Salmon, insects, and translation: The agency of salmon feed in environmental governance

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Abstract

The dissertation analyses the impact of insect meal on the Scottish salmon aquaculture industry's environmental governance. Between 2016 and 2021, the industry has transformed its production to become more 'sustainable' and committed to becoming part of the circular economy. In that period, one of the industry's efforts concerned replacing unsustainable fish meal in salmon feed with sustainable insect meal. Ultimately, the project failed, but it offers essential insights into environmental governance. Specific results are that the aquaculture industry industrialised ecological food chains in the name of sustainability. Furthermore, the dissertation finds that the circular economy is overly anthropocentric, and it draws on global food inequalities. The argument is situated within the ANT theoretical literature because the methodological framework offers essential insights into the functioning of a network composed of human and non-human actors.

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Introduction

The global salmon industry is a "fragile miracle" (Lien, 2015, p.25). It is the world's fastest-growing food production system, and salmon farming has established itself as a significant economic pillar of many country's economies (Kriener, 2017). However, adverse environmental impacts associated with salmon aquaculture constantly threaten the long-term survival of the industry. For example, Chile has experienced a 70% stock loss of salmon in 2009 because lax environmental regulation allowed a deadly virus to spread, and the industry ended up harming itself (Swanson et al., 2018; Bachmann-Vargas et al., 2021). Such events show the fragility of the salmon aquaculture industry and the constant environmental pressures, such as climate change and overfishing of wild fisheries, nudge the aquaculturists - together with scientists and the regulators - to improve salmon production's environmental footprint. The dissertation looks at the efforts by a range of actors to make salmon feed 'more sustainable' by introducing insect meal and how this attempt ultimately failed.

Specifically, the scope of analysis focuses on the Scottish salmon aquaculture industry over five years from 2016, when legislation changed allowing insect meal in salmon feed, until 2021. The central theme of the dissertation is environmental governance, defined as: "The set of institutions and processes concerned with steering organisations with responsibilities for environment and environmental policy" (Castree et al., 2013, p.26). Essentially, environmental governance is determining human interactions with nature, so it is crucial to gain an in-depth understanding of its workings and processes. While there has been much research on environmental governance in salmon farming in general (Vormedal, 2017; Mueller, 2017; Bustos-Gallardo, 2013; Gulbrandsen, 2010), none has explicitly focused on the impact of a supposedly "planet-saving technofix" (Sexton, 2018, p.12) on the industry-wide environmental governance. Within the researched period, key actors progressively established a link to form an actor-network to foster the adoption of insect meal as salmon feed. The key actors were aquaculturists, scientists, insects and salmon and the regulator. However, the network ultimately disintegrated again as two actors, the aquaculturists and the regulator, became the network's dissidents.

The dissertation asks the timely and essential question: "How did the use of insects as salmon feed impact the environmental governance of the Scottish aquaculture industry?" Crucially, the dissertation compared the results with Callon's (1986) paper to highlight how environmental governance has developed since then. His study analyses the emergence of a

network between scientists, fishermen, and scallops in St. Brieuc Bay in the 1970s. It is a landmark study of the Actor Network Theory (ANT) and provides an intellectual foundation for the dissertation. ANT allows the analysis to 'follow' human actors and non-human actors, such as salmon and insects. Nevertheless, the dissertation is driven by the processes and practices within the salmon aquaculture industry. ANT only provides the methodological tool for analysis and is not a research aim in its own right.

In 2016, the Scottish salmon industry marketed salmon as sustainable while causing adverse environmental impacts. This paradox motivated the study to fully understand the development of the salmon's supply chain away from an extractive towards a circular economy. A circular economy model is a form of environmental governance that fosters sustainability and reduces resource use. At the same time as uncovering important aspects about human-society relationships, "the study of governance is the study of power" (Ascui et al., 2018, p.15). The research is situated within a small field of geography that explores environmental governance and power relationships of the salmon industry through an ANT lens. The dissertation builds on the literature's findings, methodologies, and insights to develop novel understandings around environmental governance and innovative practices within the supply chain, which previous research has neglected.

The dissertation's key finding is that that salmon feed has agency within the network, and it changed the environmental governance of the Scottish salmon aquaculture industry in several ways. In particular, the aquaculture industry has increased its control over non-human actors by applying an anthropocentric and utilitarian circular economy model. Thereby, the circular economy supported industrial acts of violence against insects and salmon to achieve lower environmental indicators, such as greenhouse gas (GHG) emissions. Furthermore, the supply chain shift transformed salmon's ecological food chain into an industrialised supply chain. Consequently, the aquaculture industry built a controllable nature, fit for its profit-oriented purposes. Lastly, the salmon industry 'sustainably' upgraded insect protein to salmon protein to produce a food that was acceptable to Western consumers. Yet, this is a symptom of global food inequalities because the entire process and its costs could be avoided by simply eating insects.

The dissertation begins with the rationale and research aims section motivating the research. It outlines the environmental crisis and its paradox threatening the continued survival of the Scottish salmon aquaculture industry in 2016. Then, in the literature review, the study is

situated within broader academic debates. The ANT framework discussion concludes that the framework allows the dissertation to channel thoughts about the emergence of a network within an agro-industrial complex because ANT is explicitly concerned about 'localising the global' and it involves the agency of non-human actors. Moreover, the literature review explores the strands of academia that apply ANT to salmon and insect case studies.

Next, the methodology section contributes to the overall research aim by explaining the applied research methods. Semi-structured interviews and discourse analysis uncover the practices and rationales of the key actors, and these research methods inform the analysis, even though the section does not directly report the results. Instead, the analysis section closely follows Callon's concept of translation and tells the story of the network between 2016 and 2021. Specifically, five phases of translation retrace the network's creation and disintegration, namely problematisation, interessement, enrolment, mobilisation, and dissidence. The discussion section interprets the findings and shows why the results matter. Specifically, the section develops the key arguments and indicates the particular developments of environmental governance. Lastly, the conclusion sums up the answer to the research question, summarises and reflects on the research, and calls for further research into the environmental governance impacts of other environmental improvement programmes within the salmon aquaculture industry.

Rationale and Research Aims

Setting out the catastrophe

Scottish salmon is Britain's largest food export and a vital part of the rural economy (Scottish Salmon Producers Organisation, 2019). In Scotland, salmon farms are located on the west coast and the islands. Globally, Scotland is the third-largest salmon-producing nation after Norway and Chile. The environmental regulation for salmon farming in Scotland is quite fragmented (Ellis et al., 2016; Vormedal, 2017). While some areas, like the use of chemicals, are well-regulated and enforced, other areas are only regulated leniently. Apart from strong economic performance, the industry is known for some adverse environmental impacts (Kriener, 2019). Environmental threats associated with salmon production are sea lice, escaped farmed salmon, and the consequences of producing salmon feed.

Market trends have pressured the Scottish salmon aquaculturists to reduce these adverse environmental effects to avoid the fate of Chile's salmon aquaculture industry in 2009. Thus, a non-state governance incentive led to a change of practices for the Scottish salmon aquaculturists, who wanted to make salmon production 'sustainable.' Consequently, the Scottish aquaculture industry has shifted its environmental governance from a purely extractive economy towards a circular economy. The industry-wide developments were in line with the Scottish circular economy strategy, unveiled in 2016 (Scottish Government, 2016). It aimed to decouple economic growth from resource use, for instance, wild fish stocks. South American countries like Peru usually produce salmon feed from wild fisheries (Kriener, 2019). The environmental problems are the overfishing of stocks, production and transport produce large amounts of GHG emissions, and salmon feed can have adverse health effects for humans due to the high concentration of detoxification organs used in the production (Ghamkhar and Hicks, 2020). One substantial effort by the industry was to increase sustainability within the supply chain of salmon feed. The dissertation focuses on this specific development.

Rationale and Research Aims

In the wild, salmon eat insects as part of their diet, and including insects in salmon feed has nutritional, health, and welfare benefits (Belghit et al., 2018; Weththasinge, 2021; Belghit et al., 2018). Therefore, aquaculturists found out that they could farm insects in Scotland to produce insect meal as a replacement for fish meal in salmon feed. As the insects feed on organic waste, this economic system is an example of a circular economy approach, where resources are conserved. The use of insect meal in salmon feed was almost non-existent in 2016 as it was still too expensive relative to fish meal. Up until 2021, several aquaculturists adopted the practice but ultimately returned to using fish meal.

In 2016, there was a paradox within the Scottish salmon aquaculture industry. On the one hand, it was responsible for a variety of adverse environmental consequences. On the other hand, the sector publicly portrayed itself as a sustainability leader in the international salmon market. This apparent contradiction spurred aquaculturists to action, who hoped to replace fish meal to achieve a circular economy model to avoid an environmental crisis threatening their industry. Thus, the dissertation asks:

How did the use of insects as salmon feed impact the environmental governance of the Scottish salmon aquaculture industry?

The results arising from the research question are of importance because the implications of a change in environmental governance are significant. Economic growth in Scotland could be affected as well as animal welfare, the state of Scottish and international waters and fisheries and human health and financial well-being of locals. In short, environmental governance matters. Against this backdrop, the dissertation highlights the influence of a technofix on the environmental governance shift that Scottish salmon aquaculture underwent. Tracing the emergence of a network offers valuable insights into the workings of an agro-industrial complex and its corresponding environmental governance. For example, the dissertation answers who the powerful actors are and how they can exert control over others. Furthermore, the dissertation wants to draw attention to the fragility of a network that seeks to disrupt existing structures.

Literature Review

Introduction

The literature review aims to provide the academic context for the research. Specifically, it analyses, discusses and critically evaluates the ANT framework and its importance for channelling thoughts, adding perspective, and enlivening theory in the dissertation. Thereby, the research is firmly situated in previous ANT literature around salmon aquaculture and environmental governance. Furthermore, by reviewing the case studies on aquatic animals and insects, it becomes clear that there is a need to investigate environmental governance in the supply chain of salmon farming. Thus, the unaddressed gaps in the literature and the possibilities offered by an ANT framework add urgency to providing new insights into the dissertation topic.

Actor Network Theory

As the dissertation uncovers the agency of non-human actors, ANT lends itself ideally to shed light on the interactions and the dependencies of human actors and non-human actors because

ANT assumes that non-human actors can influence the world (Dankert, 2011). The Dictionary of Human Geography defines ANT as "(...) an approach to understanding stability and change in the world that situates human agency in wider networks of non-human actors and materials" (Castree et al., 2013, p.3). By that, it is a tool of making sense of relations in a particular way. Scholars of the Science and Technology Studies, led by Bruno Latour (1987), Callon (1986), and Law (1992), developed ANT in the 1970s, and it is part of a broader set of approaches known as material semiotics (Law, 2008).

ANT attributes agency (the ability to act) not just to humans but also to other materially heterogeneous actors such as animals, tools, technologies, and materials (Law, 2009). However, actors do not exert agency in isolation but through their relationships with other actors. The underlying assumption of ANT is termed 'flat ontology', where its proponents object to the ontological division between nature and society. Therefore, the world is an assemblage of heterogeneous elements produced through a set of diverse practices. This property makes ANT very suitable to study salmon farming because, as Lien says, "aquaculture is all about relations" (Lien, 2017, p.14). Within the ANT field, researchers can trace how actors produce assemblages by 'following the actor' (Latour, 2005) and investigate the consequences of their formations (Law, 2019). By following the actor, it is possible to 'follow what is going on' and thereby understand the relationships (Lien, 2015).

Humans depend on non-human actors for their survival and progress, and therefore they weave networks with them (Law, 2019). For instance, salmon and the aquaculturists that farm them form a symbiotic network, in which they sustain life by providing reciprocal services to one another (Lien, 2015; Evans-Pritchard, 1940). The example draws attention to the assumption that networks of relations are performative. Actors actively work together to achieve a goal, and they do this by performing agency. Performativity can quickly change if key actors decide to disrupt the network. Therefore, networks are fragile and are constantly at risk of disintegration. To hold networks together is a laborious process for all actors. Callon (1986) coins this as 'translation', describing both the processes and effects of a network. During translation, involved actors negotiate and delimit their identity, their interactions, and the margins of manoeuvre. This dissertation utilises Callon's concept of 'translation' of following actors into translation as it provides a suitable framework to trace a network from its inception until its disintegration.

Importantly, networks are potentially endless in time and space (Law, 2019). Each actor is involved in countless networks, and therefore researchers must pick a suitable network. The dissertation's research topic chooses to analyse the supply chain network as its case study because it represents the unique instance where a supply chain shift leads to the replacement of an unsustainable network with a sustainable network. In this case, actors weave a "better" nature that aims for better environmental governance (Murphy, 2017). Another aspect of ANT is its ability to "localise the global" and "redistribute the local" (Latour, 2005). A dissertation that monitors the localisation of a global supply chain needs a methodological frame, such as ANT, that can unveil social and natural linkages that span the globe in local formatted practices (Lien, 2016). Accordingly, ANT fieldwork is always locally embedded and approached through case studies (Law, 2016).

However, since its inception, ANT has been heavily criticised from several angles. Nowadays, there is even a set of standard criticisms levelled against it (Castree et al., 2013). Firstly, Nigel Clark (2011) argues that ANT is too fixated on physically close actors to humans. Thereby, he accuses ANT of being too human-centric, a concern ANT had set out to overcome in the first place. While not disaggregating this criticism completely, this dissertation's focus on environmental governance requires the interactions between human and non-human actors. The coastal environment of Scottish fish farming is a setting that is an interlinked social and natural system (Ascui et al., 2018; Whitmarsh and Palmieri, 2007), and insects are existentially different from humans (Bear, 2020). For these reasons, the dissertation chose a case study that is not too human-centric. Additionally, research on aquatic systems and their interactions with humans counters prevailing terrestrocentrism in geographical writing (Bear and Bull, 2011; Bull, 2009; Peters, 2010) and thereby creates a vital and needed 'more-than-human' style of research (Whatmore, 2002).

Secondly, Latour (2005; 2017) himself criticises the appropriateness and usefulness of the term ANT. In response, scholars have developed a post-ANT approach that engages much more with realities' multiplicities and imperfections. While the debate influences the dissertation, it still considers ANT to be a valuable framework because of its attention to the agency of non-human actors. Thirdly, critics claim that ANT suffers from an intentionality problem (Johnston, 2001). They argue that non-human actors cannot have agency or intentionality. For example, sceptics ask how a material can have the ability to act and influence the world? Law (2019) answers this question by arguing that knowing humans and non-humans on similar terms is an empirical tool rather than an absolute worldview. It is

helpful to uncover how actors influence each other and consequently how the world comes into being the way it is. Only by utilising this 'flat ontology' assumption can researchers uncover how different and power-saturated practices enact realities, which is crucial to understand society-nature governance (Law, 2015). In line with the argument, Lien and Law (2010) call for more research to use a performative approach to nature practices as a means to understand environmental governance.

Aquatic animals

The following provides an overview of scholarly sources on ANT and aquatic animals. In his landmark study, Callon (1986) explores how 'scientific knowledge' becomes the driving force behind a network that wants to test whether scallops could be domesticated or not. Set in St. Brieuc Bay in France, three scientists want to test whether a Japanese method of collecting scallop larvae is replicable. The aim is to restock the bay with scallops and thereby help the fishermen to prevent the scallop stocks from collapsing, which had happened in Brest. By following the actors, he argues that social and natural entities mutually control "who they are and what they want" (p. 2). All actors seek to enrol others in their manoeuvres, and all actors have equal agency, from the fishermen to the scallops. This study was groundbreaking in many respects. Today, it is remembered chiefly for the invention of the 'sociology of translation' process and as an exemplary ANT case study, which inspired many other publications.

Nevertheless, Tsing (2010) critiques Callon (1986), arguing he neglects key relationships of actors. In line with Bookchin (1993), the 'first order of nature' is missing in Callon's paper, meaning he does not take the biological, ecological relationships into account. In contrast, the 'second order of nature' refers to a human-social nature, where humans directly interact with non-human entities. Thereby, Callon ignores entities and processes beyond the visibility of human actors, the fishermen, and scientists. For example, scallops are filter feeders and feed on krill, algae, and larvae. They form part of an environmental food chain and are part of an ecosystem, which Callon did not consider in the study. To understand humanity's relationship with the non-human world, the analysis of environmental food chains is crucial. These bring actors' lives into being, such as the scallops feeding on other organisms or salmon feeding on fish/insects.

Ascui et al. (2018) apply the translation framework to engage with the influence of Big Data on salmon farming. They find that the industry turns into a highly digitalised agro-environmental food complex, governing human's relationship with salmon through technology. Significantly, this study advances the applications of ANT to environmental governance as well. The authors place their case study within the broader environmental governance structures of salmon farming in Macquarie Harbour, Tasmania. The approach inspires this dissertation to take a similar route because the authors successfully apply Callon's translation concept to modern questions of environmental governance.

Another influential text about salmon and ANT is Lien's book "Becoming Salmon" (2015). She traces the domestication of salmon as a domesticated "husbandry animal" (p.1) from the 1950s until today by utilising an ANT approach. That way, she aims to challenge the view that industrial regimes of global food production simply appropriated salmon but instead presents salmon as sentient beings who sometimes enter relationships of care and affective relationality with the fish farm workers. Therefore, salmon becomes a "companion species, complicit in, as well as resisting, the various projects in which it is enrolled" (p.7). Moreover, she disputes the prominent concept of "wilderness", an idealised form of environmental governance, where pristine lifeforms are abundant, and humans have no place. Instead, she argues that some non-human species, such as salmon, are farmed and become an industrialised bulk commodity (Lien and Law, 2012). Thus, a multispecies ANT approach brings a critical lens to understand such forms of environmental governance that are constantly in the making.

Regarding the dissertation, Lien (2015) calls for more research in the salmon feed supply chain. She sees the importance of salmon feed in the "hardening of global trajectories of feed distribution channels, linking anchovies from the South Pacific to the North Atlantic coast" (p.14). Without exploring the supply chains in further detail, she indicates that much can be learned about environmental governance by studying the salmon feed supply chains. Likewise, Swanson (2015) has investigated the global linkages of salmon farming by analysing the effects of salmon consumption in Japan on the production sites in Chile. The author argues that through outsourcing environmental costs to a developing country, the Japanese salmon fisheries had improved their practices and became more sustainable. Thus, she analyses the multispecies landscapes between peripheral and core regions. However, as others (see above), her study lacks a perspective on supply chains, which the dissertation seeks to fill.

Insects

The dissertation is also embedded in previous literature that approached insects from an ANT perspective. A growing body of literature has been concerned with the intersection of environmental degradation and insect meal's promise to deliver a "clean protein". Sexton (2018) studies how insect protein offers the ability to consume humanity out of the environmental crisis to a sustainable world and introduces the notion that insect protein is a 'technofix'. She argues that the agro-industrial "industry faces mounting limits to business-as-usual" (p.1) and therefore utilises technofixes so that production, consumption, and accumulation can continue. A shift to biotechnological production of food, in which insects are farmed in an industrial and digitised manner to control them, allows the technofix to become adopted. By uncovering these new geographies of food production, she challenges the existing economic and power structures and calls for more research on the use of insect meal. Drawing on her work, Bear (2020) sheds light on the UK insect sector and how farmers relate to the insects they breed. He shows that the relationship is generally comparable to how bee-keepers "care" (p.1) about their companion species. Contrastingly, however, the insect farmers aim to foster life with the ultimate goal of the insect's death. While the farmers pledge to kill the insects as humanely as possible, UK regulation exempts insects from animal welfare regulation because insects likely lack sentience.
Consequently, farmers do not "have to ask themselves how to care but whether to care" (p. 4). Bear (2020) also argues for more geographical research on insects because they are underrepresented in research compared to their warm-blooded counterparts, further stimulating the dissertation. In practice, Yates-Doerr (2015) showcases how the aim of scaling up insect-scientist networks to feed the world often breaks down as localised adoption often fail to materialise, a pattern repeated in the Scottish case study. Overall, research has engaged with insect farmers and the production systems, but the debates of why the insects are killed and how insect protein is used are still not answered.

Conclusion

The study situates itself in the broader ANT literature. Even though ANT faced criticism for methodological contradictions in the past, the specific application of ANT to aquatic animals and insects works well. It produces research not possible without the ANT framework. Specifically, it is advantageous to understand an exciting set of circumstances or processes in

which both human and non-human actors have agency. The literature review has informed the dissertation through a critical evaluation of previous research. Notably, the methodological approach of Ascui et al. (2018) is helpful to base this research on because it modernises Callon's (1986) concept of translation and links it to environmental governance. Altogether, the literature review has revealed three main gaps in the literature. Firstly, researchers need to address the lack of geographical engagement with aquatic animals and international environments more generally. Secondly, more research needs to engage with a case study in the supply chain where actors weave a "better" nature by replacing an unsustainable with a sustainable network. Thirdly, Callon neglected the first order of nature, but it is increasingly important to analyse human-nature indirect relationships for environmental governance.

Methodology

The dissertation uses a methodology similar to the ones used in previous ANT case studies. Specifically, a mixed, qualitative research method approach is chosen, including semi-structured interviews and discourse analysis. In this manner, the dissertation answered the research question most effectively and validly for three reasons. Firstly, ANT research must directly interact with the actors to understand their practices and rationales, and the two research methods fulfil the condition. Secondly, discourse analysis and semi-structured interviews complement each other, which increases the quality of the research. Thirdly, I utilised the existing methodological framework of Callon to allow comparability, which is crucial to contrast my analysis with Callon's findings. It is important to note that the results from the two research methods greatly informed the analysis section but are not explicitly reported. This choice is because Callon's concept of translation analysis uses research to reconstruct the findings into a story and the dissertation follows the same path for comparability. Overall, when conducting the research, I followed Bailey et al. (1999) on handling qualitative research closely. Essential for this dissertation is their call for systematic evaluation methods, i.e., coding, which is nonetheless creative, such as 'following the actor'. The following two sections cover the applicability of the methodological approach.

The first step was to conduct the discourse analysis, so the semi-structured interviews, which came afterwards, were more informed. Discourse analysis builds on the assumption that discourse constructs social life (Gill, 2000). By analysing discourse then, the researcher can

uncover how actors construct social life. But crucially, it is also possible to examine how knowledge and power are produced and disseminated. For example, Callon (1986, p.19) argues that a "discourse of certainty" unifies networks. The quote draws attention to the notion that ANT is a constructivist theory (Dankert, 2011). Thus, discourse analysis lends itself well to analyse the ANT case study because it deconstructs the discourse around environmental governance. The research attended case-specific documents, such as presentations, academic papers, and corporate reports published between 2016 and 2021. Furthermore, two online conferences on the topic (Insect as Food and Feed and Future of Food) have greatly informed the discourse analysis. The attendance revealed the practices, rationales, reasonings, and patterns of the key actors, contributing to the understanding of environmental governance. Lien (2015) highlights the advantage of discourse analysis in ANT, who points that in a field where amazement is unlikely to occur, the discourse analysis rejects a constructed reality and can thereby find new explanations of the network's status.

However, critics have argued that discourse analysis is flawed because if all discourse is constructive, then the researchers' analysis is socially constructed (Coyle, 2007). Yet, discourse analysts never questioned this in the first place. Quite the contrary, the scholars make it an integral part of their research and flag it. My social embeddedness certainly influenced my study, and I agree with Law's perspective (2019, p.15): "Instead of concealing or ignoring how we come to know the world because this is simply a means to an end, we need to place such knowledge practices centre stage." Therefore, the researcher's position can't be impartial. The findings are not authoritative on the topic but offer a glimpse at a network at a particular time in a particular place by a particular researcher.

The semi-structured interviews followed the Hermanovicz (2002) framework of conducting interviews in a responsible and informative manner. Over two months, I conducted six interviews with aquaculturists, two interviews with the regulator, four with scientists, and two with marine biologists. Each interviewee was chosen according to their relevance within the network. Furthermore, I conducted six interviews with experts on salmon farming, environmental governance, and ANT to offset the research vulnerabilities that arise from only interviewing actors that are part of an actor population (Dankert, 2011). Similar to discourse analysis, the motivations for conducting semi-structured interviews were to discover the practices, incentives, and goals of the different actor groups. Yet, the qualitative research technique is more dynamic and thereby offers the chance of more significant insights than discourse analysis (Cloke et al., 2004).

The individual interview formats followed standard practice. While interviewing, I utilised an interview guide with four broad themes after gaining informed consent and ensuring anonymity to comply with ethical guidelines of social science interviewing (Crow et al., 2006). The first theme was devoted to understanding the basic everyday practices of the actors. As I could not conduct fieldwork due to COVID-19 restrictions, I lacked on-site experience working with salmon and the other actors. Without primary fieldwork data, the research would have lacked specific insights. However, Hitchings (2012) argues that it is entirely possible to produce high-quality research by relying on people "talking about their practices" (p.1) in a revealing way. This argument explains why I focused on exploring the actors' practices. The second theme revolved around the actor's rationales in the network, and the third theme questioned the discourses and attitudes within the network. The final theme was about actors' power and their self-representation in the network. Through the four themes, I understood the actors and their relationship within the network better. The format of semi-structured interviews allowed the conversation to side-track occasionally and gave the interviewees room to raise issues of their own. Overall, the interviews usually lasted between 20 minutes and 90 minutes and took place online via Zoom or Skype. This could have been detrimental to the quality of the research because when interviewing face-to-face, the researcher can notice social and facial cues, which could be of importance (Opdenakker, 2006). After each interview, I used the snowballing technique to further my network and contact new potential interviewees.

Additionally, if granted permission, the interviews were recorded. It allowed me to categorise and code the critical findings under specific group headings. Then, I could compare the results with the discourse analysis and the essential insights developed through this method. Without semi-structured interviews, I could not have 'followed the actor' into translation and the subsequent establishment of the actor-network. Nevertheless, semi-structured interviews face criticism of being very selective and too subjective (Opdenakker, 2006). I have tried to address this concern by interviewing the six experts as well, who shed light on the network from an outside perspective. However, it is not entirely possible to disaggregate this concern. Another matter of concern is the non-representativity of humans for non-human actors. By not interviewing salmon and insects directly, I interviewed biologists, thereby giving the non-human actor a human voice. It is a suboptimal solution, but I followed Bull's (2011) advice on having the animals represented by an outside expert. By that, I could guarantee the non-human actors some recognition and a role in the network.

Translation Analysis

The following five phases of translation, closely following Callon's structure (1986), analyse the creation and disintegration of the actor-network. In line with Ascui et al. (2018), the dissertation incorporated environmental governance into translation. Overall, the section examines the trajectory of the network's construction-deconstruction by following the various actors. Notably, the phases might overlap, and the process is not as clear cut as it might appear.

Problematisation

The first phase refers to how the actors become indispensable. According to Callon (1986, p.8), "problematisation describes a system of alliances, or associations, between entities, thereby defining the identity and what they want". When the aquaculturists faced the rapid deterioration of the Chilean salmon industry in 2009, many became alarmed that the same fate could strike in Scotland. As a result, the industry stepped up previous sustainability efforts, and the aquaculturists committed themselves to produce salmon in an environmentally friendly way and become part of the circular economy. The fish's supply chain was quickly seen as an essential aspect of concern as feed constituted 50% of the total cost of production (Lien, 2015). Then, in 2016 the EU authorised the use of insect meal as salmon feed (INvertebrateIT, 2017). The legislative change prompted aquaculturists to explore insect meal as a sustainable alternative to fish meal in salmon feed. At that time, the central problematisation for the industry became: 'Can salmon feed be made sustainable through insect meal so that the Scottish salmon industry can continue to sell salmon?' This question could only be answered by involving other actors as well. The following key actors were representatives in the researched actor-network:

- Scientific community: The scientists want to further their knowledge about insects' suitability for salmon feed. The interest is driven by a commitment to solving environmental problems and by promoting a circular economy approach. Their trial studies and models have shown that insect meal as salmon feed has many

environmental, social, and economic benefits. One scientist even described the initial prospects of the innovation as a "silver bullet for the circular economy". They are partly government-subsidised but also supported by the private sector. The main scientific body pushing for the uptake of insects in salmon feed is Fera, an agro-scientific innovation centre.

- Aquaculturists: The aquaculturists aim to increase their profits. To achieve that, they have to obtain a 'social license to operate' (Runge et al., 2021), which means they have to conform to societal standards about labour and environmental practices, for example, by complying with laws. Apart from external influence, there are also internal factors influencing their behaviour. Suppose they want to continue to be a profitable business sector in the long-term. In that case, they must be environmentally friendly to avoid an environmental crisis and satisfy their shareholder demands, increasingly advocating for sustainable practices. All Scottish aquaculturists are members of the Scottish Salmon Producers Organisation. Today, few large firms dominate the salmon aquaculture industry, which increasingly controls the entire value chain. Generally, aquaculturists are relatively cohesive and act in unison when they lobby for regulatory change or market Scottish salmon.
- Farmed Atlantic salmon: Salmo salar's main objective is to gain weight in the most efficient possible way. Through many years of selective rearing programmes, the farmed salmon is bred to be hungry. They react positively to insect meal from a health, welfare, activity, taste, and growth rate perspective (Belghit et al., 2018; Weththasinge, 2021; Belghit et al., 2018).
- Insects: While it is possible to rear several insect species for insect meal, the Black Soldier Fly (Hermetia illucens) is the most widely used species. Similar to salmon, their job description entails putting on weight as quickly as possible. They live in industrial-scale factories that imitate perfect natural conditions, i.e., sunlight, heat, etc. The insects are only of value in the network when they are dead, ground up, and traded as insect meal.
- Regulator: The regulator is the Scottish Environment Protection Agency (SEPA) and the Scottish government. Both SEPA and the Scottish Government work together and are the central bodies governing environmental protection in Scotland. Well aware of the ecological linkages ("Everything in salmon farming affects something else"), they want to improve overall sustainability in Scotland. The regulator seeks to transform the country into a circular economy (Scottish government, 2016).

All five actors had aims, which they could not reach individually. As Figure 1 shows, the regulator wanted more sustainability, but it could only achieve this with the aquaculturists responsible for environmental damages. At the same time, the aquaculturists wanted to sell more fish, which was only possible together with salmon. To prevent certain environmental damages, they also required insects, scientists, and regulators. The scientists needed the insects and salmon to test their predictions, and they required funding from the regulator and the private sector. Salmon and insects wanted more feed, better welfare, and health but had to rely on the regulator to protect their demands as they had no voice of their own. Therefore, the actors had to form a network to overcome the obstacles and converged around an obligatory passage point (OPP). The OPP is something that stands between the status quo and the problematisation (Callon, 1986). In this case, the OPP was the 'price per ton' of insect meal. If the network achieved equalising the price point of insect meal to fish meal, it could replace fish meal in salmon feed. In 2016, the price of fish meal was $1400 per ton (Leek, 2016), and the cost of insect meal was "significantly higher", although specific prices are not available publicly. Thus, the price per ton could tip the balance between fish meal and insect meal and completely change the actor-network.

Interessement

The second phase of translation refers to how the actors are locked into place. According to Callon (1986, p.8), interessement is "(...) the group of actions by which an entity (...) attempts to impose and stabilise the other actors it defines through its problematisation." Specific devices and actions achieve interessement with the result that entities are cornered and physically cut off from other potential networks. Thereby, interessement leads to consolidation or alliance of actors into specific places. While there are potentially endless interessement devices, the three main mechanisms through which the devices work are force, solicitation, and seduction.

In the Scottish salmon aquaculture case, the most relevant interessement devices were market predictions, investor slideshows, and business models. Through these, the aquaculturists, scientists, and the regulator aimed to present the business case for switching from fish meal to insect meal. Essentially, the Scottish aquaculture interessement devices were models for the future. Scientists made statements about how benefits outweigh costs after adoption, and that insect meal contributed excellent value to the Scottish salmon aquaculture industry. Here again, insect meal was marketed as a 'win-win situation' or a 'silver bullet', both from an

economic and environmental standpoint. Through seduction (benefits outweigh costs) and solicitation (urging participants to act environmentally friendly), these models aimed to foster the uptake of insect meal. The approach contrasts Callon's findings, who finds that the scallops are interested through physical force by scallop larvae collectors. But both interessement devices cornered the actors along with the OPP and thereby confirmed the problematisation.

Enrolment

Translation's third phase introduces negotiations and allocations of roles between actors. More specifically, "To describe enrolment is thus to describe the group of multilateral negotiations, trials of strength and tricks that accompany the interessments and enable them to succeed" (Callon, 1986, p.10). Essentially, it is the phase that enables interessement to work if the actors weave the right relationships with one another.

Initially, everything seemed to go well in the Scottish salmon aquaculture network. Negotiations took the right direction when aquaculturists signed the first insect supply deals. Not every single Scottish aquaculturist adopted insect meal, but the fact that many did so matters because it is such a vital part of the production process. Furthermore, entrepreneurs founded several start-ups with the deliberate goal of supplying insect meal to the aquaculture industry. Also, the scientists achieved the possibility of testing their theory in practice and were satisfied with their results. They found that insect meal did not only offer advantages over fish meal but also soy protein. While not being able to be on par with soy protein, salmon showed higher protein digestibility, and the amount of protein grown on a 1500 sqm field planted with soy could be produced on 1sqm of vertical insect farming. Thereby, insect meal also promised to reduce the pressure to deforest pristine woodlands in South America. In addition, GHG emissions could be significantly reduced (Riera, 2017). Studies confirmed previous trial studies that insects are highly efficient at biomass conversion. They had a high nutritional quality with minimal risks while offering environmental, welfare, health, and taste advantages. Furthermore, the insects seemed to be well-suited for mass production in Scotland. With scaled-up production systems, projections estimated the price of insect meal to fall ultimately. Altogether, the network had entered its enrolment phase successfully.

Mobilisation

Next, the mobilisation of allies phase explores how actors' spokesmen become representative of their populations. Mobilisation is the creation of representatives for a group of actors. Callon (1986, p. 12) finds, "That which is true for a few is true for the whole population". Therefore, representation becomes a way to see how the entire network enacts enrolment by relying on a few actors. Why is representation important? "To speak for others is to first silence those in whose name we speak" (Callon, 1986, p.14). Mobilisation automatically implies that representatives silence the majority of actors they are supposed to represent. But this train of thought can be extended to other actor populations as well, especially those non-human actors without a voice. Thereby, within the network, the power balance shifts from actors to representatives—furthermore, power shifts from representatives to more powerful representatives who can articulate their preferences better.

In the Scottish case study, the populations were represented by so-called heads as well. On the one hand, the Scottish Salmon Producers Organisation spoke for the cohesive aquaculture industry. DEFRA and SEPA acted as the regulator and accredited scientific centres, such as Fera, spoke for the scientific community. On the other hand, salmon and insects lacked vocal representatives. Instead, environmental data increasingly represented salmon and insects. Specifically, at the highly digitalised salmon and insect farms, the animals were turned into numbers, data points, and indicators by their human caretakers to manage them. Examples of these were feed-in-fish-out ratios, tons, carbon emissions, price, and size. Aquaculturists, scientists, and regulators used these representations of the non-human actors to assess, influence, and manage the insects and salmon. And similar to Callon's findings, only a tiny minority of insects and salmon in Scotland became part of the network. Fish meal was still a source of food for many salmon, and insect meal had other purposes besides salmon feed as well. However, the industry still marketed the development as a breakthrough innovation. The interessement devices, in the forms of the models, continued to forecast a bright future for insect meal in salmon feed. Thus, the few representatives who upheld the network biased the picture of reality. Furthermore, scientists, regulators, and aquaculturists silenced the insects and salmon and became the heads of the entire network. The findings infer that actor-network had been built, and the OPP connected all five actors. Yet, the network was fragile and highly dependent on outside influences.

Dissidence

The last phase of translation concerns the disintegration of the network. According to Callon, dissidence begins with betrayal and controversy, which he defines as "(...) all the manifestations by which the representativity of the spokesman is questioned, discussed, negotiated, rejected, etc." (1986, p. 15). In the first four phases, the actors seemed to work in an alliance to promote insect meal as sustainable salmon feed in the Scottish aquaculture industry. But then, two significant processes shocked the network and led to a reconfigurement of the sector and disintegration of the network.

Firstly, the Scottish Salmon Producers Organisation had undertaken parallel efforts to transform the supply chain of salmon feed to become more sustainable. As of 2021, all fish meal used in Scottish salmon aquaculture comes from fisheries certified sustainable by MSC or MarinTrust. If not, the fishery is part of a sustainability improvement programme, which is a process that brings the fishery into certified sustainable management. These certification programmes are not perfect solutions to achieve sustainability, but they significantly improve environmental practices. Thereby, aquaculturists have become dissidents of the network. They have chosen to go their route, and instead of switching the entire supply chain to insect meal, they have improved practices within the existing supply chain. This act of betrayal is a symptom of the conservative business mentality of the aquaculturists who feared losing money on a relatively new product such as insect meal. Only if they had had to comply with new regulations or when the concept had been proven to work on a large scale and be profitable would aquaculturists adopt insect meal as salmon feed. In this manner, the industry experienced a technological lock-in of the existing infrastructure.

Secondly, Brexit has severely impacted Scottish salmon farming more generally and the use of insect meal as salmon feed. Since Britain has left the EU, it is slower than the EU to reform legislation around insect use. The EU promised to foster the uptake of insect meal in aquaculture in 2021 through regulatory changes and has signalled its support for insect meal in salmon feed. In contrast, the UK has not presented a roadmap for the future of insect meal in salmon feed. One interviewed aquaculturist complained that "the UK is gonna fall behind" and highlighted how Dutch insect farmers were scaling up their production as the incoming regulatory changes allowed them to produce insect meal at a much lower price point. Notably, the price per ton of insect meal is highly dependent on legislation as it regulates what production processes are allowed and the uses of insect meal. A small change in legislation can have a considerable impact on the price per ton of insect meal. UK regulation contributed to the cost of insect meal being too high to be widely adopted. One scientist presented the

three main hurdles of insect meal uptake in one of the insect conferences: 1) legislation and regulation, 2) legislation and regulation, and 3) legislation and regulation. In theory, insect meal could have the same price as fish meal. But for prices to fall, production had to be scaled up. In 2021, it made no sense for the Scottish insect market to significantly invest in production as the insect meal market was too regulated and not profitable enough. And while the EU was taking steps to address this problem, the UK lagged to take these steps.

As a consequence of the two effects, the network became destabilised. A scientist described the effects as a "double-whammy". The largest UK insect company went into administration, and several small start-ups went bankrupt as well. Overall, the market environment became increasingly uncooperative, and insect meal as salmon feed lost its attraction. Both the regulator and the aquaculturists turned into dissidents as each undermined the OPP. In Callon's case, the network is dissolved through a catastrophe when "(..) the scallops are shamelessly fished, one Christmas Eve, by a horde of fishermen who could no longer resist the temptation of a miraculous catch" (1986, p. 16). The Scottish case is more subtle and long-winding, but the results are similar. In both cases, the network disintegrated because some actors break the alliance with the rest of the network.

Furthermore, the spokesmen of the groups became disavowed by the masses of the groups. Some Scottish aquaculturists remained committed to trying out insect meal as salmon feed. However, the Scottish Salmon Producers Organisation preferred to push for sustainability certification in the supply chain. Here, the representative of the actor group breaks away from the network, unlike in Callon's case where the fishermen's representatives remained within the network, but the ordinary fishermen did dissent. Additionally, actors regarded the obligatory passage point no longer as valid. The actors have grown sceptical that the price per ton of fishmeal could cost the same as salmon feed. Yet, while the network has disintegrated, insect meal has significantly impacted the environmental governance of the Scottish salmon aquaculture industry.

Discussion

The translation analysis has shown three developments of interest within the environmental governance of Scotland's aquaculture industry. Respectively, through the introduction of insects, ecological food chains have become industrialised, global food inequalities became more visible, and the dissertation discovered a utilitarian and anthropocentric aspect of the

circular economy. The results mean that while environmental governance changes within the Scottish salmon industry have yielded positive results, such as reduced GHG emissions through the localisation of the supply chain, previous literature has overlooked the negative implications. This matters as circular economy approaches achieve a significant influence in more industries, and lessons learned from this case study could improve circular economy approaches in the future. However, more research needs to confirm these findings in other sectors and countries as the observed process was highly place-specific and time-specific.

The translation analysis highlighted how ecological food chains could become industrialised. When Callon (1986) wrote about scallops, he focused on the human interactions the scallops have. However, as presented in the literature review, he neglected scallop's relations with their ecological environment. Specifically, scallops are part of the second order of nature (direct human interactions) as well as part of the first order of nature, referring to the ecological inter-connections organisms have, such as being part of a food chain. The results show that the salmon industry, through its circular economy approach, has started to incorporate the first order of nature into its production. The insects were transferred from their ecological web into human-controlled farms for their use in aquaculture. There, their natures were appropriated for quick reproduction and to help salmon grow faster. Callon (1986) neglects the many indirect relationships the scallops have, while the dissertation places these patterns at the investigation's centre. But in St. Brieuc Bay, there has been an environmental governance shift as well, and today a sustainable fishery system has replaced the extractive methods used by fishermen in the 1970s. This change enables fishers to harvest scallops in St. Brieuc Bay until today.

Aquaculturists fed salmon on insects to resemble their 'natural' diet better. Thus, the entire ecological food web was displaced from the wild and reproduced in a human-controlled setting. It gave humans the power to manage the lives of insects and salmon much more effectively. Every insect became a controllable data point, allowing producers to know the insect's key metrics (size, weight, activity, etc.) at all times. The control offered the opportunity to produce insect meal at constant prices in a highly industrialised environment. In contrast, fish meal production was a chaotic process. Wild fishing resembled a hunting-gatherer approach to food production. Even though modern fishing has become a technologically advanced operation, the boat crews still chase wild animals. In this case, humans can't control life and can't predict whether the boats catch fish, unlike the insect and salmon farms. So, in insect farming, the natural food chain of salmon has been industrialised

to better control life. The circular economy has not only been an approach to reduce resource consumption but was also used to produce a circular model of industrialised production over life forms. The finding supports Lien's (2015) research of domestication. Specifically, it sheds light on how the domestication of an animal creates an artificial environment to grow faster. In the Scottish case, the dissertation witnessed the production of a new nature, one where human control over non-human entities was central.

A second finding from the analysis was that farming insects for salmon feed has global implications and shows food inequalities. The term 'Scottish salmon' produces the image of it being a product that is grounded in a specific place. However, salmon is inherently global. The fish meal supply chain is transnational by connecting countries like Peru to Scotland. But when insects replaced fish meal, the supply chain localised. However, the international context, specifically the EU and its regulation, influences the supply chain's environmental governance. For example, the circular economy aims to reduce GHG emissions, and insect meal as salmon feed contributes to that goal. As climate change is a global process, the localised circular solution had global implications. Therefore, environmental governance is always international and local at the same time.

Furthermore, insects are 'hidden' in the supply chain in Scotland, which shows worldwide food inequality. Worldwide, two billion people regularly consume insects (Sexton, 2018), but it is culturally unfamiliar to eat insects in Scotland. As the Scottish circular economy model must conform to cultural expectations, insects are reduced to their environmental benefits and processed for animal feed. Callon (1986) did not consider the global linkages of the St. Brieuc Bay network. This finding supports Swanson's (2015) argument that salmon production is a globally unequal process. Scottish companies can use insect meal as a sustainability differentiation strategy in a competitive market, but the consequences resonate locally and internationally.

Thirdly, the new environmental governance approach induced by insect meal is problematically utilitarian and anthropocentric. Notably, when the aquaculturists applied the circular economy governance, insects and salmons were reduced to environmental indicator measures like GHG emissions, resource impact, etc. While the sector's overall environmental performance, if measured by these indicators, is more 'sustainable', new questions arose. While the aquaculturists repeatedly assured that welfare is essential for both salmon and insects, in the end, they bred the animals to die. Even if the salmon and insects died

humanely, killing is a violent act. Yet, it is still acceptable as cruelty forms part of the web of life. The circular economy approach fosters industrialised killings of animals as long as the overall environmental parameters show reduced environmental impacts. One can critique this as overly utilitarian and anthropocentric and that the new socio-technical infrastructure ignores the value of life. Therefore, the analysis finds that the initial assumption of a researcher of insect meal being the "silver bullet" or a "win-win" situation is only partial. Instead, the circular economy is not a singular development path. Several different routes, such as sustainability certification or the use of insect meal, can achieve it, but it is never a finished end-state but rather an ongoing process. Furthermore, environmental governance plays out differently for various actors, and in the case study, non-human actors lost out in regard to other actors.

Conclusion

This research asked how the use of insects as salmon feed impacted the environmental governance of the Scottish aquaculture industry. From 2016 until 2021, the Scottish salmon aquaculture industry transformed its environmental governance because of several factors, mainly to avoid environmental concerns escalating into an expensive crisis, a lesson learned from the 2009 Chile case. One of the industry's attempts, the fostering of insect meal as a replacement of fish meal in salmon feed, proved insightful as no direct relationship existed between insects, aquaculturists, salmon, scientists, and the regulator in 2016. Based on the translation analysis of a new network's evolution and collapse, it can be concluded that environmental governance has been impacted through three main channels.

Firstly, by further industrialising the ecological food chain, the aquaculture industry has extended its control over non-human actors. In the Scottish salmon aquaculture industry, the ecological food chain of salmon was transformed into a supply chain, thereby expanding domination from the industrial into the natural realm. The dissertation showed that the ontological cleavage between humans and nature is a flawed approach. In contrast, the network has woven humans and non-humans together, but in a relationship where humans increasingly dominated the non-human actors. Callon (1986) neglects the first order of nature, and as a consequence, he can't trace these indirect relationships between humans and nature.

Secondly, the building of a network of multispecies companionship highlighted international linkages of food inequalities. To farm a global 'Scottish salmon', edible insects are diverted from human consumption to create a high-value, normatively-accepted food. Western consumers play a pivotal role by not accepting insects as a food choice. By that, the supply chain incorporates insects, where the consumer can't see them. This development entails a complex undertaking of transforming an undesirable insect protein into a desirable salmon protein. The associated environmental and financial costs stand in contrast to two billion people who eat insects regularly and do not rely on the protein being "upgraded" to suit cultural preferences. In St. Brieuc Bay, Callon (1986) overlooks such international food linkages.

Thirdly, the circular economy is problematically anthropocentric as a focus on environmental indicators deflects attention from industrial acts of violence against non-human actors. The circular economy can answer the initial paradox of the Scottish salmon sector. However, the results have shown that it is an overly utilitarian approach. For example, the industry labels itself 'sustainable' even though millions of insects die to achieve this sustainability. Furthermore, the research has shown that different pathways can achieve the circular economy, i.e. sustainability certification of the supply chain and insect meal. However, certification is by no means a perfect guarantee of sustainability and has its shortcomings too. Thus, the circular economy offers environmental benefits in some regards, but it is not a 'silver bullet' for fixing environmental governance.

Overall, this case study showed how an input substitution of a network substituted a whole chain of nature-society interactions and thereby confirmed that salmon feed has agency within the network. Notably, the disintegration of the network does not mean that insect meal has no future in Scottish salmon aquaculture. New developments in R&D, increased government financial support, or a change in legislation might turn the fortunes for insect meal as salmon feed. Therefore, the dissidence phase of the translation process is only the end of the researched network, but similar, yet different, networks might arise in the future and may lead to the adoption of insect meal in salmon feed.

The comparison to Callon's (1986) case study gave essential insights into the development of environmental governance. In the Scottish case study, a circular economy model, where sustainability is paramount, replaced the extractive production system. The same process has been happening in St. Brieuc Bay. However, as pointed out above, the circular economy

environmental governance approach claims privilege to sustainability, is anthropocentric, and draws on global food inequalities. These aspects highlight how radically environmental governance has changed since Callon's study and the Scottish case study. Drawing on Callon for the dissertation proved helpful. Still, some elements had to be developed, such as the extension to environmental governance, as Callon conducted the study more than 45 years ago.

The dissertation has demonstrated the influence of a technofix on environmental governance and fostered an understanding of the human-nature relationships within an agro-industrial complex using ANT. Therefore, the dissertation achieved each research aim and compared the findings to the environmental governance in Callon's work. In general, the methodology was effective to analyse the network. While the lack of fieldwork limited the work in some regards, the extensive discourse analysis and semi-structured interviews provided the necessary insights. In the analysis section, these results were reconstructed into a story following Callon's concept of translation analysis. ANT was chosen because it provides a methodological framework for channelling thoughts to understand networks. Not without its criticisms, ANT proved to be a productive and appropriate theory for the dissertation that pays sensibility to features of the world's material, social and environmental patterns. It was advantageous to analyse the agency of non-human actors and 'localising the global'. Thereby, it gave non-human actors the deserved recognition in the network.

The dissertation addressed several gaps in the literature and has thereby contributed to the cross-section of ANT studies and salmon farming in geography. It is the first study that considers the supply chain implications of salmon farming on environmental governance. During the dissertation process, many new questions arose for further research. Even if the environmental governance of the supply chain improves, there remain many negative environmental impacts of salmon farming. As pointed out above, sea lice and escaped farmed salmon continue to present a danger to local ecosystems. Thus, further research should explore the impacts of these areas on environmental governance.

The circular economy is still in its infancy phase and needs much more regulatory support, and Brexit has negatively contributed to its development within the Scottish salmon aquaculture industry. A mix of negative incentives ultimately led to the dissidence of the network. For the future, the circular economy is becoming more important, and policymakers should address the approach's weaknesses revealed in the dissertation. Considering that the

Scottish salmon industry wants to increase production by 2030 significantly, it is paramount to recognise that the circular economy is not the end state of good environmental governance but must be constantly questioned and developed further. Furthermore, the study highlighted that the industry only adopts specific aspects of the circular economy if the incentives are well-aligned for the key actors and if the powerful actors benefit from the adoption.

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Appendix

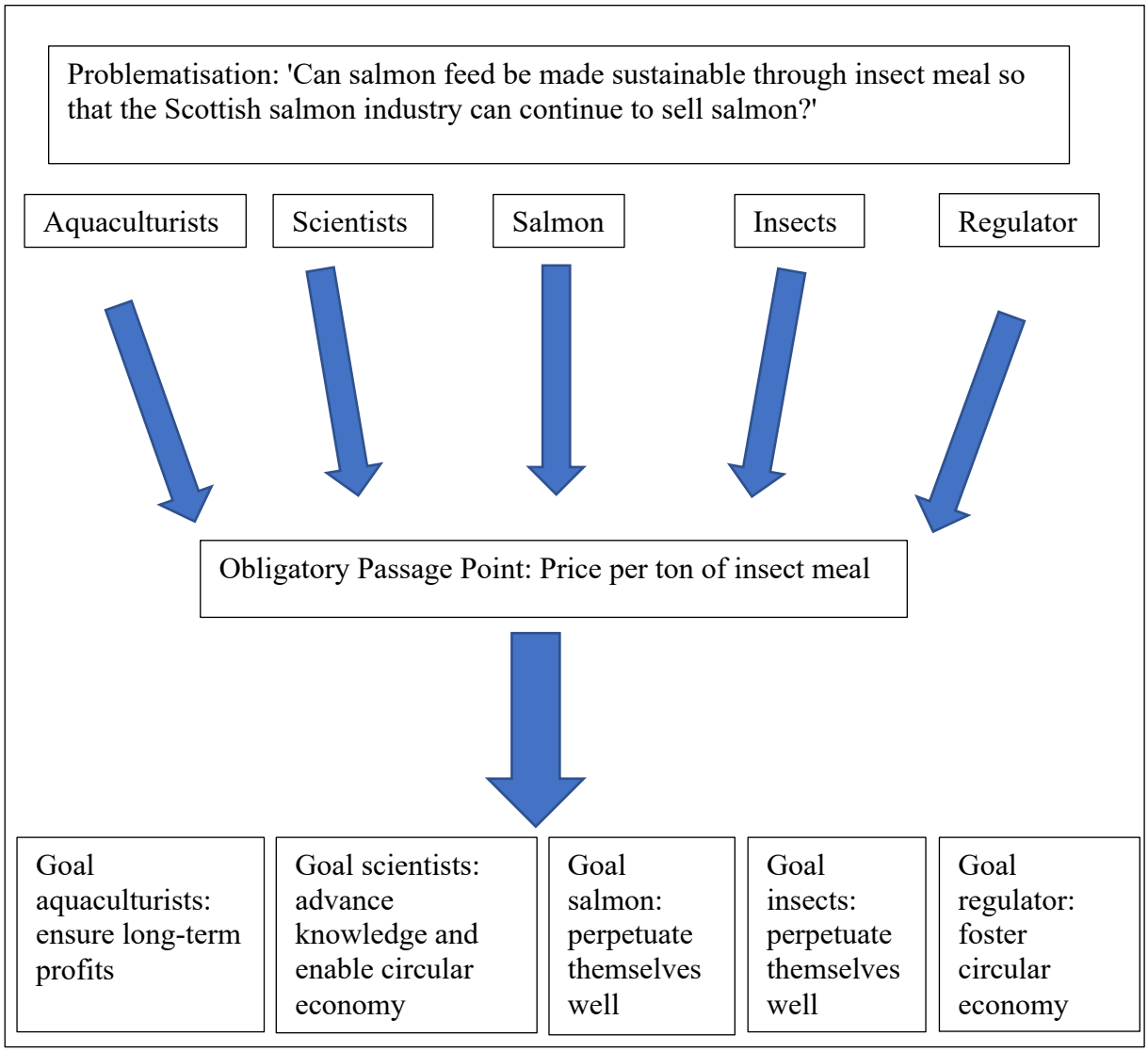

Figure 1: Problematisation phase