts between fish farming and other coastal livelihoods will increase during the 2020s.	Specific	5-step Likert
C5_7	Finnish coastal fish farming activity will become concentrated on fewer and larger companies during the 2020s.	Specific	5-step Likert
C5_8	Fish will be increasingly farmed in land-based facilities during the 2020s.	Specific	5-step Likert
C6_1	I would like fish farming on the Finnish coastal sea areas to… (1) …decrease… / (2) …not to change in amount… / (3) …increase. / (4) I do not know.	Specific	3 alternatives
C6_2	I would like fish farming in my home region to… (1) …decrease… / (2) …not to change in amount… / (3) …increase. / (4) I do not know.	Specific	3 alternatives
C6_3	I would like fish farming in my home / second-home municipality to… (1) …decrease… / (2) …not to change in amount… / (3) … increase. / (4) I do not know.	Specific	3 alternatives

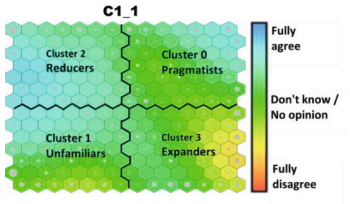
Annex 2. The questionnaire background questions.

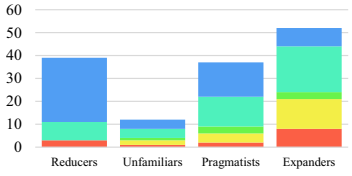
Question #	Question	Response scale
B_1	Do you live in… 1) an urban/built-up area OR 2) in the countryside/sparsely populated area?	Choose one
B_2	Did you spend your childhood mostly in… 1) an urban/built-up area OR 2) in the countryside/sparsely populated area OR 3) both?	Choose one
B_3	Do you have important childhood experiences of the sea, the coast, or the archipelago?	Yes/No
B_4	Do you engage in active nature-related leisure-time hobbies (outdoors, fishing, berry or mushroom picking, hunting, etc.) at least twice a month?	Yes/No
B_5	Do you own or have access to a second home on the coast or the archipelago?	Yes/No
B_6	Did you answer yes to any of the three above questions?	Yes/No
B_7	Which of the following did you consume at least once during 2020 (beef, pork, poultry, game, fish, Finnish farmed fish, eggs, dairy products, plant protein products, vegetables, grain products)?	Choose all appropriate
B_8	Have you considered changing your consumption of the following foods in 2021 (beef, pork, poultry, game, fish, Finnish farmed fish, eggs, dairy products, plant protein products, vegetables, grain products)? If so, how (no change, start eating, will eat more, will eat less, will stop eating)?	Choose all appropriate

Annex 3. SOM presentations and bar diagrams of the claims in clusters C1, C2, C3, and C5.

C1_1 The current kind of natural resource use cannot continue in Finland without nature suffering in the long term.

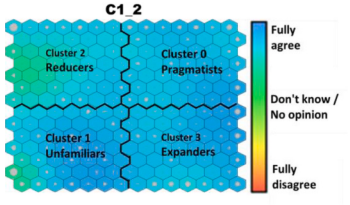
Citizens *Stakeholders*

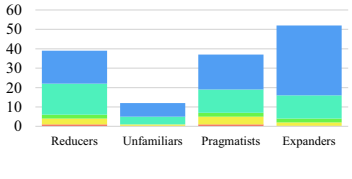




C1_2 The current state of nature enables me to enjoy the kinds of recreation in nature that are personally important to me.

Citizens *Stakeholders*





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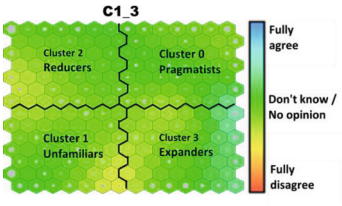
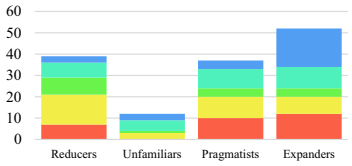
C1_3 If nature conservation in Finland contributes to decreased availability of domestic raw materials, this means that imports have to increase accordingly.

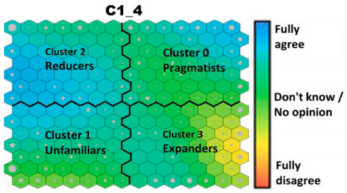
Citizens *Stakeholders*

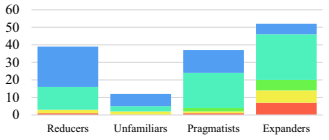




C1_4 Current human activities diminish the resilience of nature to a degree that threatens the existence of humankind.

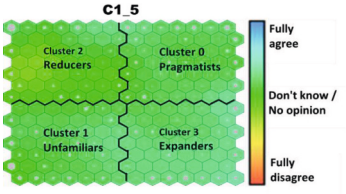
Citizens *Stakeholders*

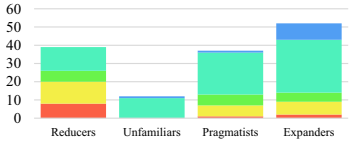




C1_5 The problems of natural resources use will be resolved through new technologies.

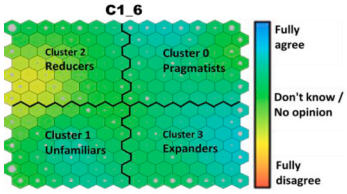
Citizens *Stakeholders*

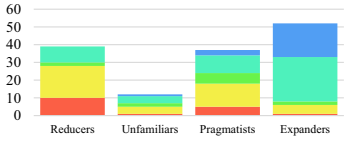




C1_6 If the use of natural resources is to be more sustainable than currently, it will be better to promote voluntary action by consumers and companies rather than to tighten environmental legislation.

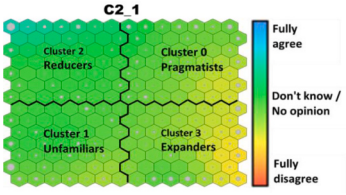
Citizens *Stakeholders*

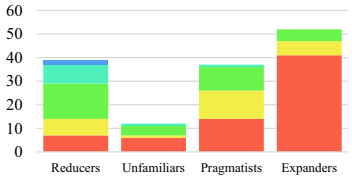




C2_1 Eutrophication caused by the nutrient discharge from fish farming is disproportionately large in Finnish coastal waters compared to that caused by the discharge from agriculture and forestry.

Citizens *Stakeholders*





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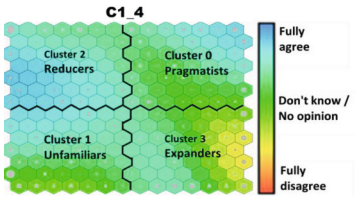
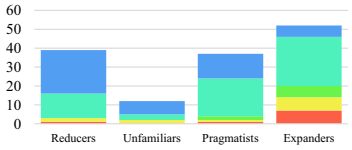
C2_2 Fish farming may be a locally important employer in coastal areas.

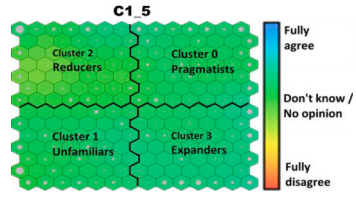
Citizens *Stakeholders*

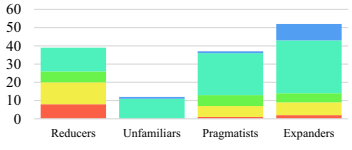




C2_3 Fish farmed in Finland does not contain concentrations of environmental toxins that would be harmful to human health.

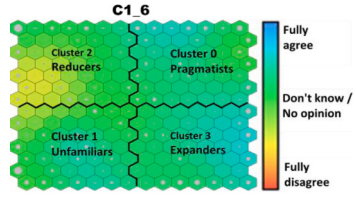
Citizens *Stakeholders*

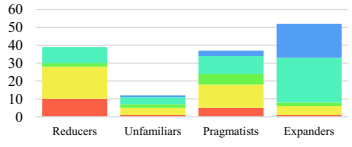




C2_4 Activities that decrease the nutrient discharge from fish farming are worth carrying out even if they mean more climate emissions than in the current situation.

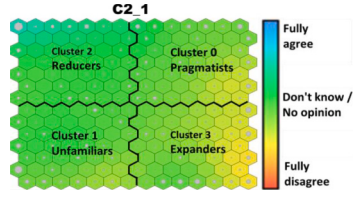
Citizens *Stakeholders*

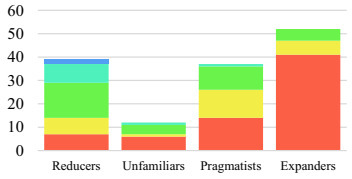




C2_5 Fish farming negatively affects the coastal and archipelago areas as attractive recreation environments.

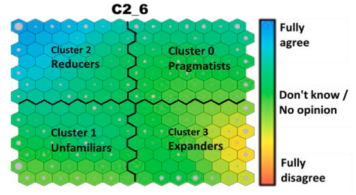
Citizens *Stakeholders*

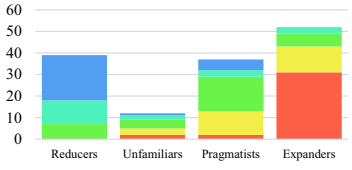




C2_6 The environmental requirements set for fish farming should be stricter than at present.

Citizens *Stakeholders*





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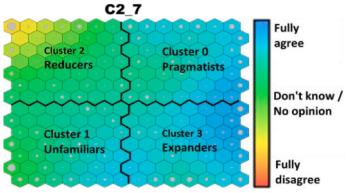
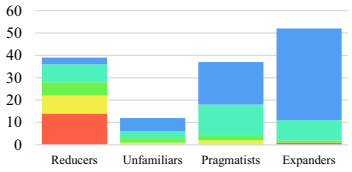
C2_7 More fish should be farmed in Finnish coastal sea areas if this can contribute to replacing fish imports.

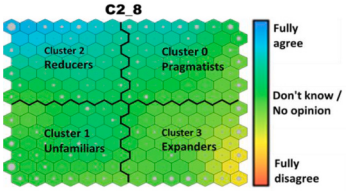
Citizens *Stakeholders*

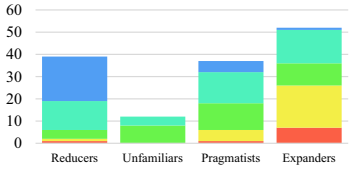




C2_8 Fish farming facilities within visible distance decrease the value of coastal second homes.

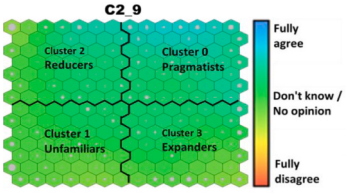
Citizens *Stakeholders*

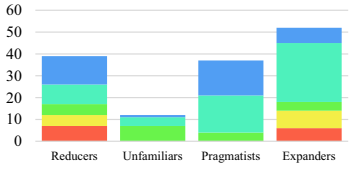




C2_9 If fish farming technology allows the establishment of facilities in the open sea, farms should be established or relocated there, even if this means higher consumer prices.

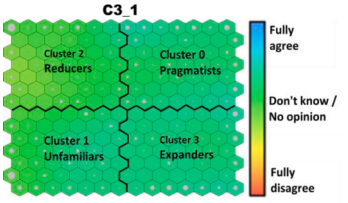
Citizens *Stakeholders*

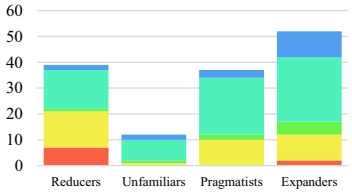




C3_1 I trust that environmental damage caused by businesses can be avoided by following environmental legislation.

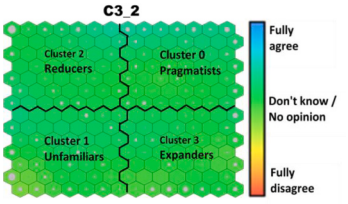
Citizens *Stakeholders*

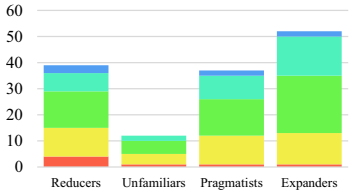




C3_2 The wellbeing of production animals is a more important factor contributing to my food consumption decisions than the amount of environmental impacts of products.

Citizens *Stakeholders*





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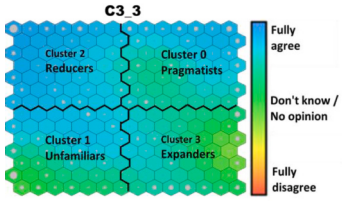
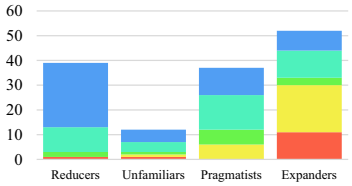
C3_3 No sector of food production should increase its eutrophication causing nutrient discharge to the Baltic Sea from the present level.

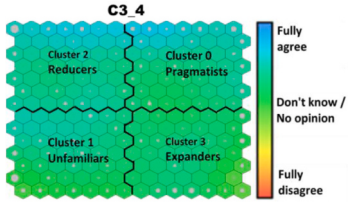
Citizens *Stakeholders*

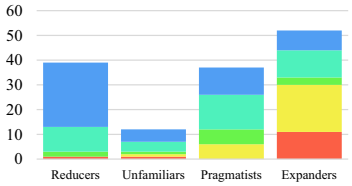




C3_4 Companies should place more emphasis on the environmental opinions of local people when making decisions about production.

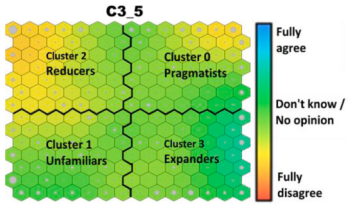
Citizens *Stakeholders*

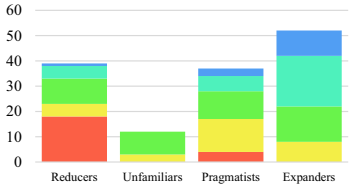




C3_5 The worst has already been seen in the eutrophication development of Finland's coastal waters.

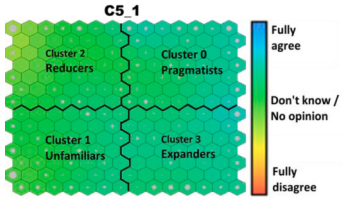
Citizens *Stakeholders*

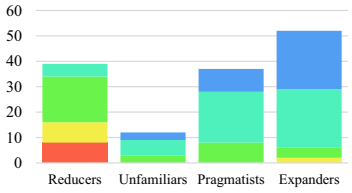




C5_1 The significance of fish farming carried out in Finnish sea areas will increase as part of domestic food production in the 2020s.

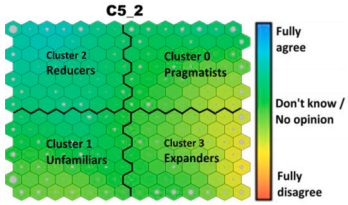
Citizens *Stakeholders*

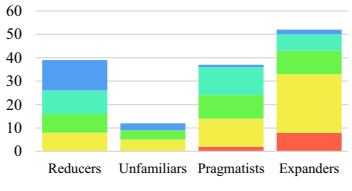




C5_2 The water quality in Finnish coastal areas will become worse than at present during the 2020s.

Citizens *Stakeholders*





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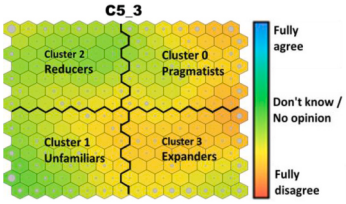
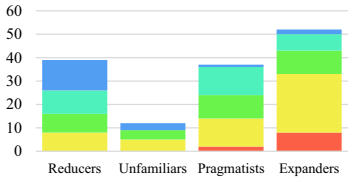
C5_3 Fish consumption by Finns will decrease during the 2020s.

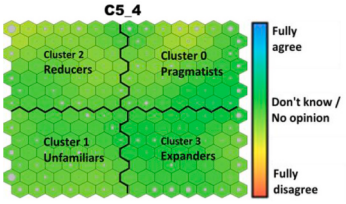
Citizens *Stakeholders*

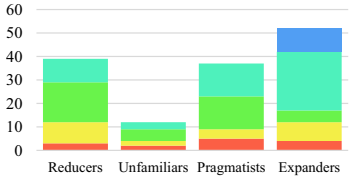




C5_4 The self-sufficiency of Finnish food consumption will increase during the 2020s.

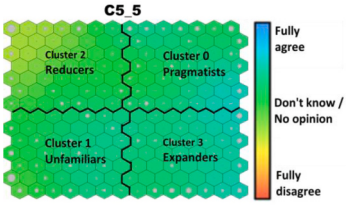
Citizens *Stakeholders*

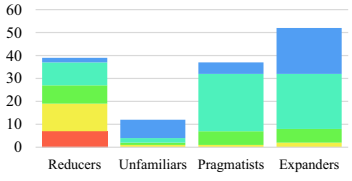




C5_5 It will be possible to predict and monitor the environmental impacts caused by fish farming so well during the 2020s that it will be possible to reliably evaluate the sustainability.

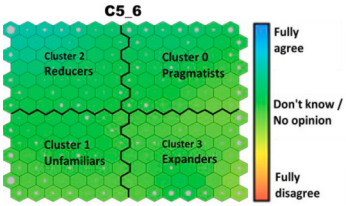
Citizens *Stakeholders*

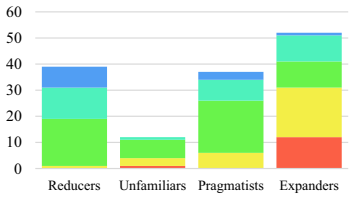




C5_6 Conflicts between fish farming and other coastal livelihoods will increase during the 2020s.

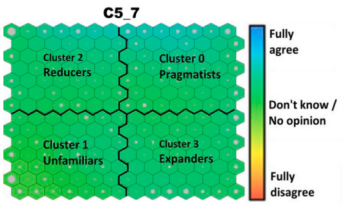
Citizens *Stakeholders*

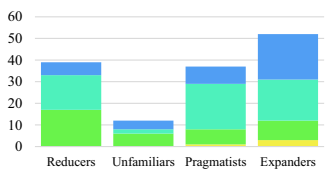




C5_7 Finnish coastal fish farming activity will become concentrated in fewer and larger companies during the 2020s.

Citizens *Stakeholders*





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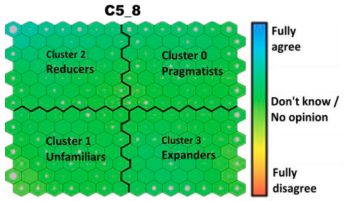
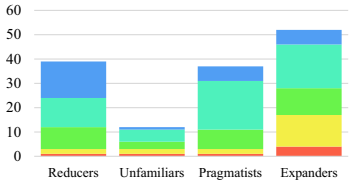
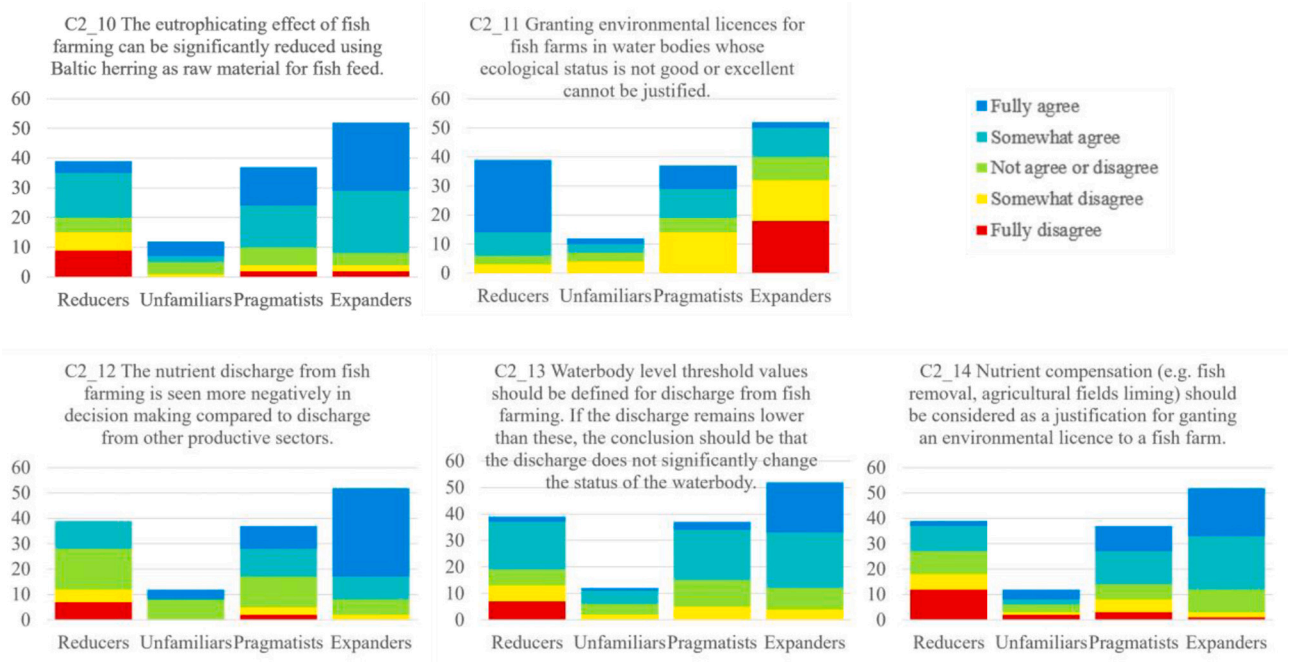
C5_8 Fish will increasingly be farmed in land-based facilities during the 2020s.

Citizens *Stakeholders*





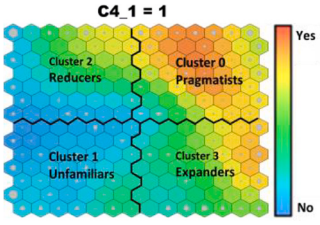
Annex 4. Bar diagrams showing stakeholder responses to claims C2_10–14 exclusively presented to them in the survey.



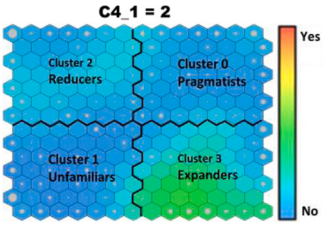
Annex 5. SOM presentations and bar diagrams of the claims in cluster C4.

C4_1 Fish farming should preferably take place…

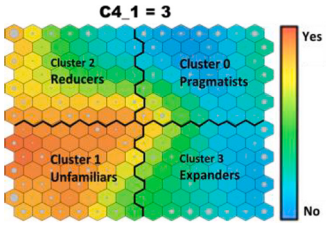
(1) …in water areas with strong surface currents so that the local impacts will be smaller.



(2) …in water areas with weak surface currents so that the local impacts do not spread more widely.



(3) I do not know.



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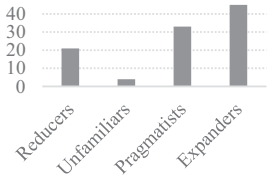
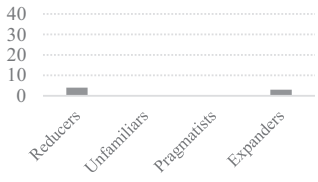
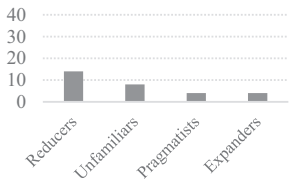
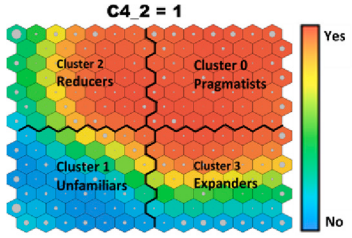


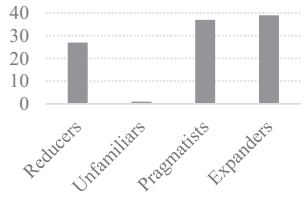




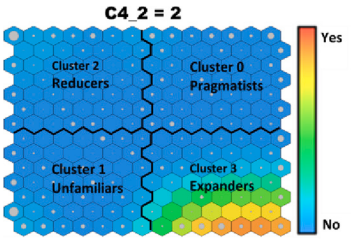
C4_2 Fish farming should preferably take place…

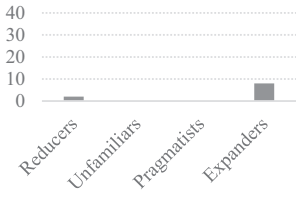
(1) …in open water areas so that the impacts will be smaller than in locations closer to the shoreline.



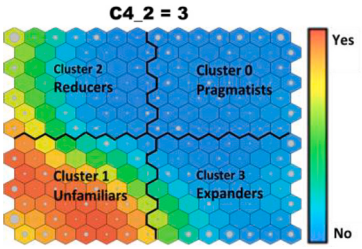


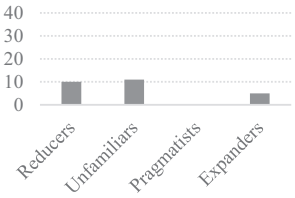
(2) …in sheltered water areas where production costs are lower.





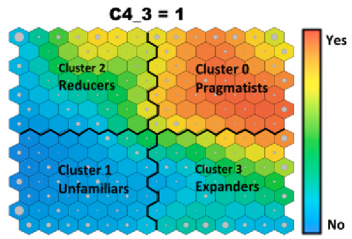
(3) I do not know.

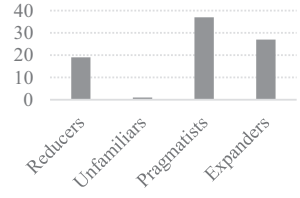




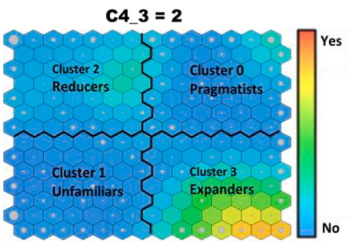
C4_3 Fish farming should preferably take place…

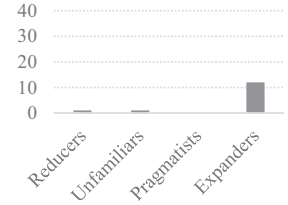
(1) …in clear waters with low nutrient content in the open sea.



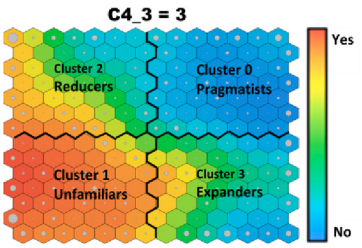


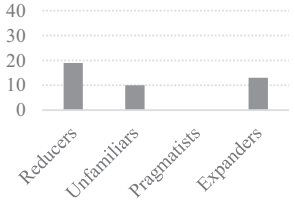
(2) …closer to the coastline in locations that already suffer from additional nutrient load.





(3) I do not know.





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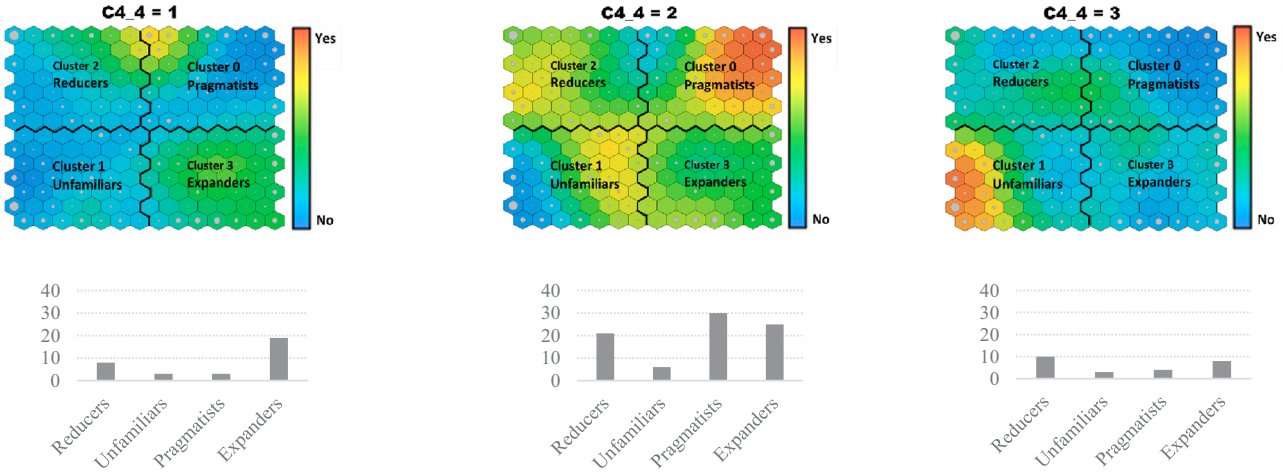
C4_4 Compared to the present situation, the evaluation of the environmental impacts of fish farming facilities should be based more on…

(1) …direct measurements in the vicinity of the facilities. (2) …impact models covering wider areas. (3) I do not know.



Annex 6. Per cluster average of citizen survey responses per claim and the rate (%) of 'I do not know (IDNK)' responses over the set of 14 general environmental claims. Point of 'NAND' = neither agree nor disagree response. 1 = fully agree, 2 = somewhat agree, 3 = NAND, 4 = somewhat disagree, 5 = fully disagree.

Cluster	Expanders	Pragmatists	Reducers	Unfamiliars	All	'NAND'
C1_1	3.07	2.37	1.87	2.57	2.48	3.00
C1_2	1.40	1.44	1.68	1.49	1.50	3.00
C1_3	2.83	2.97	3.11	3.13	3.01	3.00
C1_4	2.82	2.12	1.72	2.44	2.28	3.00
C1_5	2.28	2.46	2.75	2.53	2.50	3.00
C1_6	2.11	2.32	3.06	2.54	2.50	3.00
C3_1	2.21	2.30	2.98	2.54	2.50	3.00
C3_2	2.71	2.55	2.63	2.75	2.66	3.00
C3_3	2.30	1.69	1.36	2.06	1.85	3.00
C3_4	2.55	2.03	2.00	2.42	2.25	3.00
C3_5	2.80	3.39	3.89	3.26	3.33	3.00
C5_2	3.36	2.82	2.14	2.86	2.80	3.00
C5_3	4.03	4.00	3.54	3.64	3.81	3.00
C5_4	3.01	3.04	3.25	3.13	3.11	3.00
IDNK%	5 %	4 %	7 %	16 %	8 %	

Annex 7. Per cluster average of citizen survey responses per claim and the rate (%) of 'I do not know (IDNK)' responses over the set of 18 claims specifically about fish farming. 'NAND' = neither agree nor disagree response. 1 = fully agree, 2 = somewhat agree, 3 = NAND, 4 = somewhat disagree, 5 = fully disagree.

Cluster	Expanders	Pragmatists	Reducers	Unfamiliars	All	'NAND'
C2_1	3.52	3.15	2.60	3.09	3.09	3.00
C2_2	1.71	1.90	2.76	2.19	2.13	3.00
C2_3	2.18	2.52	3.19	2.76	2.66	3.00
C2_4	3.00	2.79	2.71	3.00	2.88	3.00
C2_5	3.92	3.10	2.20	3.21	3.12	3.00
C2_6	3.29	2.47	1.76	2.76	2.58	3.00
C2_7	1.59	1.72	2.96	2.14	2.09	3.00
C2_8	3.31	2.61	2.05	2.78	2.70	3.00
C2_9	2.82	2.15	2.62	2.93	2.62	3.00
C4_1	1.75	1.36	1.81	1.91	1.70	2.00
C4_2	1.84	1.03	1.30	1.84	1.49	2.00
C4_3	2.00	1.16	1.75	1.96	1.71	2.00
C4_4	2.03	2.53	2.34	2.25	2.29	2.00
C5_1	2.17	2.17	2.91	2.59	2.45	3.00
C5_5	2.12	2.30	3.09	2.48	2.49	3.00
C5_6	3.08	2.68	2.37	2.91	2.76	3.00
C5_7	2.34	2.22	2.36	2.64	2.39	
C5_8	2.66	2.64	2.38	2.79	2.63	
IDNK%	13 %	12 %	24 %	45 %	27 %	

Data availability

Data will be made available on request.

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