MEDIA REPRESENTATION OF AQUACULTURE IN SWEDEN

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Abstract (English)

Aquaculture is a recurring topic of controversy among public groups, often visible through news media representation. The media is an important source of information and communication, that both influences and reflects social consensus. Social license to operate (SLO) is an on-going concern within aquaculture that can impact development, limiting sustainable and ecological innovation. Aquaculture in Sweden is small however a growing interest toward cultivating finfish and low trophic species is present. This study conducted a content analysis of media representation of different aquaculture species within Sweden, over a ten-year period, exploring the tones and main topics included within this context. Overall, aquaculture representation was increasing moderately as a result of articles pertaining to salmon and algae cultivation ($R = 0.62$ and 0.75, respectively). Salmon aquaculture was perceived negatively overall, however a positive discourse is emerging. A significant disparity between positive and negative tones was present among different species ($p<0.001$), where algae, mussel and low trophic sectors were favored positively. Environmental attributes were the most utilized for every species group and technological aspects were increasing significantly over time ($R=0.80$). The main topics of discussion included: sustainable potential and benefits of low trophic aquaculture, environmental degradation and industry development. This research aims to support the development of local and restorative forms of aquaculture within Sweden, by contributing toward the understanding of the present public perspective.

Abstract (Swedish)

Vattenbrukets för- och nackdelar är ett återkommande diskussionsämne bland olika grupper i samhället, som ofta synliggörs i nyhetsmedia. Media är en viktig källa till information och kommunikation, som både påverkar och återspeglar social konsensus. Social License to Operate (SLO), innebärande samhällets acceptans eller relation till en verksamhets genomförande, är en pågående process när det gäller vattenbruk, något som kan påverka dess möjlighet till utveckling och begränsa hållbar och ekologisk innovation. Trots att vattenbruket är marginellt i Sverige idag, är industrin relativt mångsidig och det finns ett växande intresse för att öka hållbar odling av fisk och låg-trofiska arter. Denna studie genomförde en innehållsanalys av nyhetsmedia gällande olika vattenbrukstyper och arter i Sverige under en 10 årsperiod, samt utforskade de språknyanser och huvudsakliga ämnesområden som förekom. Resultaten av studien visade på en måttlig ökning av mediarepresentation när det gäller artiklar om lax- och algodlingar ($R = 0,62$ respektive 0,75). Laxodlingar uppfattades totalt sett negativt, men en positiv diskurs håller på att växa fram. En signifikant skillnad mellan positiva och negativa nyanser fanns mellan olika arter ($p <0,001$) där alger, musslor och låg-trofiska vattenbrukssystem belystes mer positivt. Ämneskategorin ”miljö” var det mest representerade för varje art/grupp och ”tekniska aspekter” ökade signifikant över tiden ($R = 0,80$). Huvudsakliga områden som diskuterades var: hållbarhetspotential och fördelar med låg-trofiskt vattenbruk, negativ miljöpåverkan och industriutveckling. Denna forskning syftar till att stödja utvecklingen av lokala och hållbara former av vattenbruk inom Sverige, genom att bidra till förståelsen av samhällets nuvarande perspektiv när det gäller vattenbruk.

1 Introduction

The world's human population is growing and is expected to reach approximately 9.8 billion people by the year 2050 (UN, 2019). Formidable yet achievable challenges for sustainable food security are present, and it will be the contribution and collaboration of many different sectors that hope to achieve it.

1.1 Aquaculture development

Aquaculture, that is the fresh and saltwater farming of finfish, shellfish, bivalves and sea vegetables, is a fast growing and diverse food producing sector (Theurerkauf et al., 2021). Asia commands most of the global production and indeed much of this growth (Table 1; Costa-Pierce and Chopin, 2021), where inland finfish and aquatic algae operations are greatest (in terms of live weight) (FAO,2020). However, development in new geographic regions is occurring. Moreover, a growing body of scientific evidence demonstrates that non-fed, low trophic aquaculture species act as net positive contributors to their environment (Marzinelli et al., 2015; Schatte Oliver et al., 2018; Gentry et al., 2019; Zu Ermgassen et al., 2020; Theurerkauf et al., 2021). These contributions, known as ecosystems goods and services, include aspects such as: improving overall water quality, carbon sequestration, hazard protection and increasing habitat benefits (Fischlin et al., 2007). For example, within integrated multi-trophic aquaculture (IMTA), non-fed species (predominantly seaweeds and bivalves) provide opportunities to increase system efficiency by optimizing the use of nutrients and mitigating the impacts of bio waste. These species have also been shown to increase species abundance by up to a factor of 3.6 (mussel farms) and species diversity by a factor of 1.3 (oyster and seaweed farms), compared to reference sites (Theuerkauf et al., 2021).

Table 1. Animal aquaculture production by region and the leading producers (Numbers in million metric tons (MMT)) (FAO 2020) (Recreated from Costa-Pierce and Chopin, 2021)

	World	**Asia**	**Africa**	**Americas**	**Europe**	**Oceania**
Inland	51.3	47.7	1.9	1.2	0.5	0.0
*Marine**	30.8	25.1	0.3	2.6	2.6	0.2
Total	82.1	72.8	2.2	3.8	3.1	0.2
		China (47.6)	Egypt (1.6)	Chile (1.3)	Norway (1.4)	

**Marine includes coastal and brackish water aquaculture. Less than 0.1 MMT is reported by FAO as "zero"*

Furthermore, as edible and valuable cultivation species themselves, they have the potential to generate additional output and increase economic returns (Knowler et al., 2020). As such, the term "aquaculture" should no longer solely represent a food producing sector, but an industry of ecological development as well. This approach to aquaculture can be explored and implemented under certain criteria in degraded or industrially threatened environments to achieve net positive results. The principles of so called "restorative aquaculture" are loosely understood under a variety of nomenclature, yet in order to consolidate knowledge and practices, The Nature Conservancy (2021) offer this definition in their white paper on the topic:

"Restorative aquaculture occurs when commercial or subsistence aquaculture provides direct ecological benefits to the environment, with the potential to generate net positive environmental outcomes"

It is known that anthropogenic stressors and developments that out-constrain our planets natural bounds are leading to exacerbated and unprecedented changes to our environment, on global and local scales. Nature based solutions, such as restorative aquaculture, are therefore crucial in mitigating such changes. Radical explorations and solutions are necessary today and over the coming decade to re-revolutionize industrial sectors, including those of aquatic food systems.

1.2 Public perception

In stark contrast to the prevailing academic understanding for the potential and timeliness of restorative aquaculture, is a particularly poor consumer perception of aquaculture generally, that persists on the European/ North American stage. Attributed by some to the infancy of the sector and its 'coming of age' during the evolution of handheld digital technology (that perhaps allowed for greater documentation); the reputation of aquaculture is decidedly controversial (Osmundsen and Olsen, 2017; Trushenski, 2019; Navedo and Vargas-Chacoff, 2021). Concerns regarding animal welfare, poor feed conversion ratios (FCR), diseases, parasites, environmental impacts and high antibiotic use have challenged the industry and plagued its social development. Scientific and industrial consensus resolves that the gravity of some of these concerns have outlived their practical reality. Whilst challenges do remain, innovative concepts such as genome editing, artificial intelligence, re-circulating aquaculture systems (RAS), and alternative protein sourcing (for example, utilizing algal feed ingredients), continue to transform the industry (Yue and Shen, 2022). Yet, there seems to be a lack of education and understanding among the general public that likely perpetuates this dissonance. A study from Lopez-Mas et al. (2021) explored European consumer beliefs regarding "farmed fish vs wild-caught fish" and report consumers believe wild fish is of a "higher quality" to farmed counterparts. Moreover, that farmed fish are "less fresh" and contain "more antibiotics". Another study (Simones, 2022) indicated similar findings from consumers within the UK and reported an overall lack of understanding of fish and shellfish farming among the participants. Results such as these are commonplace and assist in understanding the breadth of non-information and misinformation that is still being articulated among public groups, and the effects this can have.

Consumer relationships within aquaculture, its practices and perceptions, are not globally uniform. Whilst considered a relatively modern industry acquisition in Europe for example, aquaculture is an ancient practice in much of Asia, particularly China. China today accounts for 60% of global aquaculture production, and Asia in total accounts for 89% (Costa-Pierce and Chopin, 2021). Here, traditions of polyculture of rice and carp species for human consumption date back approximately 4,000 years (Stickney, 2013). Similarly, ponds to produce aquatic species have been utilized in the Hawaiian Islands prior to the 14th century (Wyban and Wyban, 1989). As such, public knowledge, integration and acceptance has been developing in different world regions under different contexts and timeframes. It is important to avoid painting all nations and cultures with the same brush. Thus, the scope of this study seeks to investigate the prevailing attitudes that may be attributed to the Western/European context, toward the development of commercial aquaculture in these regions.

1.3 Media relevance

"The Media" as a concept has been studied since the late 19th century (Briggs and Burke, 2009) and depicts a means of mass communication used unto a given audience to convey a message. It is known to have dynamic impacts on public opinion: influencing, testing and reflecting it (McCombs and Valenzuela, 2021). Rooted in storytelling, a pillar of the human experience, communication and the art of powerful rhetoric in oral and written forms is an equally ancient pursuit. The utilization of such practices within the media has the potential to shift social and political agendas when experiencing mass consensus adoption (Nilsson and Earl, 2020). Print media enjoyed reigning popularity for most of the 20th Century and traditional newspaper markets provided the most utilized form of mass media (Briggs and Burke, 2009). Since the turn of the century however, social media platforms for news consumption has grown expansively, particularly among younger people. Today, more than 50% of 18–29-year-olds in European countries use social media for daily news (Pew Research Centre, 2018). As such, new media players have emerged and many traditional print media companies have transitioned to digital platforms, amassing large social followings (Reuters Institute Digital News Report 2021 , 2022). Access to the internet ensures that communication can be global and instant, although cultural, political and geographic preferences and limitations reside. Nonetheless, most industries are exposed to influential media representation and the consensus held therein can dictate their social license to operate (SLO) (Weitzman and Bailey, 2019). The aquaculture industry is no exception, reliant on consumer acceptance and the ability to achieve and retain good social standing for development, in local and wider community contexts (Olsen and Osmundsen, 2017). Yet, media representation is susceptible to bias or inaccurate information and this can be rife from news outlets, including mainstream sources (Yariv Tsfati et al., 2020). Popular misconceptions toward aquaculture are often negatively framed elaborations of industry characteristics. For example: the depletion of wild fish populations, excessive use of antibiotics and detriments to human health (Nenciu et al., 2021).

1.4 Media analysis in Sweden

Aquaculture in Sweden is small but active and industrial and academic interest is mounting for the continued growth of sustainable practices, in line with the EU's Sustainable Development Goals (SDG's). Initiatives such as the Swedish Mariculture Research Centre (SWEMARC)

and Blå Mat- The Centre for Future Seafood are driving institutions in this sector and The Swedish Board of Agriculture has a strong vision for aquaculture in the nation. Yet, this vision is not guaranteed. Competing stakeholder interests, environmental concerns and the lack of legislation are cited as examples of challenges facing the industry (Young et al., 2019). Encouragingly, Swedish consumers have been attributed with high environmental awareness and an understanding of sustainable behaviors (Lindh, Olsson and Williams, 2015). However, it is believed that Swedish consumers generally are not eating the recommended amount of seafood in their diets (Rönnerstrand et al., 2020).

Media content analysis is a popular research methodology used to explore public attitudes on a variety of topics. Via this methodology, studies in Norway, France and Canada have demonstrated a broad range of media framing toward aquaculture, under a variety of political, health, environmental and socio-economic themes. Predominantly skewed toward negative/ risk-based tones (Olsen and Omundsen 2021; Govaerts, 2021; Kraly, Weitzman and Filqueira, 2022). Sweden is presently a net importer of fish and fish products, with over 80% of that imported coming from Norway for both direct consumption and further processing for export (Fisheries and Aquaculture Sweden, 2021). There is a desire to increase Sweden's own production to support goals of self-sufficiency and environmental sustainability (Young et al., 2019). Therefore, this study contributes toward understanding the evolving public perceptions of importing nations, and for Sweden itself to further the transition into production and facilitation of other value chain aspects. It is to the best understanding of the author that no such study has been undertaken thus far regarding the Swedish media. Moreover, the majority of previous research focuses on the media surrounding salmon farming (*S.salar*) and other cultivation species are rarely explored. As scientific research continues to develop, particularly considering IMTA and low trophic species, there is a need to explore the complexities of social acceptance that must also develop alongside these to achieve fruition.

1.5 Aim and research questions

This study aims to examine how aquaculture is depicted in Swedish news media over time and discuss how media themes and framing may influence public attitudes and behavior. Moreover, whether different types of aquaculture are present and privy to different representations. Thus, exploring whether emerging aquaculture markets (such as restorative practices and sustainable innovations), experience stigmatism via an association to any previous perceptions held. As such, the following research questions will be examined:

1. Does the topic of aquaculture increase over time within Swedish media?

2. Are different types of aquaculture represented? If so, does public perception vary depending on the species being depicted?

To further facilitate this, the role of the media shall be analyzed via the tone and main themes depicted within the articles. Additionally, exploring how the media discourse may differ from the (dominant) discourse in academic research, including any aspects of aquaculture that are being miscommunicated or not communicated within the Swedish media. This scope strives to understand the extent of negative attitudes and controversy surrounding aquaculture currently present and explore any potential development.

2 Literature review

A literature review was conducted to explore the theoretical framework for this study and gain an understanding of the current literature. The prevailing themes of aquaculture within the media were investigated to determine the direction and the context within which the following results exist.

2.1 Media Effects Theory

The media provides information on many topics that can help the public to understand and interpret what is happening in the world. As the content is not being experienced first hand, the media is depicting a second hand reality that has been created by journalists and editors (McCombs and Shaw, 1972). This reality is also referred to as the transfer of salience from the media to the public (McCombs and Shaw 1993, Takeshita, 2006). Resources and human capacity restricts the amount of data that is shared, as there are only so many pieces that can be created and consumed at a given time. Thus, strategic considerations are continually being made about what should go on the agenda. Agenda setting is a concept of the media effects theory, formally introduced in 1972 by Dr McCombs and Dr.Shaw. It principally hypothesizes that the media not only provide information but priorities it, influencing the issues that become major themes of public concern. Agenda setting is understood in studies of media, politics and public opinion as a tool that determines what is discussed and what is not (McCombs and Shaw, 1972). Over time, the issues prioritized in the media are the issues that become prominent to the public, illustrating that the media agenda bears significance to setting the public agenda (McCombs and Shaw, 1972; McCombs and Valenzuela, 2021).

Once on the agenda, framing within the media depicts how a topic is represented, which aspects are highlighted or excluded, and how they are evaluated (Iyengar, 2007); consequently, influencing people's understanding of that issue (Takeshita, 2006). When discussing a subject such as aquaculture, framing is identified as "the selection of- and emphasis upon- particular attributes for the media agenda" (McCombs and Shaw, 1972). Framing can be considered as a 'second level' within agenda setting, also known as attribute agenda setting (McComb, Shaw and Weaver, 1997; Weaver,2007). This consolidation of terms is a subject of contention within agenda setting research termed "the identity problem" (Takeshita, 2006). Framing researchers have posited this was an undue expansion of agenda setting principles to incorporate and colonize aspects of framing theory (Kosinski, 1993). Yet, early agenda setting researchers defend that it is a natural extension of the original concept and their research supports this notion (Weaver, McCombs and Shaw, 2004). For the purpose of this study, agenda setting research and framing research are concepts present in exploring the same phenomena: how the media pose and contextualize an issue to the public.

Other concerns within agenda setting research are addressed as the process and environment problems (Takeshita, 2006). The process problem posits a potential duality between so termed "genuine agenda setting " and "pseudo agenda setting" effects. It calls into question the nature of the process, dependent on the knowledge and beliefs already held by recipients, on the topic being analyzed. Genuine agenda setting is described by active inference, that denotes a set of prior beliefs that influence explanations for behavior (Friston et al., 2016). Whereas the pseudo agenda setting effect is determined by an accessibility bias, that

hypotheses individuals may instead readily rely on information with high mental accessibility when forming an opinion (Iyengar, 1990). A study exploring this division analyzed poll data in an election and displayed homogenous agenda setting effects among all respondents (Zhu and Boroson, 1997). This suggests that genuine and pseudo-effects can co-exist without significant consequence (Takeshita, 2006). However, the process problem highlights an interesting physiological variable for theorizing how agenda setting may influence different individuals and groups in the long term.

The environment problem is descriptive of a changing media landscape giving rise to potential agenda fragmentation, made possible by digital communication pathways on the internet (Feezell, 2017). Extreme hypotheses depict dramatic declines in the influence of main media outlets, as more options result in less reliance on a few leading sources (Shaw and Hamburg, 1997). Nonetheless, merely increasing the volume of communication channels is not understood to significantly correlate with increased diversity of the communications therein (Neuman, 1991). Whilst new media and social sources may distort the boundaries of traditional agenda setting, no academic consensus regarding the principles by which this occurs exists presently. Therefore, the intermedia agenda must consider the media iteratively within the context it exists (Zo-Barrantes, 2021). Agenda setting, media framing and the process problem were particularly valuable methodological aspects through-out the analysis of this study.

2.2 Aquaculture representation in the Media

Frolich et al., 2017 estimates that the amount of aquaculture representation in the media is increasing and is likely to continue as the industry develops and expands. In line with leading media effects theories, media framing can be considered as a proxy for public perception (Schlag, 2010). In 2002, Frewer at al. demonstrated that the media reporting on food 'scares' was linked directly to themes of food anxiety within the public, that waned as media interest subsided. Therefore, analysis of the media content regarding aquaculture indicates that a segmented public perception is currently present. For example, in a global content analysis study from 1984-2015 by Froelich et al. (2017) positive sentiment of aquaculture generally was developing slowly, however marine and offshore practices are considered as negative developments. Within Europe, media studies largely focus on salmon aquaculture and emerge predominantly negatively (Schlag, 2011; Olsen and Osmundsen, 2017; Govaerts, 2021; Kraly, Weitzman and Filgueira, 2022). An exception exists amongst a study of German consumers, regarding recirculating aquaculture systems (RAS) generally, however a lack of understanding for aquaculture practices was reported (Feucht and Zander, 2016). Strong themes of environment, politics, industry, economics, human health and trust are common (Amberg and Hall, 2008; Schlag, 2011; Knapp and Rubino, 2016; Osmundsen and Olsen, 2017; Govaerts, 2021; Kraly, Weitzman and Filgueira, 2022; Condie, Vince and Alexander, 2022) and social, technological and scientific advancements are represented to a lesser extent (Schlag, 2010; Richard and Feldpausch Parker, 2016; Weitzman and Bailey, 2019). Concerns of the environmental risks caused by aquaculture are often reported as the most dominant. Some studies suggest that a positive discourse is developing as a result of technological achievements and a growth in public awareness (Richard and Feldpausch Parker, 2016; Weitzman and Bailey, 2019). There is also evidence to indicate that public acceptance improves with time and proximity to aquaculture (Kraly, Weitzman and Filgueira, 2021). Conversely, a study of Tanzanian residents displayed an increase in negative media content and a polarization of attitudes as time passed (Condie, Vince and Alexander, 2022).

There is little media representation research on the variety of aquaculture, technical types and species. This may indicate a framing bias within respective media sources, or a discourse within academia to focus on certain sectors. As sustainability requirements develop and sustainable/restorative practices along with them, it is important to diversify exploration of media representation and understand how different factions can aid overall consumer acceptance. Rickard and Feld-Pausch Parker (2016) reported that scientific development and benefit inclusion emerged in a study of North American media that was in support of the shellfish industry of the Northeast region. However, they additionally reported that risks of fin-fish aquaculture remained heavily emphasized. In order to develop effective communication and education strategies, it will be crucial to perceive public understanding from the many perspectives of aquaculture, analyzing differing parameters such as species type and cultivation methodology.

2.3 Influencing sustainable food consumption

Media representation is known to have an influence on food consumption behaviors that can incite both positive and negative views (Simeone and Scarpato, 2020). Bellotti and Panzone (2015) suggested that media framing is important for sustainable food consumption, where a change in purchasing behavior may be best incited by a non-critical display of relevant information, opposed to a structured and clinical approach. However, a direct mechanism by which information may influence specific food choices among consumers is not understood. It is recognized that food choice decisions are complex and variable, with practical and psychological motives. A study of 942 respondents from The Netherlands indicated that the perceived importance for sustainable food consumption was highest for aspects of taste, price and healthiness (Verain, Dagevos and Antonides, 2015). Sustainability behaviors were largely motivated by personal beliefs and subjective knowledge (Verain, Dagevos and Antonides, 2015). Such findings assert the critical importance of attitudes, subjective norms and perceived behavioral control in forming beliefs and behaviors (Nilsson and Earl, 2020). The media can influence these beliefs via pathways of the media effects theory detailed previously. According to Hoijer et al. (2006), the media also affects consumption behavior by creating fear in outlining dramatic and seemingly urgent threats to human health and situation, that may cultivate warped perceptions. This is perhaps further influenced by the popularity of click bait journalism, which may not accurately represent the topic or content of an article, as negative and/or strategic framing is often prioritized (Marin et al., 2012). Moreover, the volume and liquidity of available content can lead to a lower rate of retention among readers (Zannettou et al., 2019). One study of the Pacific Northwest found that only 45% of participants recalled hearing any news about aquaculture, despite high exposure (Hall and Amberg, 2013). Furthermore, 80% of those that did recall media news regarding aquaculture, could only remember negative aspects (Hall and Amberg, 2013).

When considering the consumption of seafood, there is strong evidence to suggest that western demographics, including Sweden, are not meeting the dietary recommendations for this food group (Jahns et al., 2014; Rönnerstrand et al., 2020). Moreover, it is driven by slightly different antecedents to other food groups and as such, taste may not be a primary characteristic (Olsen, 2004). A systematic review across Europe, USA, Australia, New Zealand and Canada, found that seafood consumption was largely steered by health and moral beliefs, where cost, sensory obstacles and cooking skills were considered frequent barriers (Govzman et al., 2020). Neophobia can also result in the curtailment of less familiar species (Modlinska, 2019). Additional characteristics are present when analyzing consumer patterns for sustainable

seafood, and themes of mistrust and confusion are common (Farmery et al., 2018). Thus, the media's effect as a communication and educational tool could pose significant value as an ally of sustainable aquaculture, via framing and familiarization techniques. In this context, agenda setting, and framing are identified as appropriate theories for this research.

3 Materials and methods

3.1 Content analysis

Aquaculture representation within Swedish media was examined via a content analysis of news articles from five Swedish news sources, from 16th February - 11th April 2022. The study analyzed articles published from January 1, 2011 until December 31, 2021. The only exception was the online-only news source Omni, that was assessed from July 4, 2013 - 31 December 2021, as it began publishing from 2013 onwards.

Content analysis methodology assesses written, visual or verbal media; systematically summarizing qualitative data in a quantitative way (Kraly, Weitzman and Filgueira, 2022). A content analysis approach to media representation seeks to extract the meaning that may be derived from a given source, to understand what the piece is communicating, or omitting, and the impact it has on a given audience (Olsen and Osmundsen, 2017). It is considered a transparent and replicable methodology to study multi-faceted and dynamic qualitative data sources and thus, is an appropriate way to study media content (Govaerts, 2021). Interpretive choice exists due to the subjective nature of deciphering written text, for example, findings may be limited by the understanding and context of the researcher(s). However, a robust coding framework can mitigate this trait (Zaidman-Zait, 2014). Moreover, there are implications toward assessing only news media content as it cannot directly encompass the content expressed within other media types, for example television or podcasts. However, as the media both influences and reflects public opinion (McCombs and Valenzuela, 2021), it is reasoned that multimedia representation exists but the extent to which is not known. Links between public opinion and the media coverage are unlikely to represent a direct causal effect, due to the existence of multiple variables, such as pre-held beliefs and feedback loops (Lleras, 2005). However, it does enable a critical assessment to be made of the overall impressions held, allowing for an interpretation of the underlying context (Olsen and Osmundsen, 2017).

3.2 Sample collection

The data collection and coding system for this study was inspired and adapted from Kraly, Weitzman and Filgueira (2022) (Appendix A). Five news sources within Sweden were chosen that capture the majority of public readership, justified by the need to cover a large public venue and consider variations across different editorial/ political lines (Table 2.). Proximity to aquaculture was also considered.

Dagens Nyheter is a popular Swedish daily newspaper published in Stockholm, that aspires to provide national and international coverage of events from an independent-liberal political position. Aftonbladet, also published in Stockholm, is a social democratic daily evening newspaper displayed in a tabloid format. Göteborgs Posten is a daily newspaper

published in Gothenburg with coverage of local, regional, national and international issues, its stated political position is liberal. Dagens Industri is an industry newspaper in a tabloid format, that also addresses regional, national and international news pieces from a predominantly business perspective. Published in Stockholm, Dagens Industri does not ascribe to a defined political allegiance, yet is regarded as liberal conservative. Omni is online only and a relatively new news provider in Sweden. In 2013, Omni emerged as part of the evolving online and social media landscape and has amassed a large following of dedicated readers from a younger demographic. Omni ascribes that it represents all news and perspectives by analyzing stories from other sources, re-writing and sharing them in a fact-based manner only, and only shares what it considers to be the most important and relevant news (national and international).

The online databases for each news source were explored via desk search, a research method that examines and synthesizes existing data. All the articles that were available online from the respective sources formed part of the secondary dataset. This was then searched using the selected search terms: "v*attenbruk*" (aquaculture), "f*iskodling*" (fish farming), "l*ax odling*" (salmon farming), "m*usslor odling*" (mussel farming), " a*lg odling*" (algae farming/cultivation) and "r*äkodling*" (shrimp farming).

Table 2. Newspaper readership and characteristics

News source	**Type**	**Produced**	**Political line**	**Estimated readers**	**Number of articles**	**Ownership**
Dagens Nyheter	Daily newspaper	Stockholm	Independant-Liberal	819,000	78	Bonnier
Aftonbladet	Daily evening tabloid	Stockholm	Social-democratic	398,000	66	Schibsted/ Landsorganisationen
Göteborgs Posten	Daily Newspaper	Göteborg	Liberal	319,000	88	Stampen AB
Dagens Industri	Daily industry tabloid	Stockholm	Liberal-conservative	294,000	40	Bonnier
Omni	News bulletin	Online	Independant	550,000	12	Schibsted

3.3 Coding structure and selection

All articles returned under the search terms (n=838) were included and explored using the PRIMSA (Preferred Reporting Items for Systematic Reviews and Meta Analysis) method (Identification step, Fig.1). Once identified, any matching articles that appeared more than once were treated as duplicates and only one was included (Screening step, Fig. 1). Articles that had similar titles, or reported on the same stories but under different descriptions, were included in

the final analysis. Articles that only made mention to the selected keywords in passing were deemed non relevant articles and so were also excluded (Eligibility step, Fig 1). The process revealed 284 articles applicable to this study (Inclusion step, Fig 1).

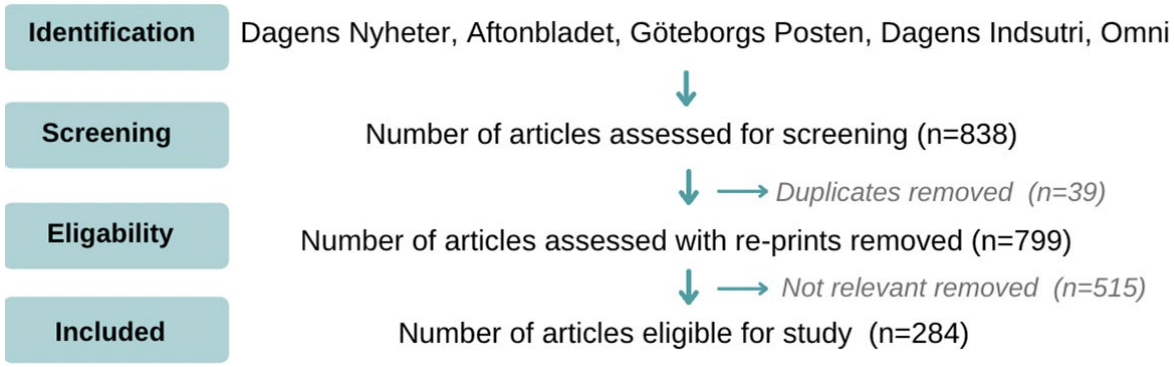


Figure 1. PRISMA flowchart article selection process within online news databases for search terms: "vattenbruk", "fiskodling", “lax odling", "musslor odling", “alg odling" and “räkodling” *(aquaculture, fish farming, salmon farming, mussel farming and shrimp farming, respectively).*

All data was analyzed using Microsoft Excel v.16.11.1. Articles were coded by the source, year, tone, aquaculture type (Salmon, Mussel, Algae, Shrimp, General and Other), PESTE attributes (Political, Environmental, Social, Technical and Economic) and main topics. Categorical data variables were converted using one-hot encoding that marked each observation either as belonging (value=1) or not (value=0) within each group. The source was used to evaluate the representation and potential understanding within different political/editorial lines and the year was used to ascertain themes and issues over time. To explore the ways that the media representation positions aquaculture, the overall tone of the article was noted as either: Negative, Neutral or Positive, by using a qualitative analysis of the language within the text, and the topic(s) discussed. The positive and negative tonal framings were assigned to articles that considered aquaculture under predominantly benefit or risk frames, respectively. A neutral category was assigned for those that presented no view of the information shared or expressed both positive and negative views in balance. (The full classification characteristics are attached as Appendix A). To explore the types of discussions that are being communicated, PESTE attributes were assigned. Depending on the representation and discussions held of the topics within each article, it is possible for one article to display multiple PESTE attributes and these were assigned as such. The type of aquaculture refers to the aquaculture species that the article discusses, where salmon, mussel, algae and shrimp groups were considered. The salmon group encompassed any salmonid species that emerged during data collection, for example trout and char. Where no species was mentioned specifically, a general category was assigned and an “other” category was assigned for any additional species that appeared during data collection. (The composition of this group is also detailed within Appendix A). Lastly, the main topics are those that dominated the discussion of each article, for example, the link between eutrophication and fish farming. Such topics were assigned iteratively as they emerged gradually during the analysis process. It was possible for one article to communicate multiple topics. Chi square tests of independence were performed to determine statistical significance between relevant categorical data groups.

3.4 Data analysis

A positive association was established between the number of articles (n=284) and the year of publication using linear regression (Figure 2a). However, the correlation coefficient (R= 0.49) indicated a weak correlation overall, as a value between 0.3-0.5 is considered as such for a linear relationship (Moore and Flinger, 2013). Articles were most frequent from Göteborgs Posten (*n*=88; 30.99 %), followed by Dagens Nyheter (*n*=78; 27.46%) and Aftonbladet (*n*=66; 23.24%). Dagens industri accounted for 14.08% (*n*=40) and Omni featured the least amount of articles with 4.23% (*n*=12). Omni was not active in 2011 and 2012, accounting for the lack of articles for this source at that time. Multiple and varied fluctuations were present between years and individual news sources (Figure 2b). Aftonbladet, Dagens Industri and Omni displayed positive associations with strong, moderate and weak correlations, respectively (R= 0.74, 0.52 and 0.24, respectively) (Moore and Flinger, 2013). Göteborgs Posten and Dagens Nyheter displayed minor positive associations and no linear relationship, indicating there was not an increase in articles over this time for these newspapers (R= 0.07 and 0.08, respectively) (Moore and Flinger, 2013). Peaks emerged in 2013 and 2019 for each source, with the exception of Dagens Industri that did not display any significant peaks or troughs. 2019 featured the highest number of articles overall (*n*=48 16.90%).

a.

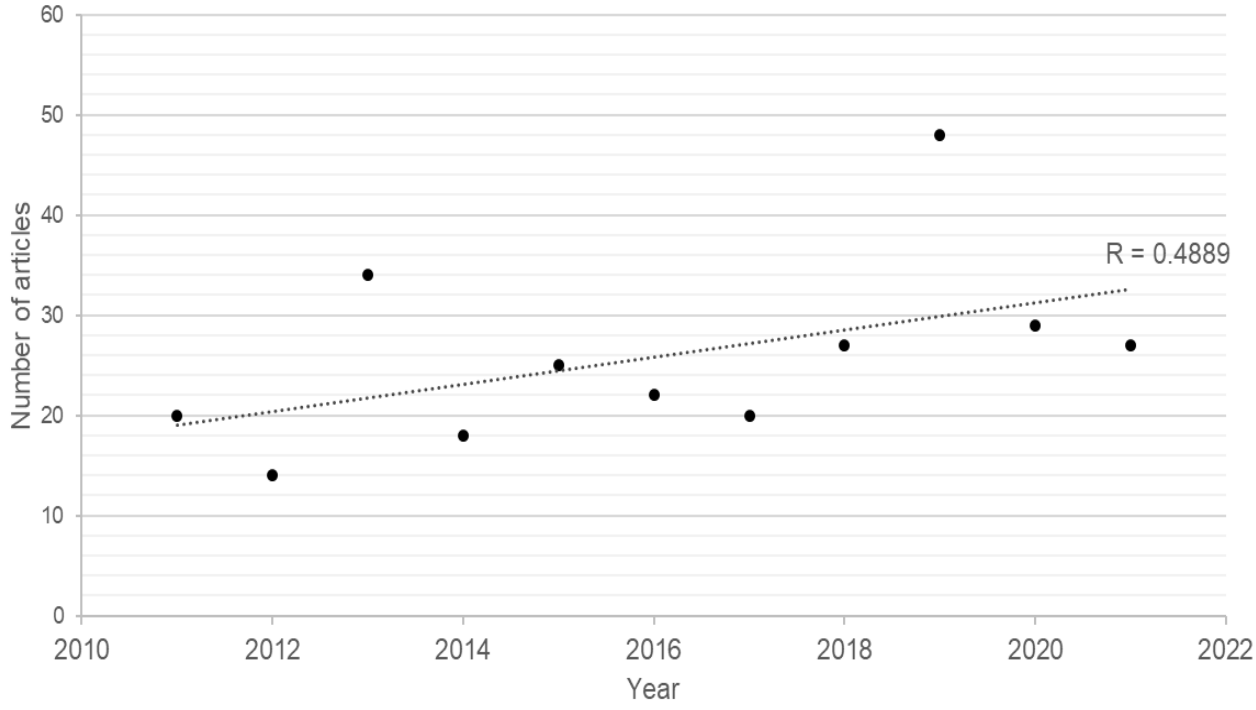
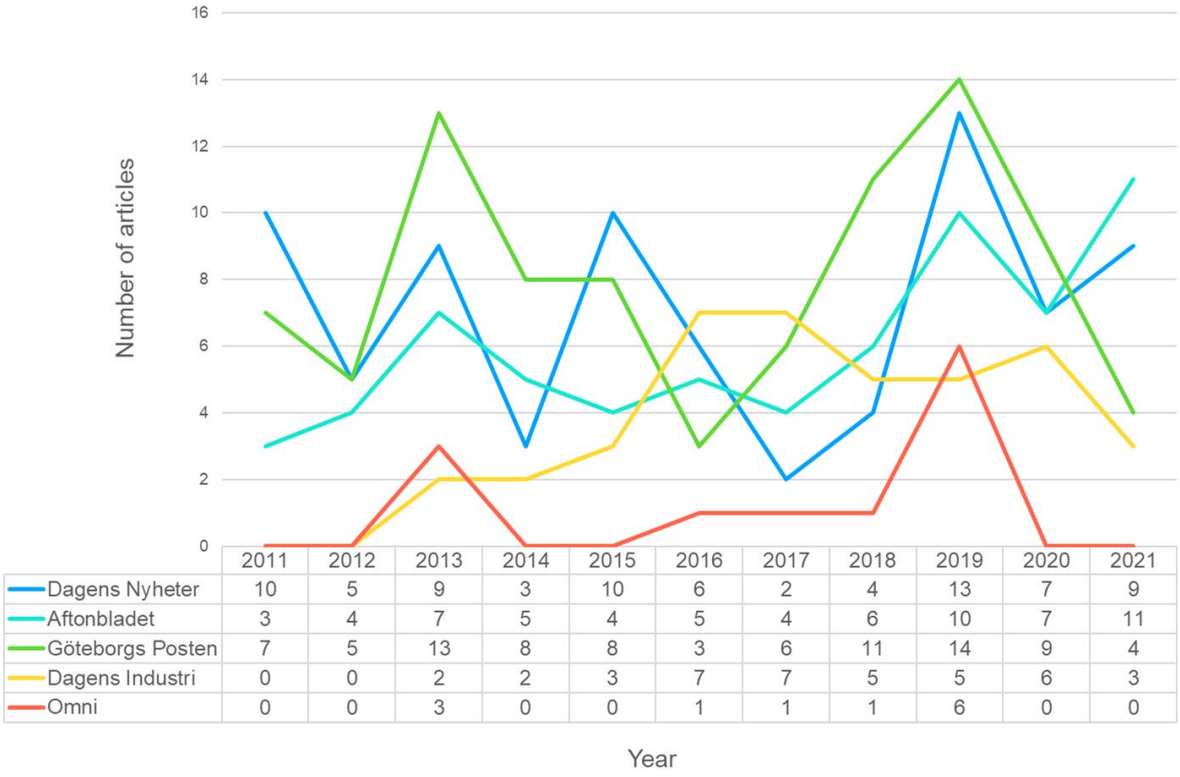


Figure 2.**a**. Linear regression analysis of total articles pertaining to aquaculture plotted over the year of publication from 2011-2021. R=0.4889, n=284.

b.



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Dagens Nyheter	10	5	9	3	10	6	2	4	13	7	9
Aftonbladet	3	4	7	5	4	5	4	6	10	7	11
Göteborgs Posten	7	5	13	8	8	3	6	11	14	9	4
Dagens Industri	0	0	2	2	3	7	7	5	5	6	3
Omni	0	0	3	0	0	1	1	1	6	0	0

Figure 2.**b**. Number of articles pertaining to aquaculture per each news source: *Dagens Nyheter, Aftonbladet, Göteborgs Posten, Dagens industri* and *Omni* from 2011-2021. *Omni* was launched in 2013.

4 Results

4.1 Tone of the Articles

Swedish media represented aquaculture across each tone (negative, positive and neutral) with a roughly even distribution. Positive representation was greatest (n=104; 36.62% of articles) and negative and neutral tones were exhibited in 32.39% (n=92) and 30.99% (n=88) of articles, respectively. Positive discourse overall was found to be increasing (R=0.71) whereas negative and neutral tones displayed no significant linear relationship with time (R=0.19 and 0.15, respectively) (Figure 3.). The peak in 2013 was largely a display of negatively framed articles and the peak in 2019 was mainly attributed to both negative and positive framings (Figure 3.).

The tone varied dependent on the aquaculture species being discussed in the article (Table 3) but did not vary significantly with respect to the news source ($p > 0.05$) (Table 4.). A Chi-

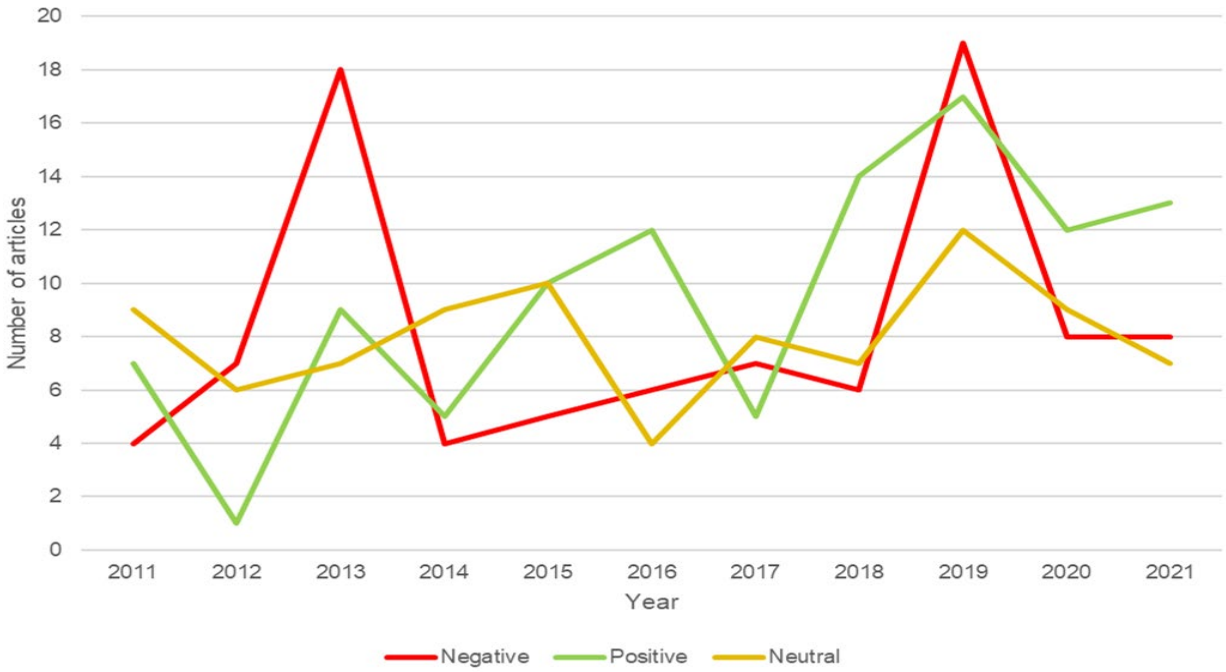


Figure 3. Tone within articles (negative, positive, neutral) over the assessed time period (2011-2021).

square test of independence was used to measure how the observed results compared to statistical expectations. The results identified a significant association between aquaculture type and negative tones, $\chi 2$ (5, n=106) = 46.11, $p < 0.001$ and a significant association between aquaculture type and positive tones was also found, $\chi 2$ (5, n=140) = 40.13, $p < 0.001$. This format (df, n = $\chi 2$, p) denotes the degrees of freedom (df), total number of values (*n),* chi square critical value ($\chi 2$) and significance value (p). There was no significant relationship between neutral tones and the aquaculture type ($p > 0.05$). Articles that discussed salmon or salmonid (df, n = $\chi 2$, p) denotes the degrees of freedom (df), total number of values (*n),* chi square species were most represented by negative tones (n=62; 54.87%), whereas articles discussing mussel and algae cultivation were predominantly positive, 58.70% (n=27) and 79.41% (n=27), respectively. The "other" category comprised mostly of lower trophic species groups such as oysters and sea urchins, and articles regarding land-based aquaponics were also assigned here (Appendix 2). Thus, the results suggested that lower trophic species and aquaponics practices were also favored positively overall (n=30; 66.67%) (Table 3.). Neutral tones were the most representative category for articles regarding shrimp cultivation and aquaculture in general, 50.00% (n=6) and 42.86% (n=45), respectively. Each group was represented across all three tonal categories, with the exception of algae that returned no negative results. Positive discourse was found to be increasing over time moderately for salmon (R=0.66), and with a strong positive relationship for algae (R=0.80). No other species experienced a significant directional change in tone over the assessed time period. It is clear that media framing of aquaculture in Sweden does change in relation to the species in question.

Table 3. Species representation per each tone (negative, positive, neutral)

	Salmon	Mussel	Algae	Shrimp	General	Other*
Negative	62	5	0	3	32	4
Positive	25	27	27	3	28	30
Neutral	26	14	7	6	45	11

**Other category components: oyster (n=15), land aquaponics (n=12), sea urchin (n=7), sea cucumber (n=3), jellyfish (n=2), sturgeon (n=2), pangasius (n=1), carp (n=1), lobster (n=1), eel (n=1).*

Table 4. Tone distribution per news source

	Dagens Nyheter	Aftonbladet	Göteborgs Posten	Dagens Industri	Omni
Negative	27	25	24	11	5
Positive	24	21	34	19	6
Neutral	27	34	19	10	1

Chi-square test of independence ($p>0.05$) for each variable combination

4.2 Species representation

In terms of quantity, salmonid aquaculture received the greatest amount of media attention (*n*=133, 39.79%), followed by aquaculture generally (*n*=105, 36.97%). Moreover, the aforementioned peak (section 4.1) in 2013 emerged largely in relation to these two groups (salmon: *n*= 15; 13.27% and general: *n*=15; 14.29%). Whereas in 2019, the peak was primarily caused by salmon articles only (*n*=20; 17.69%) (Figure 4.). Mussel and algae related articles were featured 46 and 34 times (16.20% and 11.97%), respectively. Other species were featured 45 times (15.84%) and shrimp aquaculture was discussed the least with a total of 12 articles (4.22%). Representation was found to be increasing over time for salmon and algae aquaculture only (R= 0.62 and 0.75, respectively). These coefficient values indicated a moderate and strong relationship, respectively (Moore and Flinger, 2013). There was no strong linear relationship exhibited for any of the other groups. Instead, they demonstrated periods of peak activity that rose and fell, or experienced no discernible change (Figure 4.). For example, shrimp aquaculture had a peak value in 2015 (*n*=5; 41.67%) that declined thereafter and remained constantly below this threshold.

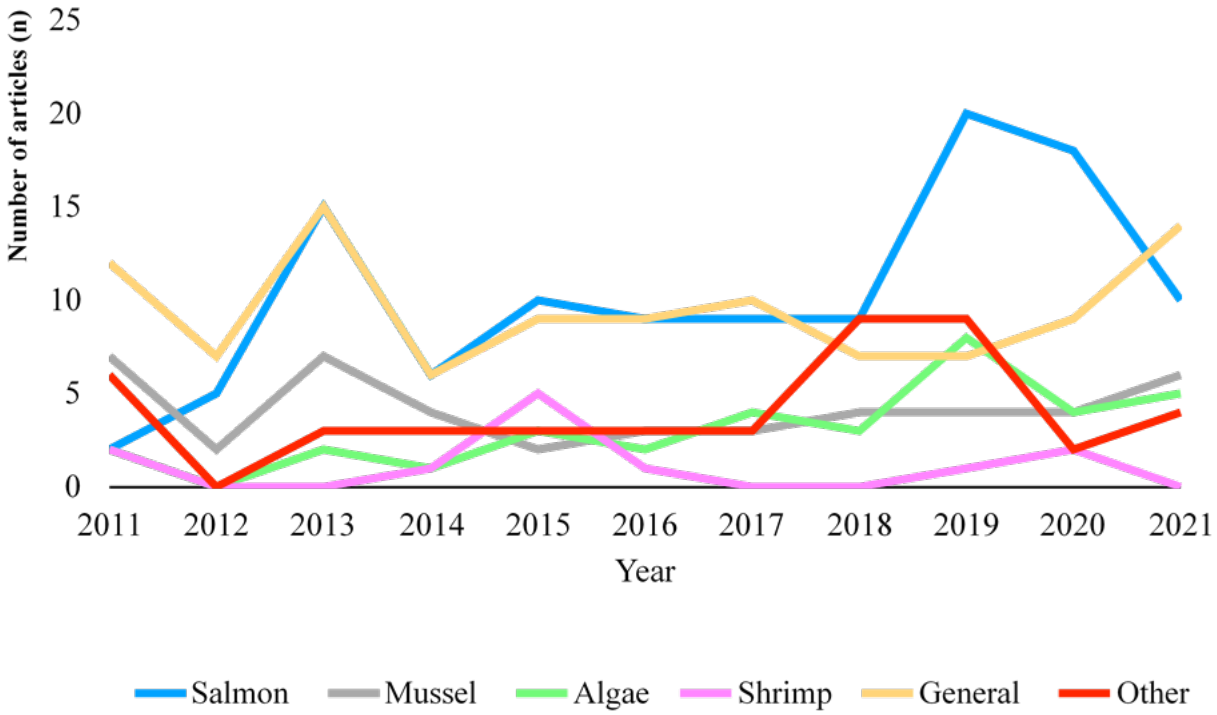


Figure 4. Distribution of articles (n) per each aquaculture type (salmon, mussel, algae, shrimp, general and other) over time (year)

4.3 PESTE attributes

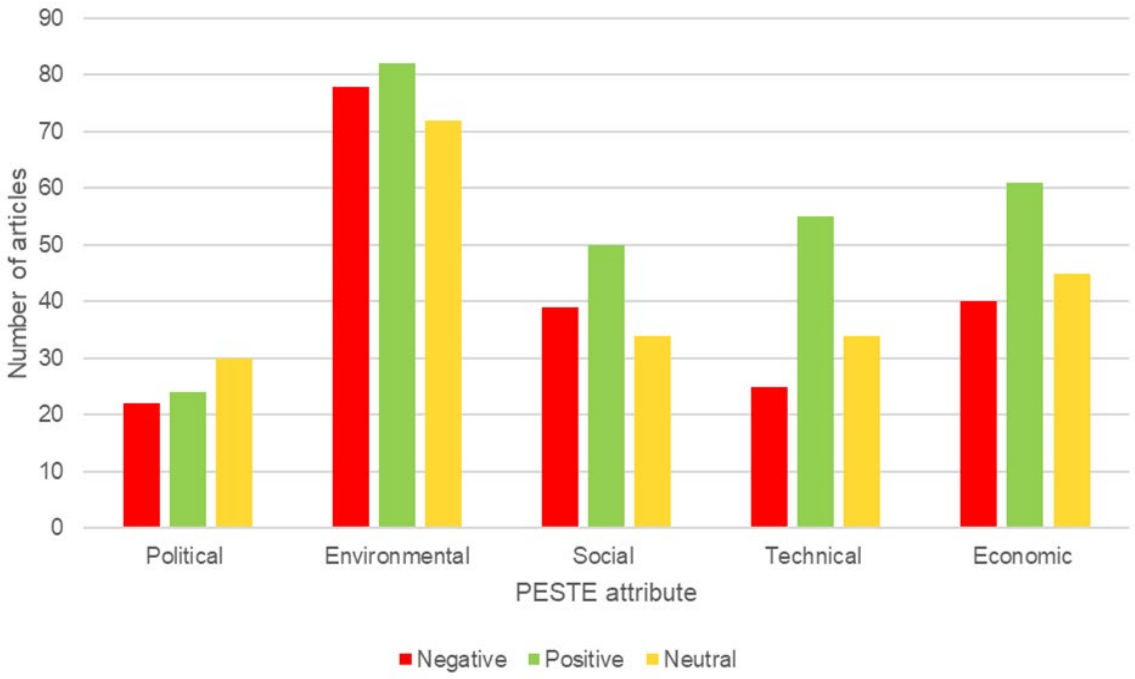


Figure 5. Distribution of representation within articles per PESTE attribute

There was no significant relatedness between the PESTE attributes displayed within an article and the individual species group(s) that article pertained to ($p>0.05$, for each aquaculture type). Yet, the representation of environmental attributes within aquaculture received the most impressions overall (*n*=232; 33.57%). Social, technical and economic aspects were considered in 17.80%, 16.50% and 21.13% of articles (*n*= 123, 114 and 146), respectively. Political aspects of aquaculture were the least discussed (n=76; 11.00%). This pattern was largely representative for each individual aquaculture type as well. Thus, it was observed for each group that the environmental attribute led; social, technical and economic aspects performed similarly but experienced no consistent pattern; and political attributes featured the least (Table 5.). The environmental attribute was also the leading consideration per each news source (not shown).

Positive tones emerged as the most utilized tone for every PESTE attribute, with the exception of the political category that was expressed in largely neutral tones (Figure 5.). The Environmental attribute overall had the greatest number of positively framed articles (*n*=82; 11.87%) yet was also represented almost equally by negatively framed pieces (*n*=78; 11.29%). Whilst the technical attribute presented second to last in terms of representation, it was the only attribute that received significant positive directional growth over the assessment period ($R=0.80$). All other PESTE attributes displayed positive associations but weak correlations over time ($R<0.47$).

Table 5. PESTE attributes considered for each tone of each aquaculture type.
(Gradient (n): 0-10; clear, 11-20; light gray, 21-30; medium gray, 31+; dark gray)

Species	Tone	Political	Environment	Social	Technical	Economic
Salmon	*Negative*	14	51	27	18	33
	Positive	5	13	11	8	20
	Neutral	8	21	11	14	13
Mussel	*Negative*	0	4	0	3	2
	Positive	7	25	16	17	8
	Neutral	4	14	5	5	6
Algae	*Negative*	0	0	0	0	0
	Positive	6	24	20	15	9
	Neutral	4	4	4	1	3
Shrimp	*Negative*	1	1	0	0	1
	Positive	1	3	2	2	0
	Neutral	1	6	4	4	1
General	*Negative*	8	28	17	6	8

Table 5. PESTE attributes considered for each tone of each aquaculture type.
(Gradient (n): 0-10; clear, 11-20; light gray, 21-30; medium gray, 31+; dark gray)

Species	Tone	Political	Environment	Social	Technical	Economic
	Positive	10	21	15	18	17
	Neutral	15	35	15	18	26
Other	*Negative*	2	4	1	0	1
	Positive	5	27	16	17	18
	Neutral	1	3	1	1	3

4.4 Main topics

A range of recurring topics emerged among the articles, and the number of topics per attribute emerged to align with the overall representation of that attribute (Table 3; Figure 6). Only topics that were represented in >1% of overall articles were included (*n*=530). These were filtered iteratively by analyzing the content of each article for the subject matter, where each article could display one or multiple topics (*n*≥ 1). The five leading topics were: (1) "Sustainable potential" (*n*= 49; 9.25%), (2) "Benefits of low trophic species/IMTA" (*n*=44; 8.30%), (3) "Industry development" (*n*=37; 6.98%), (4) "Environmental degradation" (*n*=36; 6.79%) and (5) "Eutrophication" (*n*=29; 5.47%). All of these were elements of the environmental attribute, aside from "industry development" that featured as a component of the economic attribute. The two leading environmental topics (sustainable potential and benefits of low trophic species/IMTA) represented advantageous aspects of aquaculture. Yet, the remaining topics within this category were all considered as risk orientated considerations, for example "disease and parasites" (Figure 6.). With the exception of "industry development" and "economic benefits", the first five environmental topics exhibit a greater presence than any other observed theme.

"Bureaucracy/ lack of political will" was the leading topic of the political attribute, and "user conflicts" hailed the greatest reception of the social attribute". "Local consumption" also received a similar level of press here. "Technology information/ development" was the leading interest among the technical attribute. Thus, it appeared the theme of development was prevalent across Environmental, Technical and Economic attributes. "Economic benefits" and "Economic costs" were represented similarly through-out this study. Themes of "Insufficient policy", "Antibiotic use", "Seafood consumer costs", "Alternate uses for cultivation" and "Investments/funding" represented the least dominant central topics, across each PESTE attribute, respectively.

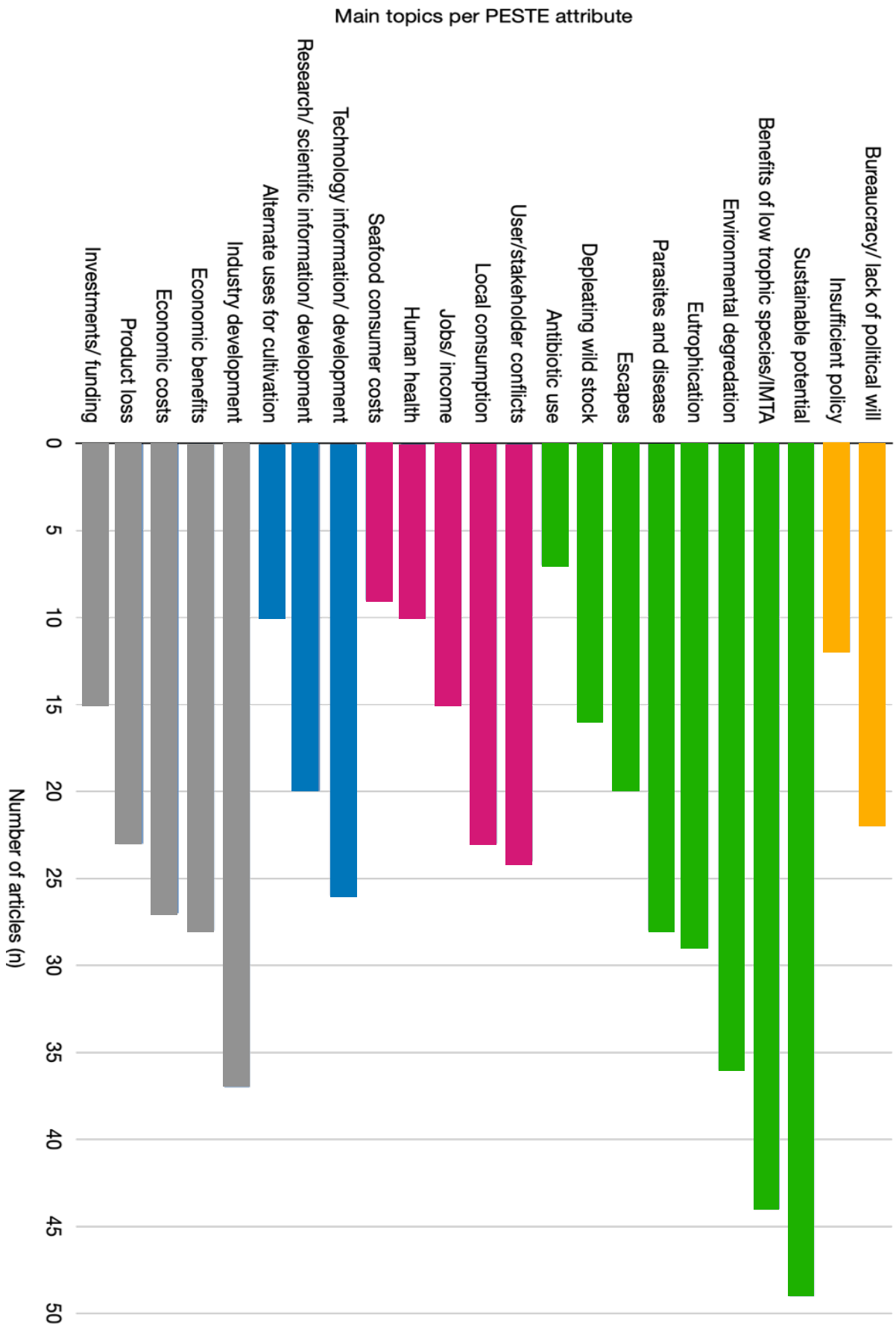


Figure 6. Main topics described within articles (n) in Swedish media, grouped via PESTE attribute. Key: Yellow; Political, Green; Environmental, Pink; Social, Blue; Technical, Grey; Economic.

5 Discussion

How individuals and the public generally perceive the risks and benefits of an industry, activity or belief is recognized as a significant factor in predicting the attitudes and behaviors conducted in relation to them. This influences the acceptance and growth that a sector could experience, particularly in an industry with pre-existing image challenges, such as aquaculture. This thesis identified how Swedish written news media has portrayed a variety of species within aquaculture over a ten year period, analyzing the occurrence of political, environmental, social, technical and economic attributes. These assist in understanding the agenda being set within this context. Framing was analyzed by considering the overall tone of the articles and the main topics on the agenda within these attributes were identified. This research is relevant in interpreting levels of social acceptance and public understanding toward the industry in this region.

5.1 Aquaculture inclusion in Swedish media

Göteborgs Posten shared the most articles (31.33%) and demonstrated positive/neutral framing in 72.72% of all publications shared (Table 4.). *Göteborgs Posten* is the only selected news source published on the West coast of Sweden, the others are published in Stockholm (East) or as online only (Table 2.). Aquaculture in Sweden is greatest in the North (46%), however the West/ South of Sweden has more than triple the aquaculture of the East (41% and 13%, respectively)(Stymne, 2018). Thus, the results may indicate that there is a positive relationship between proximity to aquaculture cultivation and benefit related media representation. However, this was not evident as a function of time during this study (Göteborgs Posten, R=0.07). An exploration of northern residents' attitudes could facilitate a better understanding of this hypothesis. As previously detailed, proximity to and history of aquaculture was reported in Kraly, Weitzman and Filgueira (2022) to correlate positively with increased acceptance. Aquaculture in Sweden does not yet have a long history, but this could suggest that a positive relationship may continue to emerge as a function of proximity and time. This is thought to be because proximity leads to increased exposure, education and knowledge sharing (Holdt Christensen and Pedersen, 2018), that could endow a public shift toward active inference - where active beliefs toward aquaculture are held. Such beliefs are presently lacking in Sweden (Rönnerstrand et al., 2020). Thus, engagement and activities with stakeholders and news groups from other parts of Sweden could be considered to facilitate more direct encounters with local aquaculture, to broaden the reach of this proposed effect. Cooking events and courses may be particularly influential for increased consumption, as a lack of perceived cooking ability is a barrier toward seafood products (Govzman et al., 2020) and perceived behavioral control is a leading attribute of attitude formation (Nilsson and Earl, 2020).

The overall inclusion of aquaculture in Swedish media displays a positive association but is weakly correlated over time (R=0.49, Figure 2.a.). This growth was largely due to positive directional increases from *Aftonbladet* (R=0.79) and *Dagens Industri* (R=0.52). These sources do not ascribe to the same political ideologies or operate under a singular ownership (Table 2.). Yet, they are both considered to provide a more conservative line of communication, and the observed growth was largely attributed to economic development within the industry. This could suggest a positive public discourse toward the economic position of aquaculture among more right wing individuals, who are cited as more efficiency minded and less egalitarian

(Müller and Renes, 2020). This posited relationship would need to be researched further and established within the context of the country in question.

There was little representation of aquaculture in the online news source Omni, that only returned 38 searches and 12 relevant articles. Omni self asserts that it only focuses on top news stories: compiling the most important pieces from other sources, re-writing them into balanced, multi perspective pieces (Omni.se, 2022). As this information is provided by the source, there is a strong possibility for bias and subjectivity. Yet, the lack of inclusion of the topic altogether could suggest a present dissociation between the Swedish media and its perceived belief in the relevance of aquaculture to the Swedish people. A total of 838 articles were isolated during data collection, 284 of which were analyzed as suitable for the study (Figure 1.). This is fewer articles than found in some similar studies conducted in production countries, like Norway, Canada and the UK (Kraly, Weitzman, Filgueira 2022; Olsen and Osmundsen 2017, Schlag 2011). However, a study of French press (Govaerts, 2021) demonstrated less articles pertaining to aquaculture over a parallel time period (n= 134). This could indicate that aquaculture is less frequently on the agenda of importing countries than production countries. A study would be required to test this hypothesis and the influence this could have toward Sweden as a country aiming to increase production. Nonetheless, a lack of representation is thought to be a disservice to growth and development of sectors such as aquaculture, and could be linked to themes of misunderstanding and a lack of understanding altogether. Rönnerstrand et al. (2020) revealed that 31-58% of Swedes lack any perception at all toward farmed fish, thus it is likely that the amount of media representation of aquaculture needs to increase in Sweden to aid public perception. Success will reside in demonstrating the value and direct significance that aquaculture has toward the lives of individuals/community groups and the environment, which was a leading consideration in this study (Table 4.).

5.2 Species on the agenda

Media representation is increasing among salmon and algae articles that have elicited moderate and strong growth trends over the assessed period (R= 0.62 and 0.75, respectively). Moreover, they were found to be attributed to the growth of positively framed articles. This is perhaps particularly significant for salmon aquaculture that, as previously discussed, has a notoriously controversial reputation, inspiring much of the research in this area (Schlag, 2011; Osmundsen and Olsen, 2017; Govaerts, 2021; Kraly, Weitzman and Filgueira, 2022). The overall perception of salmon aquaculture is largely negative in Swedish media, as this tone accounted for the largest proportion of the articles (Table 3.). Moreover, it was significantly more negative than other species framing ($p<0.001$)(Table 4.). Yet, an increasing positive discourse was present, a result that is seemingly independent to those of other studies. This was largely in relation to the beneficial economic aspects of this species group (30.30%) and the social implications it holds (22.45%). For example: “jobs and income” (Table4; Figure 6). Negative tones were most prominent for environmental considerations of this aquaculture type, where topics such as “escapes' ' and “disease” were considered. This alludes to the complex and dynamic relationships that determine public preference and acceptance, that can be juxtaposed depending on the perspective taken in addressing the topic. In their study of salmon in Canada, Kraly, Weitzman and Filgueira (2022) posit economic contributions and benefits as one of the only drivers of positive aquaculture portrayal. This was also a key finding from Thomas et al. (2017) that demonstrated the popular desire for aquaculture development (from surveyed recipients on the Swedish west coast), in order to secure economic betterment. These results indicate that it is likely positive growth will stem from this facet of the industry.

Communication strategies should therefore focus on utilizing such drivers to also depict factual information on the greatest concerns held by the public of the industry, to generate a holistic understanding in differing contexts (for example local and international). High awareness is believed to improve overall acceptability (Thomas et al., 2017) and transparency toward consumers is critical in building trust (Kang and Hustvedt, 2013).

If it is recognised that aquaculture practices in Europe are new, then the practice of cultivating and consuming algae/seaweed products is in its infancy. Neophobia and a lack of culinary tradition are possible barriers to acceptance, however there is a positive reception among consumers toward the credence of these products (Palmieri and Forleo, 2020; Losada-Lopez, Dopico and Faína-Medín, 2021). Thus, it is reasonable that the media would reflect and encourage this via positive framing and inclusion (McCombs and Valenzuela, 2021). The results indicate that algal aquaculture was not on the agenda during the primary years of this study (Figure 4.), accounting for the strong growth trend observed, although numeric values remained modest. This is in keeping with the timeline of Sweden's local successes within algal cultivation, sparked by the Seafarm project in 2014 (Thomas, 2018). The environmental benefits and potential to achieve sustainability goals via the cultivation of seaweeds were leading themes among Swedish media (Figure 6.). Indeed, seaweed farming is also attributed to possibilities beyond the realms of aquatic food systems and other uses for cultivation are posited too (Figure 6.). This may be correlated to the broader insurgence of interest toward seaweed species as potential solutions toward several global anthropogenic challenges. For example, climate change and the global fuel crisis (Mouritsen et al., 2020; Yong, Thien, Rupert and Rodrigues, 2022). It appears that seaweeds may have become a public symbol of hope, propagated by scientific rhetoric and may act as motivators for pro environmental behaviours (Ojala, 2012). This is an important and exciting consideration, yet, it is paramount that the true capabilities of seaweeds do not become overstated in the media. A nature based example of the 'no free lunch' theorem (that posits a universal optimisation strategy is impossible for any activity) (Ho and Pepyne, 2002), seaweeds should not be seen as the "silver bullet" to sustainable aquaculture. This is a central distinction from Costa-Pierce and Chopin (2021), who detail the consequences of over dependance on the theorised potential of aquaculture, apposed to its reality. The significant relationship ($p<0.001$) between positive tones and species type indicates that algal practises may be over emphasised in this group. This is not a problem in and of itself, indeed it suggests a valuable present trend for the Swedish seaweed industry. However, previous research denotes that public perception and interest in this sector does not operate unidirectionally (Costa-Pierce and Chopin, 2021; Condie, Vince and Alexander, 2022).

5.3 Factors influencing aquaculture portrayal in Sweden

Environmental aspects within aquaculture were the most dominant, irrespective of the source or species, indicating that environmental issues are overemphasised. This may present as a positive feedback loop, amplifying this aspect as both the media and the public react to each other within a closed system (McCombs and Valenzuela, 2021). However, the environmental attribute was not found to correlate with time toward a significant increase in the number of articles. Environmental risk framings were skewed toward articles pertaining to salmon, whereas low trophic species were largely framed toward benefit aspects of the environment. The former is akin too many similar studies regarding salmon aquaculture (Shlag 2011; Olsen and Osmudsen, 2017 and Kraly, Weitzman and Filgueria, 2022) suggesting that a comparable curtailment toward public acceptance is also present in Sweden. Aspects of environmental damage from abandoned equipment, escapes, disease/parasites and algal

blooms caused by fish farms tied to the general negative opinion of the industry. On one occasion a six part public debate was sparked between two opposing opinions of salmon aquaculture as an initial article called for a ban on "toxic Norwegian industrial salmon" (Dagens Nyheter, 2019). Hyperbolic language such as: "katastrof för hela det ekologiska systemet i havet" (catastrophe for the entire ecological system in the sea) and "vidrigare än han någonsin kunnat föreställa sig" (more disgusting than he could have ever imagined) (Dagens Nyheter, 2019), demonstrates the emotional response that aquaculture can elicit in certain instances.

Shellfish, seaweed and low trophic species have innate sustainability benefits by way of comparison to fin-fish species due to biological features (such as not requiring direct feed), that lend themselves to different practises within aquaculture. Rickard and Feldpausch-Parker (2016) suggest that these practical differences between species may have influenced the political, social and scientific treatment they receive, based on what it was expected they could achieve. As such, it is likely that risk mitigation would be central in fin-fish aquaculture and low trophic groups would be encouraged to emerge as sustainable or regenerative. In Sweden, the potential of mussel and algae farming to reduce eutrophication was prevalent (Aftonbladet, 2013; Dagens Nyheter, 2015) and balanced considerations towards its practicalities were present (Göteborgs Posten, 2018). This highlights that further positive discourse could emerge should IMTA practises become commonplace for fin-fish cultivation. Interestingly, few articles explored the potential benefits toward species diversity, perhaps indicating that eco-systems goods and services are not understood or valued to their full capacity in this context.

Although not a dominant theme overall (Figure 5.), the *technology* attribute was the only attribute to increase with time (R=0.8) and was largely expressed in positive tones (Figure 5.). "Technology information and development" and "Research/Scientific information/development" were the leading topics, inferring that these themes are implicit in driving the positive discourse present overall. For example, articles considering innovations that can predict algal blooms and assist with harvesting times (Aftonbladet, 2021; Göteborgs Posten, 2021). This can be viewed as a positive distinction for the public perception of aquaculture in Sweden. This finding was similar to that displayed in the aforementioned studies of salmon aquaculture in Norway and Canada (Olsen and Osmundsen, 2017 and Kraly Weitzman and Filgueira,2022, respectively). The potential benefits that improved technology could impose onto economic aspects of the industry were also considered. Negative framing was not prominent toward technological aspects but second level consequences toward the environmental impacts that irresponsibly implemented technology could cause were displayed (Göteborgs Posten, 2020). It is possible that the under-representation of scientific advancements and sustainability aspects, alongside risk rhetoric, could explain some of the on-going public controversy cited by the literature (Olsen and Osmundsen, 2017).

As previously discussed (section 5.1) e*conomic* considerations largely pertained to the industries development. For example, the implementation of a land based salmon farm in Bohuslan (Dagens Nyheter, 2020; Aftonbladet, 2020). Thus demonstrating that the economic possibilities within aquaculture are an area of public interest and a significant factor toward evolving the positive portrayal of aquaculture in this context. As previously mentioned, economic benefits have also been illustrated as a driving component of positive attitudes in other studies (Feucht and Zander, 2016; Kraly, Weitzman and Filqueira, 2022).

Social considerations largely pertained user/stakeholder conflicts, for example, articles that reported on sabotage within fish farms from environmental activists (Göteborgs Posten,

2012) Concerns regarding human health have been dominant considerations in other contexts (Govaerts, 2021), however featured less prominently within Swedish media.

Political attributes were the least influential within Swedish media overall. This is both supported and contradicted within the literature (Shlag, 2011; Olsen and Osmundsen, 2017; Govaerts, 2021; Kraly, Weitzman and Filqueira, 2022) indicating that media interest and public concerns vary in relation to the country of study. The potential political factors of aquaculture were related to how the sector is managed and approached by governing entities, largely positing balanced articles that addressed issues of bureaucracy and lack of political will (Figure 5; Figure 6). Bromley-Trujillo and Karch (2019) suggest a positive link between media coverage and legislative action is critical, as salient issues receive more attention and associated change, where topics of greater scientific uncertainty reduce the likelihood of legislative introductions. Thus indicating that the lack of political representation in Sweden may be a contributory factor toward the leading topic within the political attribute.

5.4 Lack of information and misinformation

Some false and inaccurate aspects of aquaculture emerged during this study but did not present regularly or as leading themes. For example, that half of all seafood (the consumer) eats is farmed (Dagens Nyheter, 2011). As previously stated, aquaculture production and consumption is not globally uniform and heavily skews towards Asia (FAO,2020). Therefore it is unlikely half of all consumed fish is farmed unless a consumer is located in this region (Costa-Pierce and Chopin, 2021). This disingenuous media bite could be damaging to aquaculture in aquaculture developing countries, as the public may feel undermined and inundated by a production method that they do not understand. Believing farmed products have already made it onto their every day dinner table without their knowledge. This inaccuracy could negatively impact the industry as it tries to achieve the utilisation and access it is already believed to have.

Another misconception was that there won't be any fish left in the ocean by 2050 (Dagens Nyheter, 2011). The origins of this claim are derived from the 2006 paper by Worm et al that predicted a "*collapse of all taxa currently fished by the mid 21st century*". It was scientifically concluded that the predictions made here were inaccurate and the authors themselves overturned their findings three years later (Worm et al., 2009). Nevertheless, the headline proliferated too infamy and continues to emerge over a decade later. The level of attention this paper received is not necessarily surprising as research suggests that consumer interest is greatest for negatively/ strategically focused content (Trussler and Soroka, 2014). It is therefore reasoned that the news supply would adjust to accommodate this, due to the capitalist nature of markets. It also indicates that even if negative disinformation is mentioned infrequently, as demonstrated in Swedish media, it can develop a disproportionate strong hold in societal circles. As such, it is critical that current scientific and research attributes become more commonplace in news articles generally. It is estimated that only 10% of peer-reviewed pieces of research are shared within the media (Lobo-Antunes, 2016). This study suggests that scientific aquaculture research is underrepresented in Swedish media (Figure 6.). However, media inclusion of other industries was not explored and thus cross comparison to other scientific disciplines are not made. Consistency from individuals and institutions working with aquaculture to continually make contact with news sources and market their work at every stage of its development is required. There is a reputation within academia that researchers do not want to simplify their work, even though general communication efforts are supported

(Rose, Markowitz and Brossard, 2020). Or, find a lack of institutional support and experience issues with self confidence (Rose, Markowitz and Brossard, 2020). Additionally, sharing may only occur on platforms and websites frequented within academia. Communication and branding techniques must be designed with the end consumer in mind; marketed and sold like other products to generate trust and social license. One suggestion is the cultivation of more user generated content (USG) from scientists, industry workers and advocates, building a personal brand around sustainable/ regenerative aquaculture. USG's effectiveness is supported by the self-determination theory (SDT) that identifies human physiological needs, where it principally motivates an individuals requirement for relatedness and satisfies their trust beliefs (Wang and Li, 2016). People respond better to other people than they do to businesses and this is, to an extent, displayed via the exponential growth of the 'influencer marketing' sector seen in recent years. As of 2021, the current market value for this sector is 13.8 billion dollars, an eight fold increase from the 1.7 billion market cap of 2016 (Global influencer market size 2021, Statista 2022). Presently, online social media sites like TikTok, YouTube and Twitter are some of the most effective and strategic business and educational platforms available. Research to explore public attitudes of aquaculture on social media platforms that operate in real time would be a valuable addition to this study.

5.5 Limitations

The use of an industry targeted news source (*Dagens Industri*) created an explorative context more skewed toward economic facets of aquaculture, that in turn impacted the resulting distribution of PESTE factors. This line of discourse may have been less represented if only general editorial lines were selected and this could be a consideration of change for further work. However, as the study aimed to distinguish the public perception of aquaculture in Swedish media, this selection was justified due to its popular readership that suggests its significance and influence unto the target audience.

Due to the nature of content analysis methodology, reductive and subjective limitations reside. Words and phrases were used to determine the overall framing of the articles as per the examined tones and attributes. This could have had the unintended effect of being insensitive to nuance, subject to linguistic ambiguity and does not often provide an understanding of the context. Similarly, as the author is not a native Swedish speaker, these aspects may have been exemplified. Yet, a native speaking translator was consulted to provide clarification of lexical interpretation when required and careful consideration was taken. Indeed, discussion and comparison can lower levels of cognitive bias as decision making is not anchored to an individual's reference points (Cooper and Meterko, 2019). Moreover, a replicable coding structure was employed to further mitigate such effects (Appendix A). It is reasoned that using more researchers/coders to undertake independent content analysis of the data set could generate further reliability through repetitive findings, as utilised in similar studies (Rickard and Feldpausch-Parker, 2016). Yet, this was not possible in this instance due the individual identity of a thesis paper.

The methodology also resolved to assign the overall individual article tone (negative, positive, neutral, n=1) but allowed for multiple PESTE attributes ($n \geq 1$). Thus, this strategy was unable to decipher if the tone was applicable to each attribute, to the same extent and prominence. For example, should an article consider *economic* aspects of salmon farming in a positive frame and the *environmental* impacts in a negative frame, the article would be

considered as balanced (neutral category). This was suitable within this context that sought to gain an overview of representation within Swedish media, and is inline with similar studies methodologies (Olsen and Osmundsen, 2017; Govaerts, 2021). Yet, a greater exploration into the intricacies of co-occurring themes, and perhaps to consider sub themes within the risk and benefit groups, would serve to provide a more descriptive analysis. A greater attention to the authors of the articles, contributions made by citizens, scientific/industry professionals or government agencies, would also provide insight into the expertise that was used to frame aquaculture within the articles.

This study did not seek to explore aquaculture practices, that are the physical structures/confines by which aquaculture species are cultivated. Open net pens, semi-closed pens and RAS systems are some examples of different practices that are used, and subject to different levels of understanding and legislation. Researching the inclusion, framing and perception held of these could be an interesting addition to this work. Particularly as some studies demonstrate a particular public reservedness toward offshore and marine practices (Froelich et al., 2016) that are believed to hold promising sustainable potential according to much scientific discourse. Moreover, as local consumption emerged as a main topic of consideration through-out this study, an exploration of the tone toward local vs internationally focused aquaculture articles could provide insight into public perception for local cultivation only.

Lastly, innate to this search method is the limitation that it is subject to the reliability and accuracy of the online archives, which could include errors or omissions. The extent to which this may occur is not understood but would result in samples being unwittingly altered or left out of the data collection process.

6 Conclusion

The media representation of aquaculture in Sweden correlated positively with time during the assessment period and positive representation is increasing. However, greater inclusion overall is recommended. It is unlikely that the agenda present today is conducive with the desired development in public consensus, where the potential for continued positive development is predicted, due to the beneficially framed main topics that emerged. Positive growth was established via the distribution of articles across five new sources, that indicated the Swedish media prioritize salmon and algae related aquaculture. Thus, different species are represented to different extents, wherein the tone also varied significantly among species. Negative tones were displayed mostly for salmon related articles, a common finding in similar literature analyses. However, a distinct variation is such that a significant positive line is developing. This could indicate a shift in acceptance for salmon farming, led by social and economic attributes; environmental considerations do not display this positive trend. It is clear that public acceptance is complex and highly variable in relation to the perspective taken.

Shrimp and the general category were displayed in largely neutral tones, whereas mussel, algae and low trophic aquaculture was experienced via positive framing. The latter is supported, but not regularly researched in corresponding literature. Further media analysis of alternative cultivation species are therefore encouraged to insight a holistic understanding toward public perceptions of aquaculture. In accordance with other research, it is likely that environmental

attributes are overrepresented, which may contextualize and influence the representation of other aspects of the industry. Moreover, technical inclusion is increasing which may mitigate the presence of misinformation and hyperbole. Elements of misinformation and misunderstanding were present but no recurrent themes presented significantly. Active and consistent communications from academia and industry are recommended to assist in developing this result. As a specialized and unfamiliar subject, aquaculture's reputation in the media may form the primary or only source of information available within the routine of a public audience. Therefore, the understanding held in this context is potentially disproportionately impactful to the social development of the industry and is thus crucial to understand.

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Appendix 1

Popular science summary

On the topic of aquaculture, a negative public perception is common. Images of disease, high antibiotic use and fish being used as feed ingredients are some examples of the consensus held. Perhaps these are beliefs you recognize yourself?

Whilst concerns do remain, a growing amount of research demonstrates that in recent years, a new reality within the industry has begun to emerge. The aquaculture industry has experienced incredible innovation, development, and technical change that has propelled its position within sustainable food systems. For example, that the cultivation of species such as mussels, oysters and seaweeds (also called low- trophic species) can aid the restoration of the environments they inhabit. This is called restorative aquaculture, a nature-based solution that may help fight climate change through the regeneration of degraded aquatic areas. In order to fulfill the potential of such solutions, it is crucial to understand the social perspective on aquaculture and drive public acceptance through communication, understanding and transparency.

The media is an important global tool used for communication and is known to influence and reflect public perception. Previous studies have leveraged the relationship between the media and public opinion, where the former is used as a proxy for the latter. As such, a content analysis of the media in Sweden was completed, to determine how aquaculture is represented for different species over a ten-year period. The aim of the study was to determine if aquaculture representation increased over time, if different species types were represented, and if so, did the perception differ between species groups.

The results demonstrated that the media representation of aquaculture in Sweden increased over time. This was due to an increased representation of salmon and algal aquaculture, the perceptions of which emerged within predominantly negative and positive tones, respectively. However, the positive perception of salmon aquaculture was found to be increasing over time, predominantly in relation to economic and technical considerations. Technical aspects across all species were increasing during the assessed period. Environmental considerations within aquaculture were the most dominant attribute within Swedish media, irrespective of the species in question. The leading topics within the articles were in relation to sustainability and the benefits of low trophic practices.

This study highlighted the different attitudes held between various species within aquaculture in Sweden, where low trophic groups were favored positively for their environmental and economic benefits. Salmon and aquaculture generally were considered negatively. However, a growing positive discourse toward salmon suggests that the economic advantages of aquaculture are a driving attribute toward establishing public acceptance. Aquaculture is a complex and relatively specialized topic and as such, a dynamic public consensus is present. It is hoped that this work will contribute toward the understanding of the perception of aquaculture within the public realm and aid its sustainable development.

Appendix 2

Table 1: A full depiction of the coding scheme used when analyzing articles adapted from Kraly, Weitzman and Filgueira (2022).

Category	**Description**	**Sub criteria/ indicators**
Source	Name of newspaper	Dagens Nyheter, Aftonbladet, Göteborgs Posten, Dagens Industri, Omni
Year	Year of publication	2011-2021
Tone	Tone of article (n=1)	A) Negative - Focuses mostly on risks of aquaculture (i.e environmental degradation, overuse of antibiotics, harm to humans if consumed, lack of legislation/ political will, negative lexical choices such as: “”, provides negative stakeholder opinions B) Neutral (balanced) - Discusses both positive and negative aspects of aquaculture (or has both negative and positive views located within the same article), or does not perpetuate any views/ sway the reader to change their perceptions C) Positive - Discusses the advantages/ benefits of aquaculture (i.e job creation, positive impacts to environment, sustainable development growth, positive lexical choices such as: “”.
Species	Species considered in article (n≥ 1)	A) Salmon- Salmon (*S.salar*) or species within the salmon family (salmonids) (e.g char) B) Mussels - Animals within the marine family Mytilidae (e.g blue mussel) C) Algae - Used to describe any marine macro algae / seaweeds (e.g sugar kelp) D) Shrimp - Decapod crustaceans (marine and freshwater) E) General - Any article referring to any aquaculture generally, not species specific. F) Other - Any species group not directly searched for that was identified within an article (e.g oyster)

PESTE	Attributes considered within the article (n≥1)	A) *Political:* Related to how industry is managed and governed. **Environmental assessments:** Calls for, or discussion of environmental impact assessments for aquaculture projects. **Regulation and political oversight:** Concerns with how the industry is regulated. Lack of political will and bureaucracy. The release of new laws, reports, as well as strategies. How different political parties view the pros and cons of aquaculture. **Legal developments:** Concerned with rulings and decisions on court cases of aquaculture. Discussion around moratoriums, whether that be moratoriums enacted by government, or locals/ community groups calling for moratoriums to be put in place due to the farms' environmental, or potential environmental impacts. B) *Environmental:* Concerned with interactions of aquaculture on the natural environment. **Interactions with wild populations:** Discussions around the interactions of farmed fish and wild fish, be they by way of using aquaculture as a means of positive restocking of the wild populations, or how species' may, or may not, impact wild populations through the potential transmission of disease and parasites. Discussions of escaped farmed fish potentially interbreeding. **Interactions with fisheries species:** How farmed species, and the farms themselves may have an effect on other nearby fisheries. **Escapes:** Discussions regarding escaped species from farms, whether it be by net pen failure, storms breaking the cages open, sabotage, or escaping by other means. **Disease and parasites:** Discussing the spread of disease and parasites such as sea lice from farmed to wild fish, or vice versa and the impact such diseases and parasites have on the surrounding ecosystem. **Benthic impacts:** Impacts the farms may have on the benthic environment of the area, such as any potential effects there may be from waste accumulation. **Environmental effects:** Benefits and risk. Generally discussing the environmental impacts of farming overall i.e MTA, habitat regeneration, pollution, community concerns around the impacts on the surrounding ecosystem. **Chemical inputs:** impact of chemical agents imposed on the natural habitat that result due to aquaculture. C) *Social:* Concerned with how aquaculture poses risks to society or communities, or offers benefits. **Human health issues:** Involved with safety to eat, sale or ban on infected stock, and discussion and debates regarding effects on humans. **Societal and/or community benefits:** Benefits to the community from aquaculture including discussion on access to food, and a resurgence in other community aspects, in part due to a revived economy. **Community risks:** Negative discussions on access to food such as using smaller fish to make fish feed, negative impacts on beaches/ social spaces, devaluing of property directly or indirectly from the farms, and other means by which communities are negatively affected by the farms. **Public consultation and involvement:** Regarding the public anmanagement, either through government public processes, or company outreach. Events such as community meetings/ town halls. Comments or concerns about transparency nformation, communications, or effective consultation in industry or government operations, and thus also included articles talking about local protests. **User conflicts:** Regarding the interactions and/or impacts of aquaculture with other marine users in the surrounding environment (e.g. fisheries, tourism etc..) **Jobs and income:** Regarding jobs related to the aquaculture industry. This included discussions on employment opportunities from potential expansion projects.

		D) *Technical:* Related to technological functions within the industry. Technological advancements: Announcement of new technologies, or testing of technologies in the aquaculture industry, and how they plan to be used. Research and scientific developments: Regarding scientific research related to salmon aquaculture. Announcements or discussions surrounding new studies, including aspects related to funding of research projects and interviews with scientists/ industry professionals. E) *Economic*: Concerned with the production aspects of aquaculture operations (rather than impacts to overall economic development) Industry growth: Concerned with discussions regarding potential new farms, new sites, and just general expansion of the industry in a province, regional, or city/town. Industry recognition: Concerned with awards won by industry leaders, Best Aquaculture Practice (BAP) certification, and general recognition of the development of the industry over time. Funding: Funding to support growth, be it from municipal, provincial or federal governments, other governmental agencies like the Atlantic Canadian Opportunities Agency (ACOA), or other external contributors. Loss of product: Regarding events that result in a loss of aquaculture product, for example due to storms causing escapes or other circumstances like culling due to ISA outbreaks. Economic contribution and benefits: Relating to the industry's contribution to local, regional or national economy. Economic losses: Discussing how certain technologies or practice, such as switching from open pen to land based technology would likely result in a loss of profit and revenue (i.e not economically viable)