Tampere University

MIA PIHLAJAMÄKI

Fishing for Fit

Exploring the effectiveness of Baltic Sea environmental and resource governance

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ACADEMIC DISSERTATION
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of Tampere University,
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In Otaniemi on August 16th 2021

Mia Pihlajamäki

ABSTRACT

The Baltic Sea countries have collaborated for over 40 years to jointly govern social–ecological challenges related to environmental problems and the sustainable use of resources. Still, many of the challenges persist, which implies that Baltic Sea environmental and resource governance has failed to address them effectively. Environmental governance literature suggests that the effectiveness of a governance system, that is, its capacity to solve the issues it was set out to govern, depends largely on its characteristics and how well those characteristics match the attributes of the social–ecological system it aims to govern. The underlying assumption is that the better the fit, the greater the effectiveness of governance. The literature has also identified participation as a key principle of effective governance. However, less attention has been paid on the role of participation in the fit between the two systems.

The overall aim of my thesis was to explore the effectiveness of Baltic Sea environmental and resource governance. I aspired to contribute to the ongoing environmental social science research on Baltic Sea environmental and resource governance by focusing on two specific social–ecological challenges, namely Baltic Sea eutrophication and Baltic herring catch use, in their multilevel governance contexts. The empirical, policy-relevant aim of my thesis was to provide illustrations of case-specific governance challenges and recommendations for how to meet them. The theoretical aim of the work was to increase understanding of the roles that participation could play in improving the fit between governance systems and governed social–ecological systems.

I used governance fit as a theoretical framework to 1) identify misfits between the governance and governed systems and, based on these findings, 2) establish criteria for more effective Baltic Sea environmental and resource governance, and 3) examine roles that participation could play in improving the fit. I explored the role of participation by focusing on its three dimensions: 1) the extent of involvement, 2) the form(s) of interaction, and 3) power relations. To meet the objectives, I applied an exploratory sequential mixed-method multiple-case study design. I used both interpretative and normative research approaches to explore governance challenges

and requirements, and multiple methods, namely semi-structured in-depth interviews, participatory backcasting, and surveys.

The five criteria established for effective Baltic Sea environmental governance are as follows: 1) governance actions are sufficiently coordinated based on identified needs; 2) policies are sufficiently specified to solve the governed social–ecological challenge; 3) governance and policy take regional socioeconomic and cultural diversity into account; 4) relevant policy sectors are adequately integrated; and 5) policymaking is based on multiple and diverse sources of knowledge. The results demonstrate that, on the one hand, the exclusion of certain actors from knowledge production and policymaking processes has contributed to the failure to meet the criteria and has thereby compromised the fit. On the other hand, in some cases, improving the fit called for more targeted and limited participation. A number of suggestions on how participation could improve the fit and thereby meet the criteria were drawn based on the identified deficits and lessons learnt from experimentation. I conclude that participation can help improve the fit between the governance and governed systems in many ways, but this necessitates careful consideration of who should participate, how, and for what purpose in a given governance context.

TIIVISTELMÄ

Itämeren maat ovat toimineet yhdessä yli neljän vuosikymmenen ajan hallitakseen meren tilaan ja luonnonvarojen kestävään käyttöön liittyviä sosiaalis-ekologisia haasteita. Tästä huolimatta monet haasteet ovat edelleen läsnä, mikä viittaa siihen, ettei Itämeren ympäristö- ja luonnonvarojen hallinta ole käsitellyt niitä riittävän tehokkaasti. Ympäristöhallintaan liittyvän kirjallisuuden mukaan hallintajärjestelmän tehokkuus, eli sen kyky ratkaista ongelmia, riippuu hallintajärjestelmän ominaisuuksista, sekä siitä, kuinka hyvin nämä ominaisuudet sopivat yhteen hallittavan sosiaalis-ekologisen järjestelmän ominaisuuksien kanssa. Lähtökohtaisena oletuksena on, että yhteensopivuus lisää hallinnan tehokkuutta. Kirjallisuudessa osallistaminen on myös tunnistettu yhdeksi tehokkaan hallinnan keskeiseksi periaatteeksi. Osallistamisen roolia järjestelmien yhteensopivuudessa on kuitenkin tutkittu verrattain vähän.

Väitöskirjatyössäni tutkin Itämeren ympäristö- ja luonnonvarojen hallinnan tehokkuutta. Työni täydentää Itämeren ympäristön- ja luonnonvarojen hallintaan liittyvää yhteiskuntatieteellistä ympäristötutkimusta tarkastelemalla kahta erilaista sosiaalis-ekologista haastetta monitasohallinnan valossa: Itämeren rehevöitymistä ja silakkasaaliiden käyttöä. Väitöskirjatyöni empiirisenä, päätöksentekoa tukevana tavoitteena oli tuottaa esimerkkejä tapauskohtaisista hallinnan haasteista, sekä suosituksia niiden ratkaisemiseksi. Työni teoreettisena tavoitteena oli lisätä ymmärrystä rooleista, joita osallistamisella voisi olla hallintajärjestelmien ja hallittavien sosiaalis-ekologisten järjestelmien välisen yhteensopivuuden parantamisessa.

Käytin työssäni hallinnan yhteensopivuutta (governance fit) teoreettisena viitekehyksenä, jonka avulla 1) tunnistin hallintajärjestelmän ja hallittavan järjestelmän välisiä yhteensopimattomuuksia ja näiden havaintojen perusteella, 2) laadin kriteereitä tehokkaammalle Itämeren ympäristö- ja luonnonvarojen hallinnalle, ja 3) tutkin rooleja, joita osallistamisella voisi olla yhteensopivuuden parantamisessa. Tutkin osallistumisen rooleja keskittymällä sen kolmeen ulottuvuuteen: 1) osallistamisen laajuus, 2) vuorovaikutuksen muodot, ja 3) valtasuhteet. Käytin työssäni vaiheittaista monimenetelmätutkimukseen perustuvaa monitapaustutkimusta kahden vastakkaisen tapauksen vertailemiseksi. Hyödynsin

työssäni sekä tulkinnallista että normatiivista lähestymistapaa, ja useita menetelmiä, kuten puolistrukturoituja syvähaastatteluja, osallistavaa backcasting-menetelmää, ja kyselytutkimusmenetelmää kartoittaakseni hallinnan haasteita ja vaatimuksia.

Itämeren tehokkaalle ympäristö- ja luonnonvarojen hallinnalle laatimani viisi kriteeriä ovat seuraavat: 1) hallinnan toimenpiteitä koordinoidaan hallittavan järjestelmän edellyttämällä tavalla; 2) politiikkatavoitteet määritellään sopivalla tarkkuudella hallittavien sosiaalis-ekologisten haasteiden ratkaisemiseksi; 3) hallinnassa ja sopimuksissa otetaan huomioon alueen sosioekonominen ja kulttuurinen monimuotoisuus; 4) keskeiset politiikkasektorit integroidaan; ja 5) politiikanteko perustuu useisiin ja monipuolisiin tietolähteisiin. Tutkimukseni tulokset osoittavat yhtäältä, että joidenkin toimijoiden jättäminen tiedontuotannon ja politiikantekoprosessien ulkopuolelle on osaltaan johtanut kriteerien laiminlyöntiin ja siten heikentänyt hallintajärjestelmän ja hallittavan järjestelmän yhteensopivuutta. Toisaalta joissakin tapauksissa yhteensopivuuden edistäminen saattaa edellyttää kohdennetumpaa ja rajallisempaa osallistamista. Esitän työssäni havaittujen puutteiden ja kokeilusta saatujen kokemusten perusteella useita ehdotuksia siitä, miten osallistaminen voisi parantaa yhteensopivuutta ja siten täyttää hallinnan kriteerit. Tutkimukseni osoittaa, että osallistaminen voi edistää hallintajärjestelmän ja hallittavan järjestelmän yhteensopivuutta monin tavoin, mutta se edellyttää huolellista pohdintaa siitä, kenet tulisi osallistaa, miten, ja mihin tarkoitukseen kyseisessä hallintakontekstissa.

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ORIGINAL PUBLICATIONS

Publication I Tynkkynen, N., Schönach, P., Pihlajamäki, M., and Nechiporuk, D. 2014. *The Governance of the Mitigation of the Baltic Sea Eutrophication: Exploring the Challenges of the Formal Governing System*. AMBIO 43: 105–114. https://doi.org/10.1007/s13280-013-0481-8

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Publication III Pihlajamäki, M., Sarkki, S., and Haapasaari, P. 2018. *Food security and safety in fisheries governance – A case study on Baltic herring*. Marine Policy 97: 211–219. https://doi.org/10.1016/j.marpol.2018.06.003

Publication IV Pihlajamäki, M., Asikainen, A., Ignatius, S., Haapasaari, P., and Tuomisto, J. 2019. *Forage Fish as Food: Consumer Perceptions on Baltic Herring*. Sustainability 11, 4298: 1–16. https://doi.org/10.3390/su11164298

INDIVIDUAL CONTRIBUTIONS OF THE AUTHORS TO ARTICLES I–IV

I Pihlajamäki participated in writing the paper with the co-authors. Tynkkynen had the main responsibility for the writing process. Pihlajamäki provided material for the national-level analysis from Finland and contributed to the international-, regional-, and national-level analyses. Tynkkynen provided material for the regional-level analysis, and Schönach and Nechiporuk provided material for the national-level analyses from Sweden and Russia, respectively.

II The idea for the paper was jointly developed by Pihlajamäki and Tynkkynen. Pihlajamäki was responsible for collecting the majority of the data. Data analysis and paper writing were a collective effort.

III Pihlajamäki had the original idea for the paper and the main responsibility for analysing the collected data. Pihlajamäki had a leading role in planning the data collection. Sarkki and Haapasaari commented on the ideas, and the data collection was jointly executed. Pihlajamäki had the main responsibility for analysing the results and writing the paper. Sarkki and Haapasaari provided comments on the manuscript throughout the writing process.

IV Pihlajamäki proposed the initial idea for the paper. Asikainen had the main responsibility for collecting the data, but Pihlajamäki, Ignatius, and Haapasaari participated in designing the questionnaire. Tuomisto was responsible for carrying out the statistical analysis. Pihlajamäki had a leading role in the analysis and the writing process. Asikainen, Ignatius, Haapasaari, and Tuomisto commented the manuscript.

ABBREVIATIONS

BSAP	Baltic Sea Action Plan
CAP	Common Agricultural Policy
CFP	Common Fisheries Policy
EBFM	Ecosystem-based fisheries management
EBM	Ecosystem-based management
EU	European Union
HELCOM	Helsinki Commission
IBSFC	International Baltic Sea Fisheries Commission
ND	Nitrates Directive
NGO	Non-governmental organisation
MSFD	Marine Strategy Framework Directive
SES	Social–ecological system
UWWTD	Urban Waste Water Treatment Directive
WFD	Water Framework Directive

1 INTRODUCTION

"The marine environment is a precious heritage that must be protected, preserved and, where practicable, restored with the ultimate aim of maintaining biodiversity and providing diverse and dynamic oceans and seas which are clean, healthy and productive." (Directive 2008/56/EC of the European Parliament and of the Council: 19)

1.1 Background and research setting

The Baltic Sea is a semi-enclosed marine area in Northern Europe surrounded by nine riparian countries: Denmark, Germany, Poland, Lithuania, Latvia, Estonia, Russia, Finland, and Sweden. For these countries, the sea is a historically and culturally valuable resource, which is not only a source of fishing-related livelihoods, and thereby also food, but is also a popular location for leisure activities, such as swimming, boating, summer housing, and recreational fishing. It is also a key transportation route. During the early 20th century, the environmental state of the Baltic Sea began to deteriorate, owing to human activities in the region, and by the 1960s, it had already suffered from severe environmental problems, such as eutrophication, high levels of harmful substances, and over-exploitation of some of the major fish stocks (Elmgren, 2001). In the 1970s, two platforms for macro-regional collaboration between the riparian countries were established to deal with the problems, namely the Baltic Marine Environment Protection Commission (HELCOM) and the International Baltic Sea Fisheries Commission (IBSFC), but some national and bilateral efforts date back even further in time (Carroz, 1977; Pihlajamäki and Tynkkynen, 2011).

While HELCOM was founded to encourage intergovernmental collaboration to protect the sea from all sources of pollution, the IBSFC aimed to ensure the sustainable use of shared fisheries resources. In practice, these platforms were used to jointly develop recommendations to limit the adverse human impact on the marine environment and to agree on the total allowable fish catches and their division between the countries annually. Following the EU enlargement in 2004, the Baltic Sea became almost an "inland sea" of the EU, as only one of the riparian countries, Russia, remained a non-EU country. Consequently, the use of IBSFC as a platform for collaboration on fisheries governance and management became obsolete, and the Baltic fisheries are currently managed among the EU member states within the framework of the EU Common Fisheries Policy (CFP) and bilaterally between the European Commission and the Russian Federation. In contrast, HELCOM has remained a platform for collaboration on environmental protection and a macro-regional coordinator for the implementation of EU policies. EU enlargement also meant that eight out of nine Baltic Sea countries were now legally bound to a multitude of EU regulations on, for example, environmental protection, urban waste water treatment, and agriculture.

During the 21st century, both the EU and HELCOM adopted an ecosystem-based approach to management (EBM) as the guiding principle for the formation and implementation of marine environmental and fisheries policies. The novelty of the EBM is that it considers people to be part of a tightly coupled social–ecological system (SES) and advocates for a more holistic approach to governance and management (Berkes and Davidson-Hunt, 2012). The main EU policies are the Marine Strategy Framework Directive (MSFD) (Directive 2008/56/EC of the European Parliament and of the Council) and the Common Fisheries Policy (CFP) (Regulation [EU] No 1380/2013 of the European Parliament and of the Council). The MSFD aims to achieve and sustain a good environmental status, which is determined by a set of descriptors relating, for example, to eutrophication, hazardous substances, and biodiversity, while maintaining and managing human activities sustainably (Directive 2008/56/EC of the European Parliament and of the Council). The CFP aims to ensure that "fishing and aquaculture activities contribute to long-term environmental, economic, and social sustainability" (Regulation [EU] No 1380/2013 of the European Parliament and of the Council, 22). Coinciding with the development of the MSFD, HELCOM adopted the Baltic Sea Action Plan (BSAP), which also aims to establish a good environmental status for the Baltic Sea (HELCOM, 2007). In addition to these international macro-regional arrangements, various intergovernmental, transnational, national, and subnational governance arrangements have emerged to facilitate sustainable development in the region (Gilek and Kern, 2015; Joas et al., 2007; VanDeveer, 2011; Kern and Löffelsend, 2004; Kern, 2011; Grönholm, 2020).

However, despite various governance efforts, many of the problems, including eutrophication, unsustainable use of resources (in terms of both overfishing and using wild-captured fish primarily for industrial purposes), and high levels of harmful substances, still remain (Aps et al., 2007; HELCOM, 2018a; Article III). This implies that the Baltic Sea environmental and resource governance arrangements, which have often been regarded as model examples for other regional seas (Joas et al., 2008a; VanDeveer, 2004; Haas, 1990), have not been able to address these complex issues effectively.

Effectiveness is one of the main objectives of environmental and resource governance (Adger et al., 2003; Bennett and Satterfield, 2018) and a principle of good governance (European Commission, 2001; OECD, 2015). The concept can be defined and measured in various ways, but it usually refers to the ability of governance to solve environmental and resource-use-related problems (Young and Levy, 1999; Young, 2011; Hogl et al., 2012). For instance, the OECD (2015: 3) defines effectiveness as "the contribution of governance to define clear sustainable water policy goals and targets at all levels of government, to implement those policy goals, and to meet expected targets". The ability of governance to solve complex environmental problems can, of course, be affected by the characteristics of persistent and wicked problems themselves, as well as our understanding of them, which can make solving them difficult. However, environmental governance literature suggests that the characteristics of a governance system are usually a more significant determinant of ineffectiveness than how difficult or easy the problem is to solve (Young, 2011).

Attempts have been made to identify some general characteristics of effective environmental and resource use governance. The OECD (2015) identifies four main principles of effective water governance: 1) division of roles and responsibilities, 2) appropriate scales within basin systems, 3) policy coherence, and 4) capacity of authorities. Bennett and Satterfield (2018) identified six main attributes based on a literature review: 1) the aims and goals, 2) coordination of activities, 3) capacity of relevant actors, 4) use of the best available knowledge (across disciplines and knowledge systems), 5) accountability, and 6) cost-efficiency of measures. However, the requirements of an effective governance system can be case- and context-specific, which implies that failure to achieve governance objectives is caused not only by the characteristics of the governance system but also by how well they fit the governed SES (Young 2002; 2011; 2013; 2017; Folke et al., 2007; Ostrom, 2007; Galaz et al., 2008). The mismatch between the two systems can be referred to as "the problem of fit" (Young, 2002). According to Young (2002: 55), the premise of the problem of fit is that "the effectiveness of environmental and resource regimes or, in other words, the capacity of these arrangements to prevent undesirable environmental changes and to solve environmental problems once they arise is determined in considerable measure by the degree to which they interact". Thus, the problem of fit, as a theoretical approach to scientific inquiry of governance effectiveness, focuses on the characteristics of the governance system, the governed system, and the interactions between the two. The presumption is that the better the fit, the greater the effectiveness of environmental and resource governance.

While the literature on fit focuses mainly on institutional arrangements, especially the horizontal and vertical interplay between different regimes and governance levels (Young, 2002), less focus has been placed specifically on the role of participation in the fit between the two systems (DeCaro and Stokes, 2013; Sarkki et al., 2015). The central role of participation in governance has been acknowledged and promoted by both policy and science. For example, participation has been recognised as a principle of good governance in the European Commission's White Paper on European Governance (2001) and in the European Council's 12 Principles of Good Democratic Governance (Council of Europe, 2021). Scientists also consider it key to improve the effectiveness of environmental and resource governance (Ostrom, 1990; Dietz et al., 2003; Newig and Kvarda, 2012; Newig, 2012). The underlying argument for promoting participation in governance processes – that is, in knowledge production, policymaking, and implementation – is that democratic deliberations can enhance the transparency and legitimacy of the decisions and thereby also the implementation of and commitment to policies. Still, the scientific evidence on the role of participation in improving the effectiveness of environmental and resource governance is inconsistent, which has led to calls for more research on how and under which circumstances participation can improve the effectiveness of governance (Newig and Fritsch, 2009; Newig, 2012).

Not surprisingly, environmental social scientists have shown increasing interest in the effectiveness of Baltic Sea environmental and resource governance over the past two decades. Many scholars have examined the various governance arrangements, processes, and networks that affect the ability of the system to protect the common sea or foster sustainable development in the region (Kern and Löffelsend, 2004; Joas et al., 2007; Joas et al., 2008b; Burns and Stöhr, 2011; Kapaciauskaite, 2011; Lundberg, 2013; Tynkkynen, 2013; Gilek and Kern, 2015; Doneliene, 2016; Gilek et al., 2016; Tynkkynen, 2017; Grönholm, 2020). Others have explored how governance systems have changed over time in order to adapt to changing management needs (Hjort, 1994; Hammer et al., 2011; Kern, 2011; Valman, 2014), such as those proposed by the ecosystem-based approach to management (EBM) (Wilson, 2009; Hassler et al., 2013; Hammer, 2015; Valman et al., 2015; van Hoof, 2015; Ramirez-Monsalve et al., 2016). In addition, the literature includes contributions on governance deficits caused by the way in which stakeholder engagement in knowledge production and decision-making has been organised (Stöhr and Chabay, 2010; Linke et al., 2011; Burns and Stöhr, 2011; Udovyk and Gilek, 2013; Linke and Jentoft, 2014; Linke et al., 2014; Franzen, 2015; Saunders et al., 2017). Based on the literature on Baltic Sea environmental and resource governance, three main challenges for effective governance can be identified at the outset.

First, effective governance is hindered by the characteristics of the Baltic Sea ecosystem, namely the complexities and uncertainties related to Baltic Sea ecosystem functions and the causalities between human actions and the state of the sea (HELCOM, 2010), and the apparent slow response of the Baltic Sea ecosystem to management measures (Varjopuro et al., 2014). The Baltic Sea is a young and shallow water area characterised by low salinity, strong stratification, long renewal time (limited water exchanged between the Baltic Sea and the North Sea), varying bottom topography (sub-basins), spatially and temporally changing climatic conditions, and a large drainage area. The characteristics of the sea make living conditions for marine life challenging, and consequently, species diversity in the Baltic Sea is low (Elmgren and Hill, 1997; Elmgren, 1984). Owing to these unique characteristics, the Baltic Sea is exceptionally vulnerable to anthropogenic stress caused by the over 80 million people living in the Baltic Sea catchment area (see, e.g. Raateoja et al., 2008; HELCOM, 2010).

Second, the Baltic Sea environmental and resource governance is realised in a complex, multilevel setting where the riparian countries with varying socioeconomic conditions and historical development paths interact. The Baltic Sea is an example of a common resource that is shared between multiple sovereign countries, each of which has its own specific interests in the resource, but none of which can solve the problems related to the environmental state of the sea or the unsustainable use of the resources on their own. Instead, improving the state of the sea requires collaboration between the riparian countries at the Baltic Sea level. However, for several decades, the Baltic Sea coastal countries were divided into socialist Eastern states and Western democracies. This separation enhanced diverging socioeconomic and political conditions between these two groups of countries. These differences have affected social activities, such as participation, and the inclusion of environmental issues in the political agenda (Pihlajamäki and Tynkkynen, 2011; Kern et al., 2008). Owing to socioeconomic diversity, it remains uncertain whether and how the Eastern states can develop to the same level as their Western neighbours without further burdening the environment (Joas et al., 2008a). This also relates to the question of fairness between the countries in terms of costs and benefits, which, in turn, can cause distrust between the countries instead of unity of purpose.

Third, effective governance efforts have also been hampered by the narrow scope of governance and management. Traditionally, governance and management have been driven by "silo thinking", which has overlooked the interlinkages and interdependencies between the environment and society (Curtin and Prellezo, 2010; Hassler et al., 2013; Gilek et al., 2016; Jennings et al., 2016). For instance, Rindorf et al. (2017) have argued that the primary focus of fisheries governance and management on harvesting and the principle of maximum sustainable yield have hampered the inclusion of other fisheries management objectives into fisheries governance practices. In contrast to the traditional governance and management approaches, ecosystem-based fisheries management (EBFM) places the environmental state of the ecosystem at the centre of the governance effort, but it also emphasises the need to ensure both that the related human activities are maintained and that ecosystem services (e.g. economic, social, and food security-related benefits) are maximised in a sustainable way (Regulation [EU] No 1380/2013 of the European Parliament and of the Council). Thus, the implementation of EBFM implies that the scope of the governance and management effort is widened from the sustainability of harvesting to encompass other dimensions of fishing activities, such as the contribution of fisheries to food security. However, the implementation of EBFM has only recently begun, and many uncertainties relating to how it will be realised remain (Jennings and Rice, 2011; Hammer, 2015; van Hoof, 2015; Ramirez-Monsalve et al., 2016).

Motivated by the abovementioned challenges, which are ultimately about the characteristics of and the interplay between governance and the governed systems, and after reflecting on them, I decided to use governance fit as an analytical framework to explore Baltic Sea environmental and resource governance. While previous research has focused on the effectiveness of Baltic Sea environmental and resource governance arrangements from the perspectives of, for example, single institutions (e.g. Valman, 2014) and institutional interplay between the EU and macro-regional level policies (e.g. Doneliene, 2016; Söderström and Kern, 2017), less attention has been given to governance challenges related to specific environmental and resource sustainability problems in their wider multilevel governance contexts, that is, simultaneously at the EU, macro-regional, and national levels. The rationale for a problem-driven research approach draws from the work of Elinor Ostrom (2007: 15181), for example, who has argued that to improve the effectiveness of governance, a diagnostic approach "to match governance arrangement to specific problems embedded in a social–ecological context" is needed. In other words, specific environmental sustainability problems cannot be solved with universal solutions; therefore, case-specific research is called for. The focus on the three governance levels was inspired by the work of Kern (2011), who demonstrated that the challenges of the Baltic Sea environmental and resource governance are deeply rooted in the vertical and horizontal interplay across governance systems, which lean strongly on the capacity of the riparian countries. This implies that, in addition to the EU and macro-regional levels, research on Baltic Sea environmental and resource governance should focus on the national level and the interplay between these levels. Although I acknowledge the importance of subnational and local levels, especially in eutrophication governance (Franzen, 2015; Grönholm, 2020), these governance levels are not explicitly addressed in this thesis. However, the national-level analysis also reveals some challenges stemming from the local level, for example, relating to implementation.

The empirical contribution of my thesis to Baltic Sea environmental and resource governance is two-fold. First, I provide illustrations of governance challenges and requirements stemming from the vertical and horizontal interplay between the international (EU), macro-regional (Baltic Sea), and national governance levels, and within and between different societal sectors, for example, policy, business, civil society, and science. Second, my research focuses on two case studies that represent contrasting social–ecological challenges for the Baltic Sea. The problems and challenges related to environmental and resource sustainability are diverse in terms of their impact on the (marine) environment and society, as well as when they were first identified as social–ecological problems or challenges that should be solved. In my thesis, I compare two sustainability problems that represent different ends of the spectrum: Baltic Sea eutrophication and Baltic herring catch use. The former is one of the oldest and most severe environmental problems impacting the Baltic Sea and has been subject to governance and governance-related research for decades. The latter, namely the use of wild-captured fish, such as Baltic herring, mainly as feed instead of food has only recently started to gain more attention as a pressing sustainability problem. Consequently, and in contrast to eutrophication governance, the interest in governing catch use has so far been limited, and only a few studies have explored the issues from the governance perspective. Thus, the premise of the thesis is to compare a "typical" environmental governance case with an emerging one from the same region. Such similarities and differences provide insight into governance requirements that are case specific as well as those that are more general.

The theoretical contribution of my thesis is to the literature on the role of participation in improving the fit between governance and governed systems. The focus is not only on the so-called "participation fit" – that is, the fit between participation arrangements and stakeholders' perceptions of those arrangements (Epstein et al., 2015) – but also on the role of participation in the misfits caused by other characteristics of the governance and governed systems. By comparing the two cases, my work reveals how participation could improve governance fit in different governance contexts and sheds light on the circumstances under which participation requirements may vary. The comparative analysis thus enhances the understanding of the effectiveness of marine environmental and resource governance beyond a single case. To this end, my thesis has added value not only in the context of the Baltic Sea but also beyond.

1.2 Objectives and scope

The overall aim of my thesis was to explore the effectiveness of Baltic Sea environmental and resource governance in the theoretical framework of governance fit (Young, 2002; Galaz et al., 2008; Epstein et al., 2015; Young, 2017). The main research objectives included 1) identifying misfits between governance and governed systems, and, based on these findings, 2) establishing criteria for more effective Baltic Sea environmental and resource governance, and 3) examining the roles participation could play in improving the fit and thereby meeting the criteria. I explored the role of participation in each criterion through the three dimensions of participation: 1) the extent of involvement (who is included/excluded?), 2) the form(s) of interactions (how do the actors interact?), and 3) power relations (how have power relations affected the outcome?) (Newig et al., 2018).

To meet these objectives, I designed my thesis to be based on a sequential mixed methods multiple-case study. I used a multiple-case study approach (Stake, 2006; Yin, 2018) to compare two contrasting cases from the same region, and then, based on a cross-case analysis, drew conclusions beyond a single case. The idea for employing sequential mixed methods research came from the call by several scholars working in the field of environmental and resource governance, who emphasised that a single method cannot provide a sufficient understanding of the performance of environmental and resource governance systems and the related SES complexities (Young et al., 2006; Young, 2011; O'Neill et al., 2013). A sequential mixed methods research design facilitated not only the application of different research approaches and methods to study the two cases but also the modification and adjustment of the research strategy based on the findings from the earlier phase of the research process (Creswell, 2014; Molina-Azorín and López-Gamero, 2016). My aim during the research process was to identify what kind of methods could be fruitful for examining the effectiveness of Baltic Sea environmental and resource governance. The methodological choices were therefore made during the research process and were based on critical reflection (see sections 1.3 and 3.4 for more details). I used an interpretative approach to increase understanding of the governance challenges (Case 1) and then adopted a normative approach to explore solutions for meeting those challenges (Case 2) (Fischer and Forester, 1993; Häikiö and Leino, 2014).

The empirical material for my thesis was based on two case studies relating to 1) Baltic Sea eutrophication governance and 2) the catch-use governance of Baltic herring. Although these case studies had different topics and were approached from different methodological perspectives (see chapter 3), they both depicted a complex social–ecological sustainability challenge that existing governance efforts had not been able to solve. The first case study focused on eutrophication, which is caused first and foremost by anthropogenic nutrient input from the Baltic Sea littoral states (HELCOM, 2010). Eutrophication has a severe impact on the marine ecosystem and thereby also on human activities in the Baltic Sea, such as recreation, fishing, and tourism. Although collaboration between the Baltic Sea riparian countries has been successful in reducing nutrient input into the sea, the reduction targets have not been met, and the problem persists (HELCOM, 2018b).

The second case study addressed a complex problem relating to the use of Baltic herring after landing. From the perspectives of environmental sustainability and universal food security principles, the use of wild-captured fish should be prioritised as food (FAO, 1995; 2011). Still, Baltic herring, one of the most abundant fish species in the Baltic Sea (ICES, 2018) and a source of healthy nutrition for humans (vitamin D and omega-3 fatty acids), is caught primarily for industrial purposes, such as feeding farmed fur animals and fish. Thus, there is an apparent gap between the principle of using fish primarily for food and actual practice.

From an environmental perspective, the two cases are connected through food production and consumption, and their impact on the marine ecosystem. The current food production and consumption system in the Baltic Sea region is largely driven by animal-based diets. Fish are farmed and imported from outside the region to ensure a sufficient supply of fish. Production of red meat and dairy, as well as farming and importing fish, increases nutrient input into the Baltic Sea, thereby enhancing eutrophication. Agriculture is the single largest source of nutrient input in the Baltic Sea (HELCOM, 2018b). Although nutrient input from aquaculture has significantly decreased due to improved management and practices, fish farming still enhances eutrophication locally (Ministry of Agriculture and Forestry of Finland, 2014; Saikku and Asmala, 2010). In addition, climate change is likely to further enhance Baltic Sea eutrophication (Huttunen et al., 2015). The greenhouse gas emissions related to meat production, as well as fishing at the far ends of the oceans and importing fish from long distances, are high (Madin and Macreadie, 2015; Parker et al., 2018). Thus, using locally and sustainably caught fish as a source food is considered a more environmentally sustainable option not only because fishing removes nutrients from the sea but especially because it replaces meat or imported fish (Carlsson-Kanyama and González, 2009; Nordic Council of Ministers, 2012).

In the next chapter, I describe how the second case study responds to the challenges identified in the first case study, and how these were taken into consideration in the research design.

1.3 Research process and dissertation structure

My thesis includes four published and peer-reviewed research articles, two of which relate to Baltic Sea eutrophication governance and two to catch-use governance of Baltic herring.[3] Baltic Sea eutrophication governance was studied first. I began by investigating the characteristics of the formal governance system at the international, regional, and national levels and considering how the characteristics of the system and interplay between the levels prevent effective Baltic Sea protection (Article I). My underlying idea was that to improve Baltic Sea eutrophication governance, we need to understand how the conditions for governing and the related practices shape these efforts. Then, given the long history of ecological research on the Baltic Sea in general (Leppäranta and Myrberg, 2009) and eutrophication in particular, and due to my own background in marine sciences, I became intrigued by the question of how the intricacies of knowledge itself have contributed to the apparent gap between science and policy (Article II). While Article I provided insight into the problem of fit by focusing on the characteristics of the formal governance system and called for

[3] The eutrophication case study was conducted as part of a BONUS PROBALT project (Improving societal conditions for the Baltic Sea protection, 2009–2011), and the catch-use case was part of a BONUS GOHERR project (Integrated governance of Baltic herring and salmon stocks involving stakeholders, 2015–2018).

more adequate integration between sectoral policies and accounting for socioeconomic differences in the region, Article II highlighted misfits caused by the intricacies of knowledge in the science–policy interface. Both eutrophication articles demonstrate that insufficient participation in governance practices, including knowledge production, has been a key source of misfits and thereby an obstacle to effective governance.

Moving from theory to practice in participatory governance entails research on the role of participation through experiments and projects (Fischer, 2012). Therefore, the key theoretical suggestions derived from the eutrophication case, mainly the integration of sectoral policies and stakeholder engagement in knowledge production, were explored and experimented within the catch-use case. Stakeholder groups were engaged in the development of Article III to co-produce suggestions on the integration of food security and safety aspects into fisheries governance, as called for by the universal food security principle (FAO, 1995; 2011) and the EU Common Fisheries Policy (Regulation [EU] No 1380/2013 of the European Parliament and of the Council). Article IV elaborated Article III by adding consumer perspectives to the task (of bridging the gap between policy intention and practice). Thus, while the eutrophication case focused on identifying key challenges, the catch-use case focused on identifying solution possibilities.

This thesis is structured as follows. In chapter 2, I describe the theoretical background of my thesis, that is, the key theoretical concepts and framework that have guided my analysis and are important for the interpretation and discussion of the findings. In section 2.1, I provide definitions for the concepts of governance and governance systems and elaborate the characteristics of a governance system through the dimensions of polity, policy, and politics. In section 2.2, I describe the analytical framework applied in this thesis, and then in section 2.3, I focus on the role of participation in governance. In chapter 3, I describe the two contrasting case studies and my methodological choices. I provide background information about the two cases in terms of their respective social–ecological challenges and the current governance settings in sections 3.1 and 3.2. In section 3.3, I present an overview of the four individual articles on which the thesis is based. This is followed in section 3.4 by a description of the materials and methods used for my thesis. I present the results of the thesis in chapter 4, with the main findings summarised in section 4.1 and the more detailed results presented in sections 4.2–4.6, each of which focuses on one identified criterion for effective Baltic Sea environmental and resource governance, the underlying misfits, and the role participation could play in improving the fit. I discuss the empirical and theoretical contributions of my thesis and provide my main conclusions in chapter 5.

2 THEORETICAL BACKGROUND

2.1 Environmental and resource governance

Literature reviews of the many definitions and uses of the concept of *governance* have been presented, for example, by Stoker (1998) and Kooiman (1999). The concept is commonly used in the fields of political, administrative, and environmental social sciences. In my thesis, the concept refers to the collective effort to steer society towards desired outcomes or away from undesired ones (Young, 2013) – that is, towards a Baltic Sea unaffected by eutrophication and with a sustainable use of fisheries resources, including after landing. The concept of governance is often described as involving governments as well as other relevant actors and institutions, and as encompassing the structures and the processes through which decision-making and management are arranged (Olsen and Nickerson, 2003; Kooiman et al., 2005; Lemos and Agrawal, 2006; Jentoft and Chuenpagdee, 2009; Pahl-Wostl, 2009; Pittman and Armitage, 2016). It is a wider concept than management or policy, both of which are inherently part of governance. While management is seen as a technical issue involving targets and tools and their implementation (Pahl-Wostl, 2009), policy refers to a set of plans and actions that have been agreed upon (e.g. by a majority vote) during a decision-making process (Laine and Jokinen, 2001; Sairinen, 2009). For instance, fisheries management refers to the annual practice of setting and allocating fishing quotas according to the agreed-upon fishing policies, whereas fisheries governance is the framework in which these practices take place.

Governance is also different from government, which refers to a formal decision-making authority exerting sovereign power over people at the national or local levels (Pahl-Wostl, 2009). The governing needs for a shared resource, such as the Baltic Sea, cannot be met simply by one of the riparian countries' governments. Instead, its governance calls for collaboration between the riparian counties, and this has led to the formation of international environmental and fisheries *governance systems*. A governance system can be defined as a set of elements, including *institutional arrangements*, as well as cognitive, cultural, and technical elements that carry out the function of environmental or resource governance in a particular setting (Young, 2013). Governance systems are thus more than *institutions* and *regimes*, the first of which refers to rules, rights, and decision-making procedures, while the second refers to institutions with a specific focus, such as environmental protection or the sustainable use of resources (Young, 2013).

Another useful conceptualisation of governance for the purpose of this thesis is that of three interlinked dimensions: polity, policy, and politics (Laine et al., 2001; Treib et al., 2007; Sairinen, 2009; Pahl-Wostl, 2019). Polity refers to the institutional framework that determines the rules for solving environmental and problems related to resource use. The policy dimension, as mentioned above, is about political steering through a set of plans and actions. The politics dimension refers to the actors involved in governance and the power relations between them. I used these dimensions as lenses through which I analysed the characteristics of Baltic Sea eutrophication and catch-use governance. Next, I elaborate on these dimensions further.

The polity dimension refers to governance structures (e.g. hierarchical, market, networks), the division of authority within a governance system (single location vs. multiple levels and/or centres of authority), and the degree of the institutionalisation of the interactions (Treib et al., 2007). From this perspective, the formal Baltic Sea eutrophication and fisheries governance is realised in hierarchical, top-down, *multilevel governance* settings, while catch use after landing is mainly governed by the markets (see chapter 3). Multilevel governance is a popular concept in the field of environmental governance (Jordan, 1999; Newig and Fritsch, 2009). As a theoretical concept, it focuses on the allocation of power at different governance levels (Eckerberg and Joas, 2004; Newig and Fritsch, 2009; Wurzel et al. 2019). The concept originates from studies on European integration (Piattoni, 2009) and serves to analyse the vertical and horizontal relationships and interactions between different governance levels (supranational, national, and subnational) and actors, with the nation states as the central authority that reallocates authority upwards to international and macro-regional institutions (e.g. the EU), downwards to regional and local authorities, and sideways to other actors, for example, civil society and business (Hooghe and Marks, 2003). In contrast to hierarchical, multilevel settings, where state actors dominate and the decisions that affect many can be taken collectively by a few, markets are dominated by private actors, namely businesses and companies, and their actions are driven by the ambition to maximise profit (Treib et al., 2007; Pahl-Wostl, 2019). In network governance systems, governing is often led by informal institutions, and the system's characteristics include high inclusivity and actions based on voluntary agreements (Pahl-Wostl, 2019). In addition to the hierarchical EU-led environmental and resources governance style and market-driven catch-use governance, the Baltic Sea environment and its resources are governed through networks that interlink informal and formal ways of governing (VanDeveer, 2011; Grönholm, 2020). Thus, all three forms exist in practice.

The policy dimension concerns the main governance tools – *policies* – guiding governance actions. Policies as modes of governance can be categorised into four types: coercion, framework regulation, targeting, and voluntarism (Treib et al., 2007). This categorisation is based on whether they are legally binding (e.g. legal acts and directives) or non-binding (e.g. recommendations), and whether their implementation is rigid or flexible. Coercion as a governance mode refers to legally binding policies with limited implementation flexibility. In contrast, voluntary agreements are non-binding and flexible. Targeting and framework regulation are in between coercion and voluntarism. Targeting involves non-binding agreements, but less flexibility regarding implementation, while framework regulation is legally binding, and its implementation is flexible (e.g. the WDF and MSFD). The impact of these policies on the effectiveness of governance depends on whether they direct management efforts towards actions that can adequately deal with the problems or challenges at which they are aimed (Mickwitz, 2006).

The effectiveness of environmental and resource policies is also affected by other policies that may contribute to or, in the worst case, threaten the process towards achieving the environmental and resource-use goals. Therefore, contemporary environmental and resource governance calls for *policy coherence* (EEA, 2015; Lenschow et al., 2018). den Hertog and Stroß (2013: 377) have defined policy coherence as "synergic and systematic support towards achievement of common objectives within and across individual policies". Coherence should be achieved both horizontally and vertically. While the former refers to "coherence between a policy and other policies of the same political entity", the latter is about coherence between policies at different governance levels (den Hertog and Stroß, 2013: 377). The need for improved coherence is rooted in the interrelations, especially the potential synergies and trade-offs, between the different pillars of sustainable development: economic, social, and environmental (Zeigermann, 2018). In the EU multilevel governance setting, policy domains (e.g. environment, energy, agriculture) are highly fragmented, and decision-making and implementation are realised in silos (Lenschow et al., 2018). In addition, both the environmental (EEA, 2015) and marine (Underdal, 1980; van Hoof and van Tatenhove, 2009; Hassler et al., 2013) domains are themselves fragmented, and therefore improved policy coherence within the environmental and marine domains, as well as between them and other domains (e.g. energy, agriculture) to reduce conflicts and contradictions between the domains has been called for (Nilsson et al., 2012, den Hertog and Stroß, 2013, Lenschow et al., 2018). The literature suggests that coherence can be improved by mechanisms and processes, such as collaboration, coordination, and cooperation across sectoral borders (Lenschow et al., 2018).

Finally, the politics dimension draws attention to the actors included in governance processes, especially policymaking (e.g. deciding who gets/does what, how, and why), and to those excluded from it (Treib et al., 2007; Death, 2014; Pahl-Wostl, 2019). In environmental and resource politics, the actors can be broadly divided between state and non-state actors, although the latter comprises a diverse set of actor groups, such as non-governmental organisations, businesses, academia, and the public. These actors can be involved in governance in various constellations, ranging from those dominated by state actors to those dominated by non-state actors (Treib et al., 2007). Hierarchical governance systems are often characterised by the involvement of elected representatives and technical experts, the "elite", while networks are more open to participation and joint decision-making (Pahl-Wostl, 2019). Gaventa (2006) differentiated between three types of participation spaces: closed, invited, and claimed. In closed spaces, policymaking takes place behind closed doors by state actors (e.g. bureaucrats, experts, and elected representatives) without any consultation with stakeholders and the public, as is the case in an invited space. The third type of space is formed when actors who are kept out of formal policymaking claim space for action. As this thesis examines formal governance systems, the focus is primarily on invited and closed spaces rather than claimed ones.

In addition to who is involved in governance, the politics dimension emphasises the power relations and dynamics between the actors. Like many other concepts, power is also subject to multiple definitions rooted in different scientific fields and traditions, but a shared understanding of power as unevenly divided and socially contested prevails (Morrison et al., 2017). From an analytical perspective, the power that an actor has can be categorised in terms of visible (whose interests prevail), hidden (backstage politics), and invisible (shaping people's beliefs and wants) forms (Gaventa, 2006). Wilson (2008: 114) defined power in international politics as "the ability to influence another to act in ways in which that entity would not have acted otherwise". In other words, the more powerful actors can use their power to coerce, persuade, or both (Wilson, 2008) to win the game of "who gets what, how and why" to achieve their preferred outcome (Death, 2014). However, in addition to coercion and manipulation enabled by power asymmetries, or "power over", environmental politics have been shaped by two other power dimensions, referred to as "power with" and "power to". The former refers to joint action through leadership and pioneering towards a common good, and the latter refers to action taken by individual actors and actor groups, which may or may not benefit others. While the concept of power over can provide information about obstacles to change, the other two focus more on the capacity to transition towards a more sustainable future (Partzsch, 2016). Depending on the governance setting – whether hierarchical, network, or market – power can be rooted in an actor's place in a formal hierarchy, role in the network, or wealth, respectively (Pahl-Wostl, 2019).

Unevenly divided power relations also impact actors' capacity to affect different governance processes. According to Morrison et al. (2017; 2019), the capacity to influence is affected by three power types: power by design, pragmatic power, and framing power. These power types imply that actors have an uneven capacity to set rules and policies (power by design), interpret and implement those rules and policies (pragmatic power), and frame the problem (framing power). This typology accentuates the interlinkages between politics and policy dimensions. Indeed, politics and power are widely accepted as integral parts of policy processes, which are first and foremost social activities. This implies that environmental and resource policies are products of complex processes that are shaped by the *beliefs, interests, and values* of those participating in the process (Jasanoff, 1990; 2004; Owens et al., 2006; Owens, 2015). In other words, ecological knowledge of environmental problems and resources is not merely transferred into a policy through a linear and unidirectional link, as the technical-rational model suggests, nor is knowledge merely an instrument of a political interplay of interests and power, as the political-rational model proposes (Owens, 2015).

In the next section, I describe the theoretical framework used in this thesis for analysing governance fit. I have elaborated on this framework based on a review of the problem of the literature on fit.

2.2 Governance fit to enhance effectiveness

In my thesis, following Young's (2017: 28) definition, the effectiveness of environmental or resource governance is understood as "the extent to which these (governance) arrangements contribute to solving or mitigating the problems". This definition draws from the idea that effectiveness can be analysed by focusing on outputs (e.g. the laws and plans), outcomes (changes in the behaviour of relevant actors), and their impacts (changes in the environment due to governance outputs and outcomes) (Hogl et al., 2012; Young, 2017). In practice, many analysts have focused only on the outputs and outcomes of governance, as their impacts can be more difficult to observe (Hogl et al., 2012). However, the outputs and outcomes alone do not guarantee that the environmental problem is solved (Young, 2011), as the case of the Baltic Sea also demonstrates: despite all the efforts over several decades, many of the environmental problems remain. In other words, the existence of certain governance arrangements and actions alone is not enough to ensure that the system is effective. They also need to contribute to solving complex social–ecological challenges.

Drawing from this definition and based on the governance literature on the so-called *problem of fit*, the premise of my thesis is that the effectiveness of environmental and resource governance is largely determined by the characteristics of the governance system and the governed system and how well they fit or match each other (Young, 2002; 2011; 2013; 2017; Folke et al., 2007). I used governance fit as an analytical tool to explore the ability of the governance system to deal with complex social–ecological challenges. Like Pittman (2016), I consider governance fit to be an analogue for effectiveness. This implies, following the normative assumption underlying the concept, that the better the fit, the greater the effectiveness.

This approach was chosen for this study for three main reasons. First, instead of providing predetermined criteria for the effectiveness of Baltic Sea environmental and resource governance, the approach supports the identification of the criteria by inductively diagnosing the key governance requirements in the studied context. Scholarship on environmental and resource governance has widely accepted the need for a shift from a panacea – that is, "one size fits all" governance requirements – to a context-specific tailoring of them (Ostrom, 2007; Young, 2018; Pahl-Wostl, 2019). Second, the approach has been developed for studying international environmental and resources governance (Young, 2002) and is therefore well suited for studying Baltic Sea eutrophication and catch-use governance. In my view, the diagnostic approach developed by Ostrom (2007), as well as the interactive governance theory (Kooiman et al., 2008), both of which are interested in understanding the interactions between governance and governed systems, would have been less suitable approaches for my thesis because the former focuses mainly on smaller-scale settings, and the latter is theoretically more complex.

Research on the problem of fit and the notion of *institutional fit* draws attention to the coherence between regimes (e.g. environmental and agricultural) as well as the ability and willingness of the subjects of a regime (e.g. countries) to implement the agreed policies and regulations (Young, 2002). It thus closely links to multilevel governance and policy coherence, although some differences also exist. For instance, regarding analytical tools, multilevel governance tends to place more emphasis on the role of different actors and thereby participation, while institutional fit focuses more on the interplay between different regimes and institutions. However, Galaz et al. (2008) widened the conceptualisation of fit from institutions (Young, 2002; Folke et al., 2007) to the whole governance system, thereby also placing other elements of the governance system under scrutiny, including the interactions between relevant actors in a multilevel governance context, their potentially conflicting interests, and instruments that are used within a policy area. In other words, a shift from institutional analysis to governance analysis broadens the perspective from policy and polity to include politics. As I am especially interested in the problem of fit in terms of this wider conceptualisation, I will hereafter refer to it as *governance fit* to differentiate it from the narrower lens of institutional fit. More specifically, the characteristics of the Baltic Sea eutrophication and catch-use governance systems are scrutinised from the perspectives of polity, policy, and politics.

In addition to the characteristics of the governance system, the problem with the fit approach concerns the characteristics of *the governed system*. While the governed system has often been considered as either a biogeophysical system (Young, 2002) or a social system (Meek, 2013), lately the need to address both of them simultaneously – that is, as a tightly coupled social–ecological system (SES) – has been called for (Berkes and Folke, 1998; Folke et al., 2007; Epstein et al., 2015). The underlying idea is that the requirements of environmental and resource governance and management cannot be based only on the characteristics of the social while ignoring the ecological system, and vice versa (Folke et al., 2005). As Berkes and Folke (1998) have claimed, the conventional views on ecology and social sciences as two independent systems are "artificial and arbitrary", and instead, the two systems should be viewed as highly interlinked and interdependent. Accordingly, they proposed the term *social–ecological system* to emphasise the mutual interdependencies and co-evolution between the two (Berkes and Folke, 1998). The term has since been widely adopted by researchers across disciplines.

Adding the social system as part of the governed ecological system widens the focus of governance fit on the characteristics of the ecological system to include the characteristics of the social system. In terms of governance fit, the question is how well the governance system (the polity, policy, and politics dimensions) fits the requirements stemming from the social–ecological context. The key characteristics of the ecological system include *spatial* and *temporal scales*, and *ecosystem functions*

(Epstein et al., 2015). Spatial scale is concerned with the geographical boundaries of the ecological issue and how well the institutional arrangements fit it. For instance, the administrative and jurisdictional boundaries of the governance system may be smaller or larger than the boundaries of the ecological system, which causes a misfit between the two. The second attribute of the ecological system, the temporal scale, refers to the rate of environmental change and the related fit to the timeliness of the governance system's reaction to it. The inability of the governance system to react rapidly to changing conditions can lead to worsening the problem. The last attribute of the ecological system, ecosystem functions, refers to ecosystem dynamics and how well these dynamics (e.g. between different fish species, the ecological state of the waters, etc.) are considered by governance (Young, 2002; Galaz et al., 2008; Epstein et al., 2015). The key characteristics of the social system encompass *values*, *interests,* and *beliefs*, *scale of social organisation*, and *stakeholder perceptions of participation* (Epstein et al., 2015). The first characteristic draws attention to the values, interests, and beliefs of people affected by governance and whether the policies and rules are aligned with them. This fit may be particularly hard to achieve, as values and interests relating to the environment and resource use tend to vary and conflict. The second characteristic of a social system concerns the relevant scales of a social organisation and the ability of the governance system to address all of them. In other words, the appropriate scale (e.g. macro-regional, national, subnational, local) depends on the social context. The last characteristic, stakeholders, is ultimately about whether the governance system is able to arrange meaningful participation activities that meet the expectations of relevant stakeholders. This characteristic is further elaborated in section 2.3.

As an analytical approach, the problem of fit implies that the analysis should focus on identifying which of the characteristics (or contextual attributes) of the governance and governed systems contribute to the misfit and how. Thus, in my work, governance fit refers to the interactions between the above-identified dimensions and elements of the governance system and the social and ecological attributes of the SES that contribute to the overall success of Baltic Sea environmental and resource governance (Fig. 1). More specifically, I analysed the characteristics of the governance systems through the lenses of the polity, policy, and politics dimensions of governance and determined their fitness for purpose based on the attributes of the SESs. I used these characteristics and attributes to identify which contributed to governance misfits and how. Based on this analysis, I established the criteria for effective Baltic Sea environmental and resource governance. The role of participation in governance is elaborated in the next section.

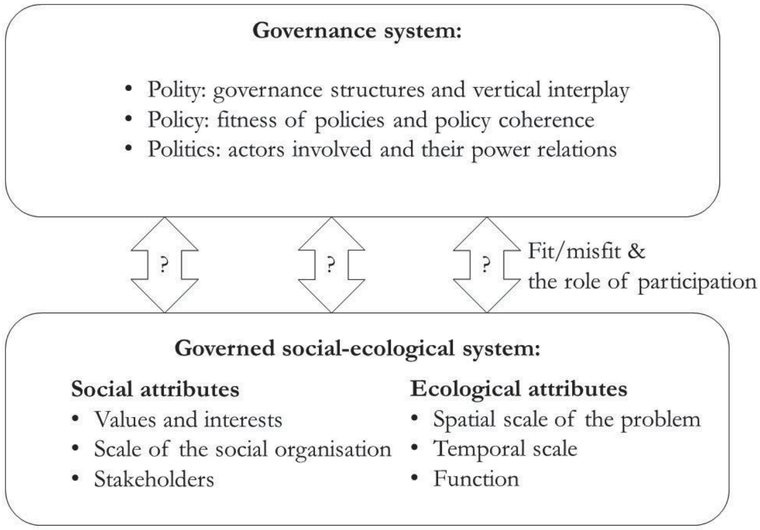

Figure 1. Theoretical framework used for analysing governance fit (elaborated from Young, 2002; Galaz et al., 2008; Epstein et al., 2015)

2.3 The role of participation

So far, in chapter 2, I have described the conceptual background of the concept of governance as used in this work and the analytical approach that was applied to study the fit between governance and governed systems. Participation relates closely to both systems. Regarding the characteristics of the governance system, the focus is on who is involved and their respective power relations, whereas the participation attribute of the governance system concerns the meaningfulness of the participation arrangements from the perspective of relevant stakeholders and the public. Here, *stakeholders* refers to non-state actors who can affect or are affected by a decision (Freeman, 1984). In this section, I first provide examples of participation typologies and describe the claimed benefits of participation in knowledge production and policymaking as well as the related criticism. Second, I present and elaborate the dimensions of participation used to examine the roles participation could play in more effective Baltic Sea environmental and resource governance.

Participation in formal governance processes is not only about who is invited to participate (Gaventa, 2006) but also about who is willing to participate in governance processes that affect them (Rowe and Frewer, 2000; Reed, 2008). Literature on participation can be roughly divided into those focusing specifically on the involvement of stakeholders (e.g. Reed, 2008) and those interested in the inclusion of the wider public, that is citizens (e.g. Arnstein, 1969; Rowe and Frewer, 2000). Different typologies of participation have been developed that can be useful for both planning and analysing participation (Reed, 2008). For example, Arnstein's (1969) "ladder of citizen participation" categorises participation based on the degree of influence citizens can have on policy outcomes. The ladder comprises eight rungs ranging from manipulation (dissemination of information) at the lowest level to citizen control (active engagement) at the top. Rowe and Frewer (2000) evaluated the most formalised public participation methods: referenda, public hearings, public opinion surveys, negotiated rule-making, consensus conferences, citizens' juries/panels, citizen advisory boards, and focus groups. They found strengths and weaknesses in each method and concluded that the selection of the best method depended on the context. Reed (2008), in turn, based on a literature review, identified "eight best practices in stakeholder participation": 1) participation should emphasise empowerment, equity, trust, and learning; 2) participants should be engaged early and throughout the process; 3) systematic stakeholder analysis and representation is needed; 4) the aims of participation need to be clear for all participants from the beginning; 5) methods should be selected and tailored case-by-case; 6) facilitators need to be highly qualified; 7) integration of local and scientific knowledge is needed; and 8) participation should be institutionalised. He argues that the success of participation depends first and foremost on how the participation process is designed. I did not use these typologies to analyse participation. Instead, I used them, particularly the works of Rowe and Frewer (2000) and Reed (2008), to engage relevant societal actors in knowledge production in the catch use case (participatory backcasting and consumer questionnaire).

Indeed, the call for participation is not limited to policy development; it also encompasses knowledge production (Young, 2002; Dietz et al., 2003; Kooiman et al., 2008; Reed, 2008; Dietz and Stern, 2008; Newig and Fritsch, 2009; Turnhout et al., 2019). For instance, the use of multiple sources of knowledge across disciplinary boundaries and stakeholder groups (ranging from local to global) is increasingly recognised as one of the key requirements for solving complex environmental problems (Lemos and Morehouse, 2005; Dejnontin and Meadow, 2018; Turnhout et al., 2019). Problem framing determines how environmental and resource-use problems are understood and defined, and what kinds of knowledge are considered relevant (Halffman, 2019). Narrow problem definitions produce limited solution possibilities (Tynkkynen, 2008), which simply cannot adequately address complex environmental and resource-use problems. Therefore, the governing of complex social–ecological systems calls for transdisciplinarity. In addition, actors outside academia who are affected by the decisions may also have relevant knowledge. Inclusion of such lay expertise in knowledge production can further improve the quality of the knowledge, the legitimacy of the solutions, and the effectiveness of their implementation (Turnhout, 2019). However, in practice, participation in knowledge production may or may not improve the outcomes. Failure to achieve participation objectives in knowledge production can be explained by the uneven distribution of power among the participants, which is reinforced and justified by the depoliticisation of the knowledge production process. This enhances the dominance of traditional (natural) scientific knowledge over other forms of knowledge, thereby limiting societal transformation. (Turnhout et al., 2020).

The claimed benefits of participation in a policymaking process include enhancing trust and understanding between those involved, thereby increasing transparency and the legitimacy of the policy decisions (see e.g. Cash et al., 2003; Reed, 2008; Djenontin and Meadow, 2018). This can, in turn, enhance the overall commitment to policy implementation (Newig, 2012; Reed, 2008; Newig et al., 2018). However, as can happen in knowledge production processes, participation in policymaking can also be counterproductive and worsen the situation (Dietz and Stern, 2008; Turnhout et al., 2010). These failures may result from poor planning and execution of participation in governance processes (Reed, 2008; Dietz and Stern, 2008). The inconsistencies in empirical evidence on the role of participation in effective environmental and resource governance have resulted in calls for further research (Reed, 2008; Newig, 2012; Newig et al., 2018).

My thesis contributes to these discussions by empirically examining the roles participation could play in improving the governance fit. I have concentrated on the three interrelated dimensions of participation: 1) the extent of involvement, 2) the form(s) of interaction between those involved, and 3) the power relations (Newig et al., 2018). The first dimension steers the focus to both the included and excluded actors (see also section 2.1). The question of who should be involved cannot be universally solved; instead, the most relevant actors for any given governance process and governed phenomenon need to be determined case by case (Reed et al., 2009). Identification of relevant actors can be risky, as it entails the exclusion of others. Those others can also be affected by the decisions and therefore wish to have a voice in the matter. Thus, the inclusion of only selected actors may undermine attempts to strengthen the support and commitment of those affected by the decisions (Turnhout et al., 2010). As for the inclusion of citizens, the theoretical and empirical research provides little insight into how this could be arranged in a meaningful way

(Reed, 2008; Rowe and Frewer, 2000); Newig et al., 2014; Rimmert et al., 2020). According to Rowe and Frewer (2000), representativeness tends to be the highest in public opinion surveys, but their weakness compared to other methods is that their influence on actual policy is indirect and often difficult to determine.

The second dimension of participation refers to the different ways in which the participating actors communicate and interact (Newig et al., 2018). For instance, information between state and non-state actors may be exchanged through one-way or two-way processes (Rowe and Frewer, 2000). In one-way communication, information is merely shared with the other actors without actual deliberation over it. Examples of such processes include hearings and consultations (Rowe and Frewer, 2000; Arnstein, 1969). In contrast, two-way communication entails deliberation and collaboration between the actors (Ansell and Gash, 2007). The overall aim of such collaborative processes is to "engage people constructively across the boundaries of public agencies, levels of government, and/or the public, private and civic spheres in order to carry out a public purpose that could not otherwise be accomplished" (Emerson et al., 2012: 2). These processes are usually consensus-oriented (Ansell and Gash, 2007), which has been criticised because of its potential for diluting differences in perspectives, thereby leading to a consensus that no longer responds to the underlying interests of the participants (Turnhout et al., 2010) and weakens commitment. Consensual processes may also deliver shallow, unambitious decisions (Young, 2011). Indeed, a risk in participatory governance is that it can lead to a lower environmental standard if the environmental ambitions of those involved in the process are low (Newig and Fritsch, 2009).

The third dimension concerns power relations and the ability of the participants to influence environmental and resource governance (Newig et al., 2018). Power imbalances and their implications for knowledge production, policymaking, and implementation have been discussed earlier in this chapter. In sum, power asymmetries determine who gets to participate in governance, as well as whose interests, values, and views dominate the outcomes. In environmental and resource governance, the most prominent power struggles take place between environmental and economic interests. Strong power imbalances may also affect stakeholders' willingness to participate (Newig et al., 2018).

3 CASE STUDIES

3.1 Case study 1: Baltic Sea eutrophication governance

3.1.1 Eutrophication as a social–ecological challenge

Eutrophication, resulting from excessive anthropogenic nutrient (phosphorus and nitrogen) input to the Baltic Sea and causing, for example, dense growth of aquatic plant life, toxic cyanobacteria blooms, and oxygen depletion, is considered one of the most severe and pressing environmental problems of the Baltic Sea (Vahtera et al., 2007; HELCOM, 2010). According to a recent assessment, 97% of the Baltic Sea suffers from eutrophication (HELCOM, 2018b). The sources of nutrient input to the Baltic Sea are presented in Figure 2. Both phosphorus and nitrogen enter the Baltic Sea via rivers (P 95% and N 70%) and directly from point sources such as waste water treatment, fish farms, and industries (P 5% and N 3%), but nitrogen also enters the sea as atmospheric input (e.g. in the form of nitrogen oxide; N 27%) (HELCOM, 2018b). The riverine load originates from 1) diffuse sources, mainly agriculture; 2) inland point sources, such as municipalities and industries; 3) transboundary sources, that is, from the catchment area beyond the riparian countries; and 4) natural background sources (HELCOM, 2018b). The largest amount of the assessed inputs of both nutrients comes from Poland and Russia (HELCOM, 2015).

Significant reductions in anthropogenic nutrient input, especially from point sources, have already been achieved (HELCOM, 2018b). Still, the state of the sea in terms of algal blooms and anoxia has not improved. Recent assessment shows that the problem of eutrophication is expanding rather than improving (Fleming-Lehtinen et al., 2015). This is, at least partly, due to the internal biochemical processes and feedback loops in the Baltic Sea ecosystem, which are often referred to as a "vicious cycle". This means that eutrophication processes can potentially become self-sustaining (Vahtera et al., 2007). The vicious cycle and the related internal load have been identified as one of the main ecological obstacles to eutrophication mitigation (Varjopuro et al., 2014).

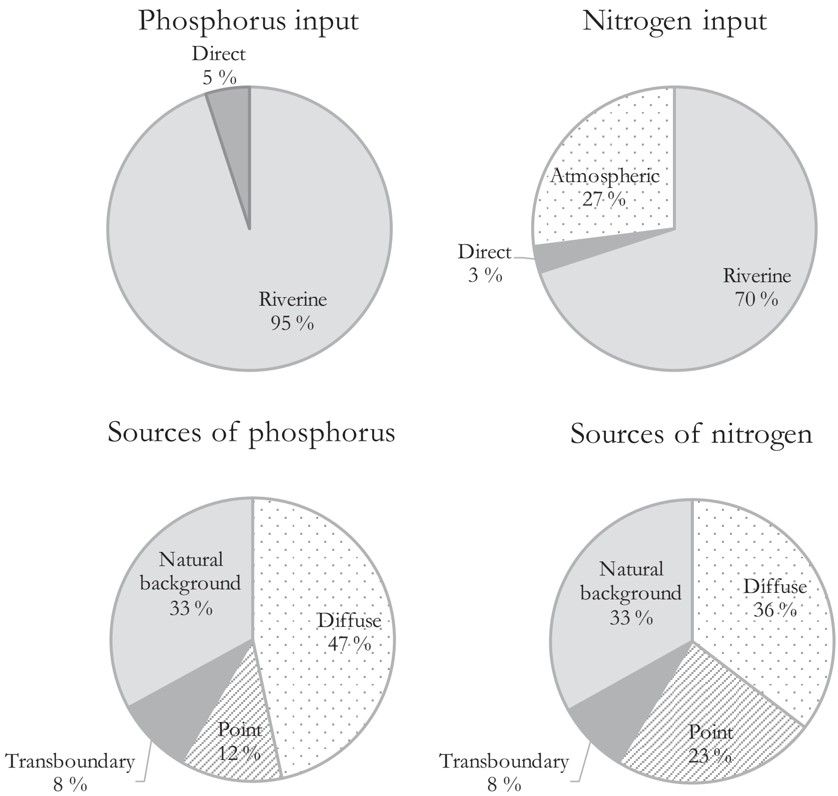

Figure 2. Input and origin of nutrients to the Baltic Sea in 2014 (HELCOM, 2018b)

3.1.2 Governance setting

The eutrophication case focuses on the formal Baltic Sea eutrophication governance system, which comprises governance efforts at the EU, HELCOM, and national levels. Although governance arrangements at the global and subnational levels also exist, these are not dealt with in this study. Similarly, informal governance efforts, such as those put forward by NGOs, are not included in this, which is not to downplay their importance in the quest for combatting the problem.

The Baltic Marine Environment Protection Commission – that is, the Helsinki Commission (HELCOM) – was founded in the 1970s to protect the sea through intergovernmental collaboration from all sources of pollution. It has been considered remarkable that members of competing military alliances agreed to sign a multilateral convention during the Cold War (Räsänen and Laakkonen, 2008). The so-called Helsinki Convention was signed in 1974 and entered into force in 1980. Since then, HELCOM has adopted over 260 recommendations on measures to address sources of environmental pollution and problems (HELCOM, 2019). In 1992, after the dissolution of the Soviet Union and reunification of Germany, the Convention was revised and the Joint Comprehensive Environmental Action Programme (JCP) was created, encompassing a list of 130 "hot-spots", many of them nutrient sources from waste water treatment, in the catchment area. Many of these hot spots have since been eliminated, but new ones have also been added to the list. In 2007, the most ambitious Baltic Sea protection programme to date, the Baltic Sea Action Plan (BSAP), was adopted. The BSAP aims "to have a Baltic Sea unaffected by eutrophication" (HELCOM, 2007: 7) and provides country-specific provisions regarding how much each of them must reduce nutrient input, based on both past reductions and current input. These country-specific allocations were revised and agreed upon in the 2013 HELCOM Ministerial Declaration (HELCOM, 2013). According to both the 2007 BSAP and the revised reduction targets in 2013, Poland has been allocated the largest share of total phosphorus and nitrogen reduction requirements. In the revised BSAP, Poland's share of the total reduction requirement for phosphorus was 52%, followed by Russia's 26% and Lithuania's 10%. Thus, these three countries bore nearly 90% of the phosphorus reduction burden. As for the nitrogen reduction burden, Poland's share of the total was 49%, while the majority of the rest of the nitrogen reduction target was more evenly allocated to four other countries: Russia 11.6%, Sweden 10.4%, Lithuania 10%, and Germany 8.6% (HELCOM, 2013). To facilitate the implementation of the BSAP, each riparian country prepared a National Implementation Programmes for achieving their respective reduction targets.

The governance setting for Baltic Sea environmental protection changed significantly after the EU enlargement in 2004. Finland and Sweden had joined the EU in 1995, and Poland and the Baltic states followed in 2004, which meant that all riparian countries, apart from Russia, were now members of the EU. This increased the EU's interest in the Baltic Sea. It also made the EU a key actor in Baltic Sea environmental protection, due to its institutional and legislative power (Schumacher, 2012). The first (and still ongoing) EU regulations combating eutrophication were adopted in 1991. These were the Urban Waste Water Treatment Directive (UWWTD; Council Directive 91/271/EEC) and the Nitrates Directive (ND; Council Directive 91/676/EEC), which provided measures for nutrient reductions from waste water and agriculture. The UWWTD provided for at least 75% of the phosphorus and nitrogen in the sewage water being removed, and the ND set limitations for fertilizer use. Nutrient input from agriculture has also been regulated by the environmental scheme of the Common Agricultural Policy (CAP) since 1992 by providing compensation to farmers for implementing certain water protection measures identified in the scheme (Council Regulation [EC] No 1782/2003; European Commission, 2005). In addition, airborne emissions of nitrogen oxides and so forth are regulated by the National Emission Ceilings Directive (NECD; Directive 2001/81/EC of the European Parliament and of the Council; Directive [EU] 2016/2284 of the European Parliament and of the Council).

It was not until the 21st century that water protection was raised as its own target in the EU and as a priority of the European Commission. Accordingly, more comprehensive water protection programmes, namely the Water Framework Directive (WFD; Directive 2000/60/EC of the European Parliament and of the Council) and, most importantly, the Marine Strategy Framework Directive (MSFD; Directive 2008/56/EC of the European Parliament and of the Council) were adopted. These directives aim to achieve a good status for inland and marine waters, respectively. Interestingly, collaboration between the EU and HELCOM strengthened during the preparation of the MSFD, due to the overlap between the development of the MSFD and HELCOM BSAP, and since the latter was considered a pilot project for the former (European Parliament, 2006). After the adoption of the MSFD, HELCOM became the main regional coordinator for its implementation in the Baltic Sea. The BSAP also served as a basis for the environmental pillar of the EU Strategy for the Baltic Sea Region, which was the first regional strategy of the EU. Again, the Baltic Sea was considered a pilot project and an example for other regional strategies.

While some Baltic Sea riparian countries have plans or strategies specifically for Baltic Sea protection, others have included Baltic Sea protection as part of broader environmental protection strategies (Pihlajamäki and Tynkkynen, 2011). In Finland, which is considered one of the front runners of Baltic Sea environmental protection, the protection efforts have been guided by several policies aimed at improving the state of the sea: for example, Finland's Programme for the Protection of the Baltic Sea (2002), which includes the actions to meet the Water Protection Targets by 2005 (1998), the Water Protection Policy Outlines to 2015 (2006), and the Government Report on Challenges of the Baltic Sea and Baltic Sea Policy (2009). The riparian countries have, to varying extent, incorporated HELCOM recommendations, targets of the BSAP, and the EU regulations in their national marine and water policies and legislation (Pihlajamäki and Tynkkynen, 2011). Overall, the implementation of HELCOM recommendations, as well as the ambition embedded in the National Implementation Programmes of the BSAP, have varied significantly between the riparian countries (HELCOM 2003; 2013; Pihlajamäki and Tynkkynen, 2011).

However, after 2004, the Baltic States and Poland started implementing the same environmental regulations as the rest of the EU member states, which is closing the gap between them and the Western countries. More recently, the EU member states have developed national implementation plans for the WFD and the MSFD, namely the River Basin Management Plans (for each river basin) and the National Marine Strategies and the related Programmes of Measures. For example, the MSFD defines a list of qualitative descriptors for good environmental status (GES), but it is up to the member states to develop national implementation plans for achieving the GES.

3.2 Case study 2: Baltic herring catch-use governance

3.2.1 Use of Baltic herring catch as a social–ecological challenge

Feeding the world's population sustainably and efficiently is one of the main societal challenges of today and the future (UN, 2015). The demand for fish as a source of food has steadily increased over the past decades (FAO, 2018). This is, on the one hand, due to the growing world population and, on the other hand, due to eating recommendations provided by health authorities based on perceived health benefits (Pauly et al., 2005; Thurstan and Roberts, 2014; FAO, 2016). Consequently, the demand for fish has outpaced the production capacity of the wild-captured fisheries, and to compensate for the limited supply, aquaculture production has increased (Branch et al., 2011; FAO, 2018), which can, particularly if poorly managed, cause adverse environmental impacts (Clavelle et al., 2019). Many developed countries and regions, such as the EU, depend on imported fish (Pauly et al., 2005; European Commission, 2018), which weakens self-sufficiency and can cause food insecurity in poorer regions of the world where fish may be the main source of animal protein (Atta-Mills et al., 2004; Asche et al., 2015; Watson et al., 2017). At the same time, around 20% of the wild-captured species, namely small pelagic species, are used for industrial purposes (i.e. to feed animals and farmed fish) instead of for food (FAO, 2018). From a food security perspective, this practice is unsustainable, and the prioritisation of fish resources as food instead of as feed has been called for (FAO, 1995; 2011). Using fish primarily as food and secondarily (i.e. the by-products) as feed in aquaculture would maximise its contribution to food security. In this case study, food security refers to the definition provided by the UN Food and Agriculture Organisation (FAO) in 2008 – physical availability of food, economic and physical access to food, food utilisation, and the stability of the three dimensions over time – whereas food safety is about the quality of the food and addresses whether certain food products are safe to eat.

The case study focuses on Baltic herring, which, in terms of landing volume, is one of the two largest commercial catch species in the Baltic Sea (ICES, 2018). Although Baltic herring has been a traditional food in the Baltic Sea countries, its consumption has decreased over the past few decades and is currently low compared to that of other fish (see e.g. Natural Resources Institute Finland, 2017; Swedish National Food Agency, 2013; European Commission, 2013; Eschbaum et al., 2019). Instead, the catch is used as feed, primarily in fur farming and secondarily in aquaculture (Lassen, 2011; ICES, 2018). For example, Finns consume approximately 3% of their Baltic herring catch (Setälä et al., 2018). During the 21st century, Finns consumed around 14 kg of fish per person per year, and at the same time, Baltic herring consumption decreased from 1.5 to 0.3 kg/person/year (Natural Resources Institute Finland, 2017). The overall domestic consumption of Baltic herring decreased from over 30 million kg per year in the 1980s to around 3.5–4 million kg in the 2010s (Natural Resources Institute Finland, 2016). The trend is similar in many of the Baltic Sea countries.

Thus, Baltic herring has a far greater contribution potential for food security in terms of improved regional self-sufficiency than what is currently realised. Increasing the use of Baltic herring as food also has other benefits. From an environmental perspective, using sustainably and locally harvested Baltic herring as food can be considered an ecologically more sustainable option compared to, for example, imported tuna or farmed salmon and rainbow trout. In Finland, for example, salmon and tuna are the most commonly consumed species and have contributed to the increase in fish consumption in general (Natural Resource Institute Finland, 2017).

From the fishers' perspective, selling the catch for food instead of feed is more profitable (Setälä et al., 2016). However, the price of herring sold for fishmeal production has improved and is becoming competitive with food prices (Personal communication with a fisheries expert, 2016). The competition between different catch uses is likely to increase in the future, which may also increase the profitability of herring fishing (Alder et al., 2008; Tacon and Metian, 2009). Moreover, using Baltic herring as food or as raw material in fishmeal production can increase employment in the fishing sector (e.g. in processing) (Setälä et al., 2016).

From a public health perspective, Baltic herring is a good source of omega-3 fatty acids and vitamin D; therefore, Baltic herring consumption is beneficial to human health (Swedish National Food Agency, 2013; Tuomisto et al., 2015). However, large (over 17 cm) Baltic herrings in the northern and eastern parts of the Baltic Sea contain high levels of dioxins, which can cause a threat to human health if the total intake of dioxins exceeds a certain threshold set by the European Commission (Commission Recommendation [EU] 2016/688). Owing to the dioxin problem, the availability of Baltic herring in the EU food market is limited, as EU countries cannot sell herring that exceeds the maximum allowable level of dioxins in the EU. Finland and Sweden, the two countries that catch herring from the Bothnian Sea, where the dioxin content is the highest, have applied for an exemption that allows them to place such non-compliant herring in their national food markets. These two countries must provide consumers with adequate information about the health risks related to Baltic herring consumption. Accordingly, in Finland, the risk groups (i.e. people at the fertile age and children) are advised to limit Baltic herring consumption to one to two times per month (Finnish Food Authority, 2019). In Sweden, women at the fertile age and children have been advised to limit Baltic herring consumption to two to three times per year, and other consumers have been advised to limit it to once a week (Swedish National Food Agency, 2020). The other riparian countries have different strategies for dealing with the EU regulations: some fish Baltic herring for food from areas where the maximum dioxin levels do not exceed the recommendations, and others sort the catch and use only small (under 17 cm) herrings as food (see Article IV).

In addition to the dioxin problem, there are at least two other reasons for the decreased demand for Baltic herring for human consumption (see Articles III and IV). First, the consumption of locally caught species has been replaced by imported and farmed fish, such as tuna and salmon. Second, many of the Baltic herring fleets target herring for industrial purposes, which decreases its availability for human consumption.

3.2.2 Governance setting

Like environmental marine governance, the formal Baltic Sea fisheries governance is organised through a top-down multilevel setting. Since the macro-regional governing body, the IBSFC, became obsolete in 2004, fishing has been governed by the EU CFP (Regulation [EU] No 1380/2013 of the European Parliament and of the Council) and the related multiannual plan (Regulation [EU] 2016/1139 of the European Parliament and of the Council). In this setting, decisions on common policies, regional multiannual plans, and annual fishing rights have been made at the EU level, and the division of fishing rights between fishers is made at national levels. In addition, two macro-regional forums, namely the Baltic Sea Advisory Council

(BSAC) and BALTFISH, have been established to facilitate stakeholder participation and collaboration between the Baltic Sea riparian countries. The BSAC was originally established in 2006 as per the European Council decision (Council Decision 2004/585/EC; Commission delegated regulation [EU] 2015/242), and it aims to facilitate the inclusion of stakeholders in decision-making. BALTFISH was established by the Baltic Sea countries (those that are EU member states) to facilitate regional fisheries governance and stakeholder involvement and to foster agreement on Baltic Sea issues between the Baltic Sea riparian countries and thereby decrease the decision-making power of other EU member states in the Council.

The contribution of EU fisheries to food security was raised as its own management objective in the 2013 CFP. More specifically, the most recently reformed CFP states that "the CFP shall ensure that fishing and aquaculture activities are environmentally sustainable in the long-term and are managed in a way that is consistent with the objectives of achieving economic, social and employment benefits, and of contributing to the availability of food supplies" (Regulation [EU] No 1380/2013 of the European Parliament and of the Council: 29). The rationale for this objective is the apparent high dependence of the EU on imported fish: "the CFP should also contribute to the supplying of highly nutritional food to the Union market and to reducing the Union market's dependence on food imports" (ibid., 23). However, the CFP's strategy to achieve the food security objective is based solely on aquaculture, while the contribution of forage species is not addressed. This has not always been the case. The use of the catch was governed by an EU regulation between 1977 and 1998, which stipulated that herring caught by EU member states should be used primarily for human consumption (Council Regulation [EEC] No 2115/77; Council Regulation [EC] No 1434/98). The reasoning behind this requirement was that the ecological state of the stocks had decreased significantly due to overfishing, and therefore the catch volumes had declined as well. This implies that the use of the EU's enforcement power to increase the contribution of forage species to food security would not be an unorthodox approach to govern catch use.

Although the formal governance system does not address catch use per se, it must consider the food safety requirements imposed by the EU food safety agency (Commission Regulation [EU] No 1259/2011; Commission Recommendation [EU] 2016/688). In addition, in the absence of formal catch-use governance, the use of the catch has been determined by an informal governance system driven primarily by market conditions (i.e. supply and demand). In addition, multiple bottom-up initiatives have emerged to increase the use of forage and coarse fish as food. For example, the Marine Stewardship Council (MSC), which is an international non-profit organisation, certifies sustainable fisheries in collaboration with scientists, fisheries, and seafood producers and brands. The Finnish herring fishery was certified in 2018. Also, if a fishery holds MSC certification and the fish is used in aquaculture, the farmed fish can be granted certification by the Aquaculture Stewardship Council (ASC). Other examples of bottom-up initiatives include the John Nurminen Foundation's Local Fishing Project, which aims to increase the use of domestic coarse fish (mainly cyprinids) as food; the WWF sustainable fish food guides, which provide guidance for consumers on sustainable fish food choices; and the Finnish Pro Fish Association, which has worked towards increasing public awareness of domestic fish products.

3.3 Overview of Articles I–IV

Article I explores governance challenges of the formal Baltic Sea environmental governing system to combat eutrophication. The paper describes and analyses governance arrangements, specifically the main institutions, policies, and actors, at different governance levels, including eight Baltic Sea coastal countries (Germany, Poland, Lithuania, Latvia, Estonia, Russia, and Finland), the macro-regional (HELCOM) level, and the EU level, and the interplay between them. The paper presents four main governance challenges of Baltic Sea eutrophication mitigation: 1) absence of a supranational regulatory body that encompasses all the littoral states and has enforcement power, 2) socioeconomic differences between the littoral states and the lack of environmental awareness and engagement, 3) insufficient spatial and temporal specification of policies, and 4) inadequate policy integration. To meet these challenges, the paper calls for a region-wide "primus motor" for eutrophication governance and suggests more inclusivity in governance practices at different governance levels.

Article II examines the perceptions of scientists on the intricacies of scientific knowledge that affect the science–policy interface in the Baltic Sea eutrophication governance in Finland. The paper aims to provide illustrations of the susceptibility of scientific knowledge to uncertainty, human interpretation, and politics (Jasanoff, 2004), and how these intricacies have prevented effective eutrophication governance. The paper identifies five aspects of scientific knowledge that hamper effective eutrophication governance: 1) uncertainties of knowledge concerning ecological processes; 2) heterogeneity of knowledge; 3) societal and political call for (certain) knowledge; 4) contingency of the knowledge that ends up taken as a baseline for decision-making and further research; and 5) linkages of knowledge production, processing, and communication to particular characteristics of individual researchers and research societies. To deal with these aspects, the article suggests improving participation in the knowledge–policy interface, such as including not only researchers but also laypersons more extensively.

Articles III and IV respond to the research requirements identified in Articles I and II, namely the inclusion of stakeholders and the public in knowledge co-creation on how to bridge the gap between policy intention and action by improving the integration between policy sectors. Using Baltic herring as a case study, the aim of Article III is to examine how food security and safety could be integrated in fisheries governance. As a result, the paper presents a number of actions to increase the contribution of Baltic herring to food security. Actions to get the dioxin problem under control include the following: sorting the catch and using small (under 17 cm) herrings for human consumption; managing the Baltic Sea fish stocks, for example, via selective fishing, to allow herring to grow faster, thereby decreasing the dioxin levels in Baltic herring; managing dioxin sources to decrease input to the Baltic Sea; changing dioxin risk perception, for example, by adopting the Finnish and Swedish risk management approach at the EU level; and lowering dioxin risk by reducing dioxin exposure from other foods, namely by adopting low-dairy and low-meat diets. The actions to increase the use of Baltic herring as food aimed at the following: increasing the amount of direct Baltic herring consumption in the EU and of that exported outside the EU for food; acquiring certifications for Baltic herring products; using Baltic herring-based fishmeal and oil for human consumption; and maximising the indirect contribution of Baltic herring to food security by increasing the use of Baltic herring in aquaculture. For each of these governance actions, actor group-specific actions were identified. These groups included policy, business, civil society, and science. The paper then discusses the implications of the results for governance and proposes three main changes required in fisheries governance to support sustainable catch use: 1) the incorporation of a catch-use objective into the policy, 2) a broadening of the scope of fisheries governance, and 3) the establishment of proactive catch-use governance.

While Article III identifies uncertainties relating to changes in human consumption behaviour as one of the main risks for implementing proactive catch-use governance, Article IV sets out to explore consumer perceptions on the consumption of Baltic herring and to discuss the implications of the results for catch-use governance, thereby also contributing to the question of how to bridge the gap between policy and practice. The paper examines 1) the role of sociodemographic determinants and 2) the drivers for and barriers to Baltic herring consumption in four Baltic Sea countries. In addition, the drivers and barriers are compared to those of Baltic salmon, the use of which is also limited by the dioxin problem, although it is still fully utilised as food, unlike Baltic herring. Results demonstrate that from the consumer perspective, the consumption of Baltic herring is driven by taste preference and health considerations, whereas it is limited by harmful chemicals, poor availability, and lack of eco-labelling. Fish consumers who do not eat Baltic herring at all most commonly reported that they dislike the taste, are not used to eating it, worry about health risks, or cannot acquire it. However, over half of the fish consumers in the surveyed countries eat Baltic herring at least sometimes. The results support the idea of proactive catch-use governance, providing that the governance 1) takes into account the species- and country-specific intricacies of fish consumption; 2) improves the availability of safe-to-eat Baltic herring in the fish food market; and 3) provides sufficient information to consumers about the species, the sustainability of the fisheries, and the related health risks and benefits.

3.4 Materials and methods

3.4.1 Methodological approach of the thesis

Methodologically, my thesis leans on a pragmatist, problem-based worldview, which emphasises the research problem and the use of diverse methods, data collection and analysis, and philosophical approaches to understand it (Creswell, 2014). More specifically, I employed an exploratory sequential mixed methods multiple-case study design. A case study approach is useful and well-suited for producing practical context-dependent knowledge about social–ecological phenomena (Flyvbjerg, 2006), such as environmental and resource governance. Although all empirical research deals with case studies, the case study approach is different, as it focuses on a holistic analysis of a phenomenon and particularly on social processes (Laine et al., 2007). Case studies can include either one or multiple cases, depending on the overall aim of the study. While a single-case study can provide invaluable information on, for example, a critical, unusual, or longitudinal case, a multiple-case study is often considered stronger and more robust, as it draws conclusions based on cross-case analysis (Yin, 2018). This kind of analysis focuses on identifying relevant similarities and differences between the cases in order to improve the understanding of the studied phenomenon (Stoke 2006; Yin, 2018).

A case study methodology is subject to varying and sometimes even contradictory characterisations (Yazan, 2015). For instance, methodologists have presented opposing views on how case study research should be designed, but they seem to agree on the benefits of using multiple methods. Regarding the former, Yin (2018) emphasised a stricter predetermined case study design and protocol, while Stake (1995; 2006) called for flexibility during the research process. A flexible multiple-case study design draws from the notion that "the course of the study cannot be charted in advance" (Parlett and Hamilton, 1972: 18). This notion relates to the idea of "progressive focusing", which implies narrowing the focus of research during the research process on emerging issues (ibid.). These issues may simply not be known in advance. But it is not only the focus of the research that may change; different methods may also be applied across cases. Stake (2006) noted that using the same methods across cases may be more useful in studies that employ primarily quantitative methods. Using the same methods across cases may simply not be an option in qualitative multiple-case studies due to the time and effort required to collect qualitative data (Yin, 2018). In addition, the methodologists seem to share an understanding of the benefits of using multiple methods in case study research. In practice this seems to imply using either multiple qualitative methods (e.g. Stake, 1995; Flyvbjerg, 2006) or mixing qualitative and quantitative methods (e.g. Yin, 2018). In contrast to qualitative research, which focuses on making interpretations and increasing understanding of a particular phenomenon, quantitative research aims at making generalisations (Häikiö and Leino, 2014; Creswell, 2014). As Flyvbjerg (2006) points out, both methods are needed in social sciences, as they have opposite strengths: the advantage of qualitative research is its depth, and its weakness is its breadth. The situation is the opposite for quantitative research. Therefore, it is not surprising that many scholars advocate employing both qualitative and quantitative methods in solving complex social–ecological problems (Flyvbjerg, 2006; Young et al., 2006; Young, 2011; O'Neill et al., 2013) and especially in multiple-case studies (Yin, 2018). The use of both qualitative and quantitative methods in research has formed the third paradigm of science, in addition to qualitative and quantitative paradigms, referred to as "mixed methods research" (Johnson et al., 2007; Denscombe, 2008). Johnson et al. (2007: 123) defined mixed methods research as "the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches for the broad purposes of breadth and depth of understanding corroboration". Mixed methods research thus considers multiple perspectives and standpoints in problem-solving (ibid.).

As mentioned above, my thesis was designed as an exploratory sequential mixed methods multiple-case study (Fig. 3). Eutrophication governance and Baltic herring catch-use governance represent two contrasting cases regarding Baltic Sea environmental and resource governance, and the two articles related to each case represent embedded mini-cases or units of analysis (Stoke, 2006; Yin, 2018). The selection of a multiple-case study design was motivated by the aim to explore the effectiveness of Baltic Sea environmental and resource governance from the perspectives of governance fit and participation. The case studies were employed in a sequential order, which was useful for narrowing the focus of the research to pressing issues emerging from the previous phases. The results of the eutrophication study highlighted a lack of sectoral integration as an obstacle to more effective governance. The Baltic herring catch-use case, which was studied after the eutrophication case, focused on sectoral integration by exploring how the food safety and security sectors could be integrated in fisheries governance. Instead of using the same method(s) across the cases, I used a sequential mixed methods research design (Creswell, 2014; Molina-Azorín and López-Gamero, 2016). More specifically, I used what Creswell (2014) calls "exploratory sequential mixed methods", where research begins with qualitative research and then, based on the results, the quantitative phased is planned. A mixed methods approach also allowed me to test the fruitfulness of different methods for examining the effectiveness of Baltic Sea environmental and resource governance.

My work comprised three consecutive research phases in which different methods were employed and which were informed by and built on the previous phases (Fig. 3). The eutrophication case was studied during the first phase, and the Baltic herring catch-use case was considered during the second and third phases. The first phase was based on interviews that were conducted to explore the perceptions of governance actors on the challenges of combating eutrophication and of eutrophication governance (Articles I and II). The results of this phase called for the inclusion of a wider stakeholder base in the production of scientific knowledge to facilitate the identification of solution possibilities for complex social–ecological challenges. This was taken into consideration during the second phase, as experts representing relevant stakeholder groups were engaged in a participatory backcasting exercise to develop pathways of governance actions needed to change the prevailing catch-use trend (Article III). In other words, the first phase focused on identifying governance challenges, and the second phase focused on developing solutions, particularly to one of the identified challenges in the first phase: lack of sectoral integration. Based on the backcasting results, uncertainties relating to consumer behaviour, and especially whether it will change – that is, whether the demand for Baltic herring to be consumed as food will increase – remained one of the key governance obstacles. This finding fuelled the interest in studying consumer perceptions in more detail. The perceptions were studied during the third phase via a consumer questionnaire (Article IV). The third phase was thus designed based on the results of the second phase. I present a summary of the materials and methods used in Articles I–IV in the next section (3.4.2), but a more detailed description can be found in the original publications.

After finalising my research on the two different cases, I conducted a cross-case analysis for Articles I–IV to explore the effectiveness of Baltic Sea environmental and resource governance, following three interrelated steps. First, I used the governance fit framework (Fig. 1) to identify misfits between the governance and governed systems in both cases. Second, I grouped the identified misfits under similar categories and then established the criteria for effective governance inductively from these empirical findings while leaning on previous literature (see section 1.1). Third, I examined the role of participation in each criterion. More specifically, I explored the roles participation could play in improving the fit by comparing the observed participation arrangements with the identified participation requirements in and across the cases. This analysis was conducted inductively through the three dimensions of participation: 1) extent of involvement (who is involved/excluded?), 2) form(s) of interaction between those involved (how do those involved interact?), and 3) power relations (how have power relations affected the outcome?). I used these dimensions to tease out illustrations of the ways in which participation had contributed to the misfit and to identify participation requirements to improve the fit.

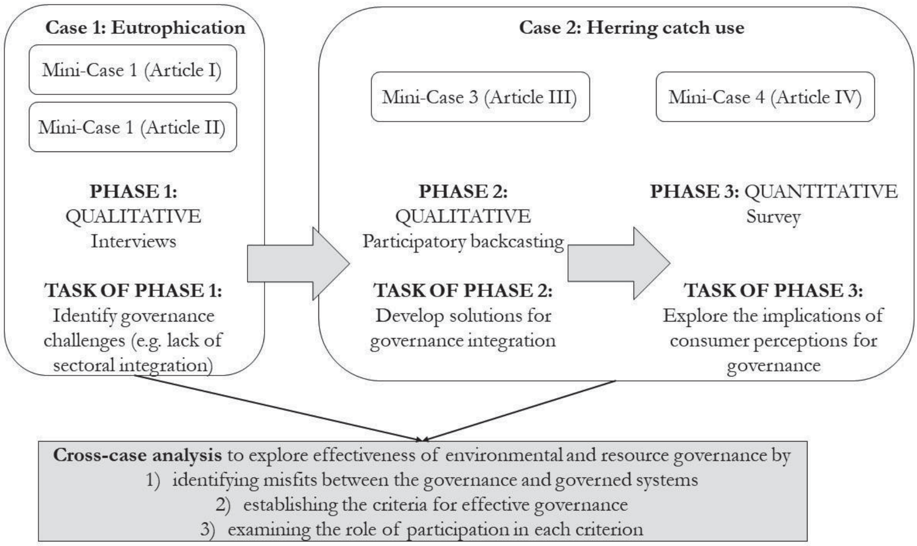

Figure 3. The exploratory sequential mixed methods multiple-case study research design applied in the thesis

3.4.2 Summary of the materials and methods of Articles I–IV

The materials used in the eutrophication case study (Articles I and II) included interviews, policy documents, and literature. Interviews are useful for gaining an understanding of the interviewees' perceptions and experiences of the problem at hand and its solution possibilities (Tracy, 2013). I conducted 37 in-depth semi-structured interviews (Taylor et al., 2016) with politicians, authorities in government agencies and relevant ministries, members of subnational administration and interest groups, representatives of NGOs, and eutrophication experts (scientists). The interviews were conducted in Finland between 2009 and 2011. The structure of the interviews was adjusted to focus on the expertise of each interviewee, but in general, they all included questions about how they framed the eutrophication problem and its solution possibilities, and what they considered the main obstacles to more effective governance. All interviews were recorded and transcribed. Article I synthesises the results of an international research project and therefore utilises all 37 interviews I conducted in Finland (including HELCOM), as well as 80 others conducted by my collaborators at EU and national levels (Sweden, Poland, Russia, Germany, Estonia, Latvia, and Lithuania)[4]. Article II uses the 18 interviews that I conducted with Finnish eutrophication experts, namely scientists representing academia and sectoral research institutes. In these two studies, qualitative content

[4] The case studies are presented in Pihlajamäki and Tynkkynen, 2011.

analysis (Tuomi and Sarajärvi, 2013) was applied to identify structural and institutional weaknesses of the formal governing system of the Baltic Sea eutrophication mitigation (Article I) and to classify and conceptualise the data to identify different aspects of scientific knowledge that affect science–policy interface and describe how these aspects are manifested in eutrophication governance (Article II).

The primary material for Article III came from a participatory backcasting exercise (Robinson, 2003; Quist and Vergragt, 2006; Robinson et al., 2011) that was arranged as part of a two-day international expert workshop (n=11) on the dioxin problem of Baltic herring. The advantage of participatory workshops and other forms of group discussions compared to interviews comes from the group dynamics, which can lead to learning among the participants and thereby to the production of novel ideas and solution possibilities (Tracy, 2013). Backcasting is a futures research method[5] that was used to facilitate the group discussion during the second day of the workshop. It "involves working backwards from a particular desired future end-point or set of goals to the present, in order to determine the physical feasibility of that future and the policy measures that would be required to reach that point" (Robinson, 2003: 842). In other words, it facilitates the co-production of recommendations on how to reach a desired future state. The workshop and the backcasting exercise focused on the dioxin problem of Baltic herring. The participants included fisheries and dioxin experts from Finland, Sweden, Estonia, and Denmark, and they represented fishers, producer organisations (both food and feed), science, administration, and NGOs. As part of the backcasting exercise, a future vision or target relating to Baltic herring was defined, pathways to reach the target were developed, and actor-specific governance actions were identified. Article III also used triangulation (Taylor et al., 2016) to enhance the credibility of the empirical material from the backcasting exercise. More precisely, secondary material, which included empirical material from the other workshop sessions, literature, policy documents, and statistical databases, was used.

Article IV examines the use of Baltic herring as food from the consumer perspective. The underlying idea was that developing policies and strategies to increase the use of Baltic herring for human consumption necessitates an

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[5] Futures studies has its own epistemological and ontological basis, but it follows the same criteria and principles for good scientific practices as any other field (Rubin, 2004). From the epistemological perspective, the definition of knowledge is different than that in other scientific fields, in the sense that futures knowledge is visionary knowledge, which combines factual information with visions (Malaska, 2017). The ontological starting point of futures studies is also wider, as it involves both possibilities in the present context and possible futures (Rubin 2004).

understanding of consumer perceptions of the consumption of forage species such as herring. The material for this paper was collected via an internet survey (Balch, 2010; Cowles and Nelson, 2015). Survey research is common in social sciences to numerically describe the trends and views of a population on a given problem or issues by studying a sample of that population (Creswell, 2014). The collected data came from respondents from four Baltic Sea countries: Finland, Sweden, Estonia, and Denmark. Over 500 respondents were recruited from each country (total 2,117), and therefore the results can be generalised for each surveyed country (Cowles and Nelson, 2015). Quantitative data analysis, namely descriptive statistics and logistic regression analysis, was conducted to unravel the factors affecting Baltic herring consumption[6].

Table 1. Summary of the four independent research articles (I–IV)

	Research tasks of the articles	**Methods**	**Outcomes**
I	Explore the challenges of the formal governing system of the mitigation of Baltic Sea eutrophication	Stakeholder interviews in eight Baltic Sea countries and at the HELCOM and EU level (n=117), qualitative content analysis	Sets of main challenges at different governance levels that hamper the effective governance of Baltic Sea eutrophication mitigation
II	Examine the intricacies of scientific knowledge that affect the science–policy interface in Baltic Sea eutrophication governance in Finland	Interviews with Finnish eutrophication scientists (n=18), qualitative content analysis	Categorisations of aspects of knowledge that scientists consider problematic for the knowledge–policy interface in the case
III	Examine how food security and safety issues could be integrated in fisheries governance	Participatory backcasting exercise with experts from four Baltic Sea countries (n=11), triangulation	Pathways to deal with the dioxin problem and to increase the contribution of Baltic herring to food security
IV	Explore the consumption of forage fish from a consumer perspective	Survey in four Baltic Sea countries (n=2,117), descriptive statistics and logistic regression analysis	Consumer perspectives on increasing the use of Baltic herring for human consumption and their implications for catch-use governance

[6] The data and all the results are available at: http://en.opasnet.org/w/Goherr:_Fish_consumption_study.

4 RESULTS

4.1 Summary of the results

The overall aim of my thesis was to explore the effectiveness of Baltic Sea environmental and resource governance. This was done by applying exploratory sequential mixed methods multiple-case study research to two contrasting cases: Baltic Sea eutrophication governance and Baltic herring catch-use governance. In doing so, I used the governance fit framework (Fig. 1) to identify misfits between the governance and governed systems in both cases and then established criteria for effective Baltic Sea environmental and resource governance based on cross-case analysis. I examined the roles participation could play in improving the fit by comparing the observed participation arrangements with the identified participation requirements within each criterion. The role of participation was analysed inductively through three dimensions: 1) extent of involvement, 2) form(s) of interaction between those involved, and 3) power relations. By comparing the two case studies that represent contrasting social–ecological challenges inherent to the Baltic Sea, my aim was to enhance the understanding of the effectiveness of Baltic Sea environmental and resource governance beyond the scope of a single case. The cross-case analysis focused on identifying similarities and differences between the two cases in terms of governance misfits and the role of participation, thereby shedding light on governance requirements that are more general and those that are case specific.

The five criteria for effective governance established through the research were as follows: 1) governance actions are sufficiently coordinated based on identified needs; 2) policies are sufficiently specified to solve the governed social–ecological challenge; 3) governance and policy take regional socioeconomic and cultural diversity into account; 4) relevant policy sectors are adequately integrated; and 5) policymaking is based on multiple and diverse sources of knowledge. These established criteria and how participation could improve the fit between governance and governed systems, thereby helping to meet each criterion, are summarised in Table 2.

As explained previously in chapter 3, the formal governance arrangements between the two cases are different: formal eutrophication governance is top-down and driven by the EU and HELCOM, while in the absence of formal catch-use governance, the use of the catch is driven by market forces and small-scale, bottom-up initiatives. While both cases provided insight into the participation requirements for each criterion, the catch-use case was not able to observe participation in all of them, owing to the characteristics of the current governance setting and the subsequent lack of attention to certain criteria. Moreover, most of the criteria relate to policy requirements, and in contrast to eutrophication, catch use has not been included as a specific objective in fisheries policies. Therefore, especially regarding these criteria, participation could not be observed, which deepened the misfit between the identified ideal participation and the observed current state.

Despite the underlying differences, scrutinisation of both cases from the perspectives of governance fit and the role of participation in improving the fit reveals first that although general criteria for Baltic Sea environmental and resource governance can be established based on two contrasting cases, their implications for the specific cases may vary significantly. Second, the participation requirements can also be case specific. These imply that general governance criteria and participation requirements should not be adopted in any region or governance case without careful consideration of more specific needs.

The results are presented in more detail in the following five sections (4.2–4.6), which correspond to the interlinked criteria for effective governance in the Baltic Sea region. In these sections, I first present the main results from both cases and then compare them to highlight their similarities and differences.

Table 2. Criteria for effective governance and the role of participation in each criterion

Criteria		Eutrophication governance	Baltic herring catch-use governance
Coordination of governance actions	Specific governance requirement	Coordination by governing body that has enforcement power to facilitate the implementation and commitment to policy across the region	Coordination by fisheries governance to deal with the multifaceted and complex challenges related to Baltic herring catch use and to create incentives for action
	Role of participation	All nine riparian countries are engaged in collaborative effort and subjects to the governing body's enforcement power	Actions by state and non-state actors across governance levels and sectoral borders
Specification of policies	Specific governance requirement	Spatial and temporal specification of EU policies to meet the needs of the Baltic Sea	A policy objective for the use of forage species for human consumption is defined and then taken up by policy (i.e. the CFP)
	Role of participation	1) Authority allocated to regional, national, and subnational level actors to design policies; 2) broad participation may weaken the outcome	Fisheries governance engages relevant state and non-state actors to define the policy objective
Inclusion of macro-regional diversity	Specific governance requirement	Social, cultural, and economic differences between the riparian countries are also taken into account in EU- and Baltic Sea-level policymaking	Country-specific strategies needed to deal with dioxin problem as well as the drivers for and barriers to Baltic herring consumption
	Role of participation	National experts and scientists across disciplines invited to policymaking	National experts and scientists across disciplines are engaged to develop strategies that also consider consumers' perceptions
Integration of sectoral policies	Specific governance requirement	Eutrophication abatement objectives are integrated into other policies, especially the EU CAP	Food security and safety aspects are integrated into fisheries governance
	Role of participation	Sectoral integration calls for collaboration and coordination between relevant policy sectors and across governance levels	The fisheries governance claims designing power by collaborating with environmental and public health sectors to develop strategies for catch use
Use of multiple and diverse knowledge sources	Specific governance requirement	Policymaking is based on multiple sources of knowledge across disciplines, but also on local experience-based knowledge	Co-production of knowledge to inform policy-makers about feasible solutions to increase the contribution of Baltic herring to food security
	Role of participation	Inclusion of scientists across disciplines and relevant stakeholders, such as farmers	Collaboration between scientists across disciplines and relevant stakeholder groups, including consumers, from the Baltic Sea countries

4.2 Coordination of governance actions

The eutrophication case calls for coordination by a leading governance body that has the enforcement power to facilitate the implementation of policies and regulations across the Baltic Sea region (Article I). Meeting this criterion entails that all Baltic Sea riparian countries are subject to coordination (Article I). This requirement stems from the need for all riparian countries to implement measures to reduce nutrient input from their respective territories. More to the point, owing to the varying and, in some cases, low interest of the countries in implementing the Baltic Sea eutrophication abatement measures (see more in section 4.4), the case calls for a leading governing body that can enforce commitment to and compliance with the agreed nutrient reduction targets. However, neither the EU nor HELCOM fit the position perfectly. The advantage of the EU as a leading governing body is its apparent enforcement power. Failure to comply with or implement EU regulations has implications for EU member states, such as fines. HELCOM, in contrast, lacks such enforcement power. Indeed, the results of Article I demonstrate that the ability of HELCOM to enhance commitment to the jointly agreed measures – that is, to provide sufficient coordination – has been weak. The EU member states have prioritised the transposition of the EU regulations to their respective national legislations over HELCOM recommendations, many of which have not been transposed to the national legislations despite their long history. The advantage of HELCOM as a leading governing body is that all nine riparian countries participate in the governance led by it. In contrast, the EU engages only eight of them, as Russia is not an EU member state. Excluding Russia from regional governance and collaboration is not ideal because of the large share of the nutrient input to the Baltic Sea originating from Russia (section 3.1). In addition, despite the aims of the EU to collaborate with non-member states on transboundary issues (see, e.g. EU WFD), the results of Article I are not promising in this regard, as it was found that Russia has not been keen on collaborating with the EU on matters concerning the Baltic Sea and would instead prefer to see HELCOM as the main transnational governing body for the protection of the Baltic Sea environment. Thus, while the EU meets the criterion better in terms of sufficient coordination (i.e. enforcement power), the role of HELCOM as the leading governing body is supported by the ability to engage all riparian countries in a collaborative effort.

The catch-use case also calls for coordination across governance levels and sectoral borders to support and encourage action. The rationale for this coordination requirement is two-fold. First, it stems from the observation that small-scale decentralised governance efforts to increase the use of Baltic herring as food have not been able to change the trend of using wild-captured fish primarily as feed. Second, the case calls for the coordination of actions across sectors and governance levels to deal with the identified highly interlinked obstacles to using Baltic herring primarily for human consumption. These obstacles include the lack of a well-specified policy objective (see section 4.3), ambiguities relating to the governance of the dioxin problem (see section 4.5), and poor availability of herring suitable for human consumption in the market (Articles III and IV). Indeed, based on the consumer survey (Article IV), the poor availability of herring in the food market is one of the main factors limiting consumption. The poor availability, in turn, was found to be caused by the practice of fishing primarily for feed, which has been driven by the combination of steady demand from the fur farming industry, changes in consumer behaviour from choosing small pelagic fish, such as herring, to preferring top predators, such as salmon and tuna, and the dioxin problem (Article III). To break this wicked cycle, Article III suggests a shift from reactive to proactive catch-use governance, but also recognises that the fisheries governance cannot implement the required actions alone. Instead, these actions need to be implemented in collaboration with fisheries, the public health and environmental sectors, the fishing and food industries, NGOs, and the scientific community (Article III and IV). By acting as a coordinator and showing commitment in terms of, for example, providing financial support for shifting from feed- to food-directed fishing and setting policy initiatives (section 4.3), the fisheries governance system could also invite and encourage other relevant state and non-state actors across sectoral borders to act and thereby claim some authority over the issue of Baltic herring catch use. So far, however, the fisheries governance system, the main candidate for coordinating catch-use governance, has shown little or no interest in governing it. Thus, the governance of Baltic herring catch use does not meet the established criterion.

Cross-case analysis suggests that although both cases call for the coordination of activities, the more specific coordination requirement depends on the case. In contrast to the eutrophication case, which calls for a leading governing body that has enforcement power to ensure that the measures are implemented across the region, the catch-use case rejects the idea of strict top-down enforcement, although the enforcement power of EU could also be used for this purpose. Instead, the catch-use case calls for a more proactive approach from the formal fisheries governance towards increasing the contribution of wild-captured species to food security by adding the issue to its agenda and supporting action. This difference can be at least partly explained by the observed difference in the interests of those subject to coordination to implement the required measures and actions (section 4.4). The role of participation in meeting this criterion was also different. The eutrophication case emphasised the inclusion of all riparian countries in the coordinated effort, while the catch-use case called for the inclusion of a multitude of actors across governance levels and sectoral borders. These requirements are not mutually exclusive but rather show where the current pain points lie.

4.3 Specification of policies

The eutrophication case calls for spatial and temporal policy specification, which implies the specification of policies to meet the needs of a regional sea, as well as the prioritisation of measures that can lead to the largest nutrient reductions and achieve the reduction the fastest (Article I). As indicated in the previous section, the Baltic Sea countries that are members of the EU tend to prioritise the implementation of EU policies over HELCOM recommendations. However, the EU policies are often less ambitious in their nutrient reduction requirements than, for example, those agreed within the framework of HELCOM and, in some cases, national legislation, thereby failing to meet the criterion. Owing to their unification, certain EU policies (e.g. the UWWTD and the CAP) have failed to consider the unique characteristics of the Baltic Sea. As an example, the phosphorus reduction requirement in the EU UWWTD is not as strict as that recommended by HELCOM. This implies a misfit between certain EU policies and the requirements of the Baltic Sea region, and highlights the role of participation in terms of who is included in and excluded from policymaking. Decisions on EU policies that are unified across the region, such as the UWWTD, are agreed upon by the EU countries, many of which may not have the same needs to reduce nutrient input into the environment as the Baltic Sea riparian countries. In comparison, HELCOM recommendations are agreed upon only by the Baltic Sea riparian countries, which has clearly facilitated the inclusion of regional specificities in the recommendations. Thus, the eutrophication case demonstrates how participation can be too broad to produce ambitious environmental targets.

The agri-environmental scheme of the CAP provides another example of how the broad participation of stakeholders, in this case farmers, has hampered achieving the spatial policy specification requirement. This specification need stems from the varying importance of cultivated areas when considered from the perspective of Baltic Sea eutrophication. The magnitude of nutrient leaching varies between the areas; therefore, nutrient reductions from certain areas are more important from the perspective of eutrophication mitigation than from others. However, for example, in Finland, agri-environmental measures have been implemented, and the related compensation allocated equally across the country. This is mainly because the agri-environmental scheme does not prioritise water protection over the other environmental objectives, but also because of its role as an income subsidy (for more details, see Pihlajamäki, 2011). Article I argues that to increase the effectiveness of the agri-environmental measures from the perspective of eutrophication governance, they should be redirected to areas where the benefits are the greatest. This would imply limiting the access of farmers to the scheme to those areas that are most crucial from the perspective of Baltic Sea eutrophication.

The specification of EU policies has taken steps forward with the MSFD and the WFD, which facilitate regionalisation by allocating authority and responsibility to the member states and to subnational levels to design effective measures to reach environmental protection targets. It is expected that they will yield policies that are more suitable for combatting eutrophication than unified EU policies. However, whereas the MSFD and the WFD may facilitate the spatial specification of policies, they may fail to respond to the temporal specification requirement due to their inherent flexibility in reaching a good environmental state. This, combined with the varying interests and abilities of the member states to implement eutrophication policies (see section 4.4), is likely to cause implementation delays that hamper progress towards a Baltic Sea that no longer suffers from eutrophication. Focusing nutrient reduction efforts on sources from which the largest reduction can be achieved the fastest implies prioritisation of certain measures and sectors over others (Article I). For example, stricter nutrient reduction requirements in urban waste water treatment could help with reducing anthropogenic nutrient input to the Baltic Sea faster than the reduction of nutrient input from the main nutrient source (agriculture), which has proven to be much more difficult to realise in practice (see also, e.g. Aakkula and Leppänen, 2014).

The catch-use case also calls for more specified policies regarding the use of forage species, such as Baltic herring, after landing to increase the contribution of fisheries to food security (Article III). Such policies can strengthen the inclusion of different dimensions, such as environmental, economic, and social, in fisheries governance, thereby supporting the sustainability of the fisheries. While the CFP includes the contribution of EU fisheries to food security as one of its main objectives, it mentions only aquaculture as a strategy for achieving it. In contrast, the contribution potential of forage species for achieving this target is not addressed. Of course, using Baltic herring in aquaculture also increases the contribution of fisheries to food security, albeit indirectly. Still, it has been widely accepted that maximising the contribution of wild-captured fish to food security entails that both direct and indirect human consumption are considered. The case study suggests that the absence of a clearly defined target for the use of the catch has been one of the main obstacles to increasing the use of Baltic herring for direct human consumption. A specified objective was considered a premise for coordinated action and the development of related strategies to change fishing practices (Article III) and consumer behaviour (Article IV). Without it, a transition from feed- to food-directed fishing may lack incentive, especially since the demand for herring as fish feed in aquaculture has been increasing in recent years, and the current feed-directed catch is suitable for this purpose (Article III). To this end, the case study suggests that fisheries governance should widen its scope to include food security issues more explicitly and, as part of this, define targets for the use of forage species in the EU CFP and the related regional multiannual plans. However, the case does not suggest adding a strict requirement for catch use but rather engaging relevant stakeholders in policy planning. The results of the case suggest that the specification of fisheries policy in terms of catch use reflects the views and values of the relevant state and non-state actors from different Baltic Sea countries (Article III).

Both case studies demonstrated how a lack of policy specification has caused misfits between governance and governed systems. More specifically, the eutrophication case identified misfits caused by a lack of spatial and temporal policy specification, and the catch-use case identified inadequately specified policy objectives. However, while the eutrophication case calls for stricter policies to deal with specific Baltic Sea conditions, the catch-use case calls for the EU-led governance system to define a policy objective in collaboration with stakeholders for the use of forage species after landing. Participation also played an important role in this criterion. The eutrophication case argued that policy specification entails that the EU allocates authority to regional, national, and subnational levels to take the spatial and temporal aspects into consideration. The catch-use case also highlighted the importance of involving relevant stakeholders in catch-use-related policymaking at the EU and regional levels. While the EU level seems to be suitable for more general objectives, the regional level provides a platform for species-specific plans. However, the eutrophication case also identified problems with broad participation. First, it showed how the inclusion of too many EU countries in policymaking has watered down the ambition of relevant EU policies. Second, it illustrated that allowing all farmers access to the agri-environmental scheme dilutes the potential impact of the measures.

4.4 Inclusion of macro-regional diversity

This criterion was based on the identified role of values and interests inherent in the social systems, especially their diversity, and of the varying socioeconomic conditions across the region in achieving the governance target. The eutrophication case (Article I) provides examples of how the failure to incorporate knowledge of varying interests and socioeconomic conditions between the riparian countries into formal eutrophication governance has hampered the outcome of nutrient reduction efforts. Article I illustrates that the implementation of the EU, HELCOM, and national-level eutrophication and water protection policies, as well as the related governance arrangements in the Baltic Sea riparian countries, tend to vary, not only in terms of ambition but also in terms of appearance and continuity. Finland and Sweden in particular are considered the pioneers or front runners in Baltic Sea environmental protection. The apparent awareness of the eutrophication problem and interest regarding the state of the common sea in these two countries is not surprising, considering that they have the longest shorelines and the unique Archipelago Sea, which make the Baltic Sea a popular and common place for summer houses and leisure activities, such as sailing, boating, swimming, and fishing. These activities are especially popular during the warmest summer months, when the eutrophication problem is also most visible and often restricts swimming in the sea. As for the other riparian countries, in general, the Western countries have a longer and more ambitious history of environmental governance than the former socialist countries, which can at least partly be explained by the more pressing societal and economic challenges in these Eastern states, especially after the dissolution of the Soviet Union.

The eutrophication case also demonstrates that the country-specific nutrient reduction targets do not acknowledge varying socioeconomic conditions between the littoral countries. For example, HELCOM BSAP places the highest and most expensive nutrient abatement burden on the developing countries – Poland, Russia, Latvia, and Lithuania. Many of the littoral countries have been struggling to implement even the less stringent regulations, not to mention the stricter ones. Thus, a misfit exists between the prescribed management measures and the interest levels and capabilities of the riparian countries, which, according to current policies, should carry the largest nutrient reduction burden. This is an important obstacle to meeting the overall nutrient reduction requirements. To deal with these attributes inherent in the governed SES, the case study calls for taking them into account in policymaking. From the perspective of participation, this entails the involvement of scientists and experts across disciplinary borders and from the different riparian countries in policymaking. In other words, the selection of scientists and experts engaged in policymaking should be broadened from natural scientists to include, for example, environmental economists and social scientists (see section 4.6).

The catch-use case also calls for the inclusion of social attributes in governance. In contrast to the eutrophication case, the catch-use case found that state and non-state actors across the Baltic Sea region and relevant policy sectors have a shared interest in prioritising the Baltic herring catch for human consumption (Article, III). This implies that the inclusion of values and interests in catch use governance is a simpler task than in eutrophication governance. The case also calls for the inclusion of macro-regional diversity by developing country-specific strategies to deal with the dioxin problem as well as the drivers for and barriers to Baltic herring consumption. This call stems from the need to design strategies for catch use that consider the country-specific intricacies relating to the required actions (Article III, IV), as well as the heterogeneity of Baltic herring consumers (IV). First, Article III points out that the examined countries, namely Finland, Sweden, Denmark, and Estonia, have had different strategies to deal with the dioxin problem in herring and that the catch-use trends vary between them. For instance, Sweden and Finland aim to hold on to Baltic herring consumption traditions by implementing an exemption to the dioxin problems, which allows them to place large herrings (which are likeliest to exceed the total allowable dioxin levels) in national fish markets, but the countries still sell the majority of their catches for industrial purposes. In contrast, the Estonian herring fishery targets small, safe-to-eat herrings and sells the majority of the catch for human consumption. This implies that the actions needed also vary between the countries. Second, Article IV highlights diversity by showing that Baltic herring consumers are not a homogeneous group across the case study countries; instead, Baltic herring consumption habits seem to be embedded in country-specific conditions. For instance, while the Estonians were likeliest to eat Baltic herring, the Danes appeared most uncertain about the type of herring they eat (i.e. herring from the Baltic or the North Sea), and the Swedes were most concerned about harmful chemicals in fish. The sociodemographic determinants, such as age, explained Baltic herring consumption only in Finland and Denmark. Interestingly, although Baltic herring is widely considered a sustainable and environmentally friendly source of animal protein, this was rarely one of the primary reasons identified by the consumers for its consumption. Yet, the key factors for increasing the use of Baltic herring as food include fewer chemicals found in fish, improved availability, and eco-labelling. These actions were also among those identified by the experts at the stakeholder workshop (Article III). While Article III identifies the uncertainty related to changes in the demand for Baltic herring as food as a possible obstacle to the implementation of the identified actions, the results of Article IV are encouraging, as it seems that by ensuring food safety and increasing availability, the demand for Baltic herring is also likely to increase. Thus, the results of Article IV support the idea of proactive catch-use governance suggested initially in Article III. However, given that Baltic herring consumers are a heterogeneous group, country-specific intricacies should be taken into consideration when designing strategies for catch-use governance. The results of the catch-use case study suggest that the inclusion of these aspects in policy could be facilitated by the participation of national experts and the public in knowledge production.

A comparison of the two cases shows that they share the call to consider socioeconomic and cultural diversity during policymaking. The eutrophication case illustrates how the differences between the countries in terms of environmental awareness in general and interest in combatting Baltic Sea eutrophication in particular, as well as the capabilities of the countries to implement the required measures, varies. However, while implementation of eutrophication policies in some Baltic Sea countries was hampered by low interest, this should not be the case with catch-use governance. Instead, a shared interest to change the catch use trend was observed. The situation regarding the catch-use case is clearly different, as the policies do not currently address the catch-use issue at all. But like the eutrophication case, even this lack of attention to catch use was found to be related to the supremacy of the natural sciences over the social sciences, namely that the fisheries management is so strongly built on the goal of maximising harvesting in a sustainable way that it leaves little room for other issues to be thoroughly addressed (Article III). Thus, both cases call for broadening the scope of policies to take into account socioeconomic and cultural differences. The Baltic Sea countries, scientists across disciplines, and local stakeholders can produce relevant information about these discrepancies for policy. Increasing environmental awareness also entails reaching out to the general public, for example, to improve the understanding of general perceptions and to inform them of the social–ecological challenge (Articles I, III, IV).

4.5 Integration of sectoral policies

The eutrophication case calls for a more systematic integration of the environmental sector, especially with the agricultural sector but also with, for example, energy, fisheries, transportation, and housing sectors at the different governance levels (Article I). Article I demonstrates that the integration between the environmental and agricultural sectors has so far been realised primarily by acknowledging the need for the agricultural sector to consider the protection and conservation of the marine environment rather than systematically and holistically addressing the synergies and trade-offs between the two. In addition, the implementation of agri-environmental measures has been voluntary. This partial integration between the two sectors implies a power imbalance between them and has led to a misfit, which has hampered eutrophication abatement. The more specific challenges of the agri-environmental scheme from the perspective of eutrophication relate to 1) insufficient specification of the agri-environmental measures (see section 4.3), 2) unequal access to the programme across the EU member states due to required co-funding from the member states, 3) failure to motivate participation (e.g. in Sweden) due to the rigidness of the programme and the related bureaucratic burden, and 4) measures taken by the farmers being undermined and aims of the eutrophication governance being contradicted by the CAP's aim to increase the production intensity and the areal coverage of cultivated land. These challenges indicate, however, that participation can play multiple roles in improving the fit. The first challenge (insufficient specification of measures) was identified as calling for more limited participation (section 4.3) to ensure that measures are implemented in areas where they have most impact. The second challenge (unequal access to the programme) relates to the discussion in the previous section (4.4) and the call to involve a broader range of scientists and experts across disciplines in policymaking to take the underlying socioeconomic differences into account. As discussed in the following section (4.6), the motivation of farmers (challenge number 3) and the effectiveness of agri-environmental measures could, in turn, be improved by engaging farmers in policymaking and using their experience-based knowledge. The last identified challenge (watering down eutrophication measures by the CAP) calls for collaboration and coordination between the two sectors, especially at the EU level, to support a more holistic integration between them.

The premise of the catch-use case was that increasing the contribution of Baltic herring to food security necessitates cross-sectoral collaboration between fisheries and the public health sectors. Based on the results, the interests of different policy sectors regarding the use of Baltic herring are aligned, but a lack of collaboration and deliberation on the matter has obscured the solution possibilities and, in the worst cases, worsened the situation. For example, the dioxin problem has been considered "a killing factor" by the fisheries sector, which has responded to the EU's dioxin regulation through a variety of national strategies. This approach has increased the ambiguity of dioxin management, thereby tarnishing the image of Baltic herring and limiting the demand for it for human consumption (Article IV). However, the findings and lessons from the catch-use case suggest that joint deliberation between the fisheries and the public health and environmental sectors can produce practical solutions for increasing the use of Baltic herring as a safe-to-eat food (Article III). Moreover, increasing the availability of safe-to-eat Baltic herrings in the fish market calls for a holistic approach in which actions are simultaneously taken across sectoral borders. Cross-sectoral collaboration is also needed to change consumer behaviour by providing improved information to consumers about fish species, their origin, the environmental and climate effects of their consumption, the ecological state of the stocks, and the benefits and risks of Baltic herring consumption to human health, and by increasing awareness and changing perceptions of the consumption of a forage species (Article IV).

Eutrophication and catch use are both examples of cases that are affected by human activities across multiple sectoral borders and which, in turn, have implications outside their respective sectors. Therefore, it is not surprising that both cases call for sectoral integration. The role of participation in this criterion is related to the engagement and participation of other policy sectors in environmental and resource governance through collaboration and coordination at different governance levels. In the ideal case, policy sectors collaborate to identify governance and management solutions instead of simply imposing regulations and policies (that may or may not work) on each other.

4.6 Use of multiple and diverse knowledge sources

The eutrophication case calls for the use of multiple knowledge sources in policymaking. The case illustrates how limited consultation of scientists and other stakeholders in eutrophication-related policymaking processes has caused misfits between the policies and the SES. Article II found that only certain researchers have been consulted and heard in policymaking, which has led to limited and, in some cases, suboptimal solution options, not only because scientists are not experts on everything but also because there are different interpretations and definitions of environmental problems, such as eutrophication, and their solution possibilities. As an example, scientists have had differing views on the role of nitrogen as a cause of eutrophication and therefore whether it should be reduced or not. The consequences of these debates can be seen, for example, in the reluctancy of the formal governance system in Finland and Sweden to implement the nitrogen reduction requirement of the EU UWWTD. As discussed in previous sections, the use of multiple knowledge sources across disciplines is also needed to meet many of the other criteria. This implies inviting scientists and experts across disciplines to advise on policy.

Article II also demonstrates how the uncertainty and heterogeneity of knowledge can hamper the use of scientific knowledge in policymaking. Uncertainty was identified as opening up an opportunity for opposition and focusing public discussion on these uncertainties instead of on the main message. The identified challenge related to the heterogeneity of knowledge was that decision makers can often choose the knowledge they use to justify the decisions. As a result, only some knowledge ends up being used in policymaking (and then becoming the focus of further research). To deal with these challenges, some researchers have called for scientific consensus to strengthen the message of science directed at policy (Article II; see also Saunders et al., 2017).

In addition to the inclusion of a wider scientific knowledge base, the eutrophication case also calls for the involvement of so-called "laypersons" and their experience-based knowledge in governance and management. For instance, Article I shows how the exclusion of local experience-based knowledge from the agri-environmental scheme of the CAP has hampered efforts to reduce nutrient input from agriculture. Instead, the management measures have been implemented from the top down and were described as rigid – leaving no room within the formal governance system for the local actors to self-organise and coordinate action. This inability of the governance system to adapt to identified management needs has decreased the willingness and motivation of the farmers to participate in the environmental scheme of the EU CAP in some of the littoral countries (e.g. Sweden) (see also section 4.5).

The results of the catch-use case also call for the use of multiple sources of knowledge and suggest based on experimentation that ideal participation regarding this criterion could be realised by 1) engaging experts that represent relevant stakeholder groups from different Baltic Sea countries (Article III), and 2) consulting the consumers from these countries (Article IV) to co-produce knowledge for policy. The results suggest that there is a common interest in diverging from the current feed-driven catch-use path to a food-dominated path and that collaboration between experts across sectors and disciplines can produce fruitful solutions to the matter. Moreover, such knowledge co-production processes can facilitate the revision of the problem definition. Based on the case study, the problem primarily relates neither to the dioxins detected in some Baltic herring nor to low consumer demand but rather to how these challenges are governed (Articles III and IV). For instance, while the experts identified multiple pathways to ensure that the dioxin problem was under control, the consumers' perceptions suggested that the implementation of these actions would increase the consumption of Baltic herring. Indeed, there is a call for a shift from reactive to proactive catch-use governance in which the governance system actively seeks ways to deal with the identified obstacles instead of trusting that market forces and self-organised fishers can deal with them on their own.

As both cases demonstrate, the framing of the governed challenge and the respective solution possibilities are highly dependent on those involved in knowledge production. The eutrophication case suggested involving a wide range of scientists and stakeholder groups in governance. Following this requirement, the catch-use governance case set out to engage multiple stakeholder groups and the public to explore possibilities to increase the contribution of Baltic herring fisheries to food security. The findings support this requirement, as the study demonstrated that including stakeholders and experts across sectoral borders as well as citizens in knowledge co-creation can produce a range of solutions to the social–ecological challenge that could not be created from the perspective of, for example, a single sector or discipline. Moreover, such deliberations can broaden the scope of governance and allow for a more thorough integration of different objectives in governance.

5 CONCLUSIONS

The overall aim of my thesis was to explore the effectiveness of Baltic Sea environmental and resource governance by identifying misfits between the governance and governed systems, using the misfits to establish criteria for effective governance, and exploring the roles participation could play in improving the fit and thereby meeting the criteria. I used an exploratory sequential mixed methods multiple-case study research design to compare two contrasting cases – Baltic Sea eutrophication governance and catch-use governance of Baltic herring – and conducted a cross-case analysis using the framework of governance fit. The five established criteria for effective governance are as follows: 1) governance actions are sufficiently coordinated based on identified needs; 2) policies are sufficiently specified to solve the governed social–ecological challenge; 3) governance and policy take regional socioeconomic and cultural diversity into account; 4) relevant policy sectors are adequately integrated; and 5) policymaking is based on multiple and diverse sources of knowledge. The criteria are similar to other established governance requirements found in the literature (see e.g., Dietz et al., 2003; Young, 2011; OECD, 2015; Bennett and Satterfield, 2018). Still, the criteria have added-value in both theoretical and empirical terms. First, as the comparison between the two cases demonstrates, the causes of the identified misfit were often different; therefore, the more specific governance requirements behind each criterion may also vary substantially. This implies that, although these types of generic governance requirements can be identified, their successful implementation in a given governance context may necessitate some adjustments. This finding strengthens the call for a diagnostic approach determining governance requirements for a specific social–ecological challenge (Ostrom, 2007). Second, the criteria provides policy relevant suggestions on the governance requirements for the two studied cases.

By exploring the role of participation in each of the five criteria, I have demonstrated how and under which circumstances participation could improve governance fit. Drawing from the empirical results presented in this study, I conclude that participation can play multiple roles in improving fit, thereby meeting the criteria. The results showed that poorly arranged, insufficient, or a complete lack of participation in the studied governance processes contributed to the identified governance misfits. The results also showed that, like other governance requirements, participation requirements in environmental and resource governance are ultimately case specific. Therefore, in line with Fischer (2012), who called for experimentation to develop an understanding of the role of participation in practice, the results suggest that participation in a given governance context should always be planned specifically for the case at hand, based on experimentation, and allow for learning and for the evolution of participation practices over time. As Young (2011) pointed out, governance systems are dynamic and always changing; therefore, their effectiveness also varies from time to time. This indicates that the established criteria as a whole, the identified participation requirements for each criterion, and their role in improving the effectiveness of Baltic Sea environmental and resource governance should be re-evaluated and adjusted accordingly in the future.

In recent years, research on participation has focused extensively on the inclusion of stakeholders (non-state actors) and the public in policymaking (Linke et al., 2011; Linke and Jentoft, 2014; Newig et al., 2014; Rimmert et al., 2020). This research has revealed many challenges related to the inclusion of stakeholder and citizen perspectives in policy and governance. However, the results of my thesis highlight that governance challenges are rooted not only in the engagement of stakeholders and the public but also in the engagement of state actors across policy sectors and governance levels. Indeed, by scrutinising the roles participation could play in improving the fit, I have demonstrated the many ways participation is interlinked with other governance requirements. This implies that, in addition to making the aims of participation clear for all participants from the beginning (Reed, 2008), it is also crucial that the formal governance system considers participation more comprehensively and systematically in relation to the governance criteria.

Based on the results presented in the thesis, I argue that the organisation of sufficient participation in the governance processes is currently a major challenge for effective Baltic Sea environmental and resource governance. The fit between governance and governed systems could be improved by paying closer attention to the participation arrangements, especially in terms of who participates in a given governance process (e.g. knowledge co-production, policymaking, and implementation), how the participation is arranged (e.g. collaboration or consultation), and by carefully considering why such participation is arranged in the first place (what is it that the participation aims to achieve?). These participation requirements depend on the governance context and the criterion to be met. Other authors have also stressed the importance of careful planning in the organisation of participation in practice (Fischer, 2012; Franzen, 2015). For instance, Franzen (2015) found that farmers' commitment to water management measures could be enhanced by appropriately organised and motivated participation arrangements.

However, it is worth pointing out that some of the criteria and their participation requirements may be harder to meet than others. This relates to the abovementioned more specific governance requirements behind each criterion, and thereby the governance context. For example, regarding the eutrophication case, meeting the first criterion (the call for coordination by a leading governance body), which has enforcement power to facilitate implementation of the policies and regulations across the Baltic Sea region, does not seem plausible, because only the EU has the required enforcement power and only eight out of the nine countries participate in the decision-making within the EU and are subject to its policies. Moreover, in recent years, the implementation of the MSFD and the WFD has strengthened the role of the EU as the leading governing body, while HELCOM has become the regional coordinator for its implementation. Although this double leadership might be the best available compromise to achieve both the criterion and the participation requirement (see also Söderström and Kern, 2017), Article I identified an important problem related to this particular arrangement – namely, that it is not optimal from the perspective of Russia, the only non-EU member state and a major source of nutrient input to the Baltic Sea. Considering the state-centricity of Baltic Sea environmental and resource governance (Kern, 2011), this may become a problem if it discourages the participation of Russia in Baltic Sea eutrophication governance.

Another example of a criterion that will be difficult to meet in the context of Baltic Sea eutrophication governance relates to regional disparities, especially the varying interests and abilities of the riparian countries to implement the agreed measures. Indeed, the governance literature suggests that inclusivity may decrease the ambition of policies, as policies tend to reflect the values and interests of those participating in decision-making (Newig and Fritsch, 2009; Young, 2011). Yet, the results presented in this thesis do not fully support this claim. Despite the differences in interests and values, the Baltic Sea countries have been able to agree on more stringent nutrient reduction requirements from, for example, the urban waste water treatment plants within the framework of HELCOM compared to those set in the EU UWWTD. Moreover, considering the enforcement power of the EU, the implementation of the MSFD and the WFD in EU member states is optional and depends on whether or not the countries are interested in the environmental protection of the Baltic Sea. However, despite the EU's enforcement power, the varying abilities of the riparian countries, in terms of, for example, funding, infrastructure, and knowhow, remain a pressing challenge for Baltic Sea eutrophication governance. Varjopuro et al. (2014) also demonstrated that significant implementation delays related to the implementation of the MSFD are likely to occur due to observed differences in national capabilities. Thus, although the results imply that the inclusion of national experts and scientists across disciplines in policymaking can facilitate the consideration and incorporation of these differences in eutrophication policies, it remains a challenge to agree on reduction requirements that are both fair and feasible.

A comparison between the two case studies indicates that the criteria would be easier to meet by catch-use governance, owing to the synergies between the objectives of the fisheries and the environmental and public health sectors, combined with the underlying shared interests of other stakeholders, to increase the use of Baltic herring for human consumption. The benefits of such a starting point should not be underestimated, as many studies have illustrated the ongoing difficulties in breaking the silos of sectoral governance and moving towards more holistic governance arrangements, as required by the EBM (Hassler et al., 2013; Hammer, 2015; Doneliene, 2016). Thus, the catch-use case may be an exception in this regard, as the results suggest that governing catch use is ultimately a question of whether fisheries governance takes up the issue in its agenda and coordinates the related collaboration between policy sectors and other stakeholder groups. Considering the shared interest, it is somewhat surprising that, so far, the governance system has shown little interest in catch-use governance.

The methodological aim of my thesis was to identify methods that could be fruitful for examining environmental and resource governance. I used a multiple-case study approach to compare two contrasting cases and, based on a cross-case analysis, to establish criteria and explore the role of participation in meeting them. I used an exploratory sequential mixed methods research design to modify the research plan and adjust the methods according to the findings of the earlier phases. This approach allowed me to consider the findings of the eutrophication case in the catch-use case. In doing so, the catch-use case focused more specifically on sectoral integration, which was identified as a governance challenge in Article I, and engaged relevant expert and stakeholder groups in a participatory backcasting exercise to develop practical solutions for the complex multidimensional sustainability challenge (Article III). It also widened the engagement to consumers (IV). The obvious limitation of this approach was that it did not allow for a comparison of the two cases in the strictest manner, as called for by Yin (2018), for example. Instead, it facilitated the testing of some of the key findings of the eutrophication case (i.e. the need for stakeholder engagement and cross-sectoral collaboration in solving complex social–ecological challenges) in the context of the catch-use case. Despite the differences between the approaches, both of them provided insight, through empirical findings, into the challenges and requirements of effective Baltic Sea environmental and resource governance. Such practical context-dependent knowledge contributes to the scientific understanding of governance requirements and challenges that cannot be revealed or explained by predictive theories (Flyvbjerg, 2006). However, due to methodological choices, the catch-use case was able to produce several pathways of actor-specific governance actions to deal with the complex multidimensional problems and obstacles related to Baltic herring catch use. Such participatory future visioning would also be useful for dealing with the many challenges related to Baltic Sea eutrophication governance.

Finally, my thesis focused primarily on the EU, macro-regional, and national levels, while subnational and local levels were not included in the study. This is another limitation of this study, especially regarding the eutrophication case, as these levels are crucial for the implementation of the EU, HELCOM, and national-level policies. Although I did not examine the subnational and local levels explicitly, the national-level analysis also revealed some challenges relevant to these two levels. However, future research on Baltic Sea eutrophication governance could pay more attention to these governance levels and to the interplay between them and the EU, macro-regional, and national levels, especially from the perspectives of policy coherence and the role of participation in knowledge–policy–action interfaces.

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The Governance of the Mitigation of the Baltic Sea Eutrophication: Exploring the Challenges of the Formal Governing System

Nina Tynkkynen, Paula Schönach, Mia Pihlajamäki, Dmitry Nechiporuk

Abstract This article focuses on the governing system of the mitigation of eutrophication in the Baltic Sea. Policies and measures of the Baltic Sea coastal countries, the macro–regional (HELCOM) level, and the level of the European Union are described and governance challenges explicated. We found that the main challenges at different governance levels include: differences between coastal countries in terms of environmental conditions including environmental awareness, overlaps of policies between different levels, the lack of adequate spatial and temporal specification of policies, and the lack of policy integration. To help to meet these challenges, we suggest closer involvement of stakeholders and the public, the improvement of the interplay of institutions, and the introduction of a "primus motor" for the governance of the mitigation of eutrophication in the Baltic Sea.

Keywords Baltic Sea · Environmental policy · Eutrophication · Governance

INTRODUCTION

The Baltic Sea environment is among the most persistently addressed political issues in the Baltic Sea region (e.g., Hjorth 1996; VanDeveer 2011). Various arrangements shape the efforts to protect the Baltic Sea marine environment, including the European Union (EU) and the Helsinki Convention with its governing body the Helsinki Commission, HELCOM. At the same time, the Baltic Sea is regarded as one of the most polluted marine environments in the world. There is a stark contrast between the formally successful governance system and the actual state of the Baltic Sea. In particular, this applies to the problem of eutrophication, which is regarded as the most intricate environmental problem of the Baltic Sea (e.g., Wulff et al. 2007; HELCOM 2009). The extensive nutrient input to the Baltic Sea originates from the large catchment area comprising fourteen countries[1] with over 85 million people. The main sources of nutrients include natural outflow from land, up-welling of phosphorus-rich deep water (i.e., internal load), atmospheric deposition of nitrogen, and, most importantly, anthropogenic sources such as municipal and single household wastewater, agriculture, and industry (e.g., HELCOM 2009). Eutrophication has negative impacts on recreational activities, biodiversity, and livelihoods, such as fishing and tourism. Some success in the reduction of nutrient load from point sources has been achieved, but nutrient input from diffuse sources, especially from agriculture, is still a major challenge.

The complexity of human activities causing heavy anthropogenic stress, the unique ecological characteristics of the sea, and the dynamic and complex nature of ecological processes make the management of the eutrophication problem intricate. The nature and severity of the problem vary between different basins (see e.g., HELCOM 2009). Nutrient emissions drift from estuaries and coastal waters to the Baltic proper and to the territorial waters of other countries. Russia and Poland are the major sources of waterborne nutrients, but they do not suffer from extensive eutrophication in their territorial waters as their nutrient loads drift to other parts of the Baltic Sea. In terms of societal perceptions of the problem, eutrophication lacks the definitional, ideological, and symbolic clarity typical for many other environmental issues. This makes it

[1] The Baltic Sea encompasses nine coastal countries: Denmark, Germany, Poland, Lithuania, Latvia, Estonia, Russia, Finland, and Sweden. The other countries in the catchment area are Czech Republic, Slovak Republic, Ukraine, Belarus, and Norway.

speculatively a less "trendy" issue compared with environmental problems such as climate change (Pihlajamäki and Tynkkynen 2011a; see also Lundberg 2013).

In this article, we examine the governing system of the Baltic Sea eutrophication mitigation. According to Kern (2011), the governing system is a social system including different institutions and steering mechanisms that contribute to the development of a "system-to-be governed," in this case the Baltic Sea ecosystem. The governing system and the "system-to-be-governed" form a dynamic relationship that is affected by the diverse, complex, and vulnerable character of both. The governing system of the Baltic Sea environment originates from the establishment of the Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea area in 1974 (HELCOM 2008; Räsänen and Laakkonen 2008), and has evolved from a single convention to a multifaceted governing system of the common sea especially since the dissolution of the Soviet Union in 1991. The transition of former state socialist countries to market economy, the global agenda on sustainable development, and the enlargement of the European Union, have triggered the development of various cooperative arrangements aiming at managing the Baltic Sea environment over the last three decades (Joas et al. 2008). In this system, international and EU policymaking has gained an increasing importance. At the same time, a variety of new, broader forms of cooperation have emerged including private and public actors (Gänzle 2011; Kern 2011; VanDeveer 2011). Despite the growing number of nongovernmental actors involved, national governance is still considered the backbone of the governing system of the Baltic Sea environment (Kern 2011; Lundberg 2013).

This article portrays a synthesis and describes the main conclusions of the research project PROBALT: "Improving societal conditions for the Baltic Sea protection," carried out as part of the BONUS+ program during 2009–2011 under the coordination of the Finnish Institute of International Affairs. In the project, main challenges of the formal governing system of the mitigation of the Baltic Sea eutrophication were scrutinized with the help of case studies that focused on the European Union, HELCOM, and all but one of the riparian countries, i.e., Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia, and Sweden[2] (for case studies see Pihlajamäki and Tynkkynen 2011b). In this article, we refer to the results of the cases conducted by the authors of this article (Sweden, Finland, Russia, and HELCOM), and on the synthesis articles of the remaining cases, published in the final report of the project by those project members that are not among the authors of this article (Dmochowska and Szaniawska 2011; Hautakangas and Ollikainen 2011; Jokela 2011; Schumacher 2011a, b). While appreciating the growing involvement of a variety of other actors, this article focuses on the formal governing system as set out in the scope of the PROBALT project that is based on the state-centricity of the contemporary governing system (see Kern 2011).

The research data for all case studies consist of policy documents and interviews with representatives of the national level actors, HELCOM, and the EU. Interviewees represent the domains of politics and administration, national governments, and ministries, as well as national and EU agencies. Also other stakeholders, including representatives of the research communities and interest groups such as farmers' unions and NGOs, were interviewed in the project. The interviews were thematic and semistructured, implying that questions varied according to the field of expertise of the interviewee, and the answers were of free format, conversational style. The interviews were recorded and transcribed. The number of interviews totaled 171, varying between 10 (Russia) and 33 (EU) (see Table 1).

The interviews and other data were analyzed by applying the empirical methods of qualitative content analysis (Roberts 1997). In general, the analysis proceeded by first identifying the key elements of each country's national Baltic Sea eutrophication prevention endeavors and the most important mechanisms to support them. Then, the interviews and relevant documents were analyzed with the focus on structural and institutional weaknesses of the present governing system of the Baltic Sea concerning the problem of eutrophication. The challenges identified are presented as four summarizing and interlinked categories.

The approach to studying governance applied in this article is focused on explaining the polity and policy dimensions of governance rather than that of politics (see Pahl-Wostl 2009). That is, instead of explaining the way of policy-making and political processes, we concentrate on analyzing the institutional structures that are in the core of the governing system: the main institutions, policies and actors at each administrative level, and the main governance challenges met at these levels.

THE GOVERNING SYSTEM OF THE MITIGATION OF EUTROPHICATION IN THE BALTIC SEA

Overview of Governance at the Levels of the EU and HELCOM

Following the enlargement in 2004, the European Union comprises all the Baltic Sea riparian countries except Russia, and a number of noncoastal states that contribute to

[2] Due to *a force majeure*, a case study on Denmark was unfortunately not conducted.

Table 1 Background of interviewed persons in the PROBALT project

	Academia	NGO	Regional authority	National authority	Local authority	Other	TOTAL
Baltic states	9	3	–	10	–	–	22
Germany	4	6	7	5	–	4	26
Finland	18	1	1	10	2	4	36
Poland	8	1	5	2	5	10	31
Sweden	4	3	–	5	1	–	13
Russia	2	4	3	–	1	–	10
European Union	4	8	4	7	–	10	33
Total	49	26	20	39	9	28	171

nutrient input via air pollution (e.g., Great Britain, the Netherlands and Belgium). The EU has developed into an important institutional and legislative power in the protection of the Baltic Sea (see Schumacher 2012). As described by Schumacher (2011a), the first EU regulations aiming to reduce nutrient input into water bodies, the Urban Wastewater Treatment Directive (UWWTD) and the Nitrates Directive (ND), were adopted in 1991. These directives prescribe different standards for sewage treatment and farming practices, respectively. Another instrument for nutrient input reduction is the agri-environmental program of the Common Agricultural Policy (CAP), through which compensation can be paid to farmers who carry out certain water protection measures. Since 2001, airborne emissions of, e.g., nitrogen oxides and ammonia have been addressed in the National Emission Ceilings Directive (NECD). More comprehensive instruments include the Water Framework Directive (WFD), adopted in 2000, and the Marine Strategy Framework Directive (MSFD), adopted in 2008. The main objective of the former is to reach good ecological status of European surface waters and groundwater by 2015, while the latter aims to achieve or maintain such a status in the marine environment by 2020. In order to implement these directives, the member states were invited to develop national water and marine protection plans through which the targets in their territorial waters could be met. By introducing these regulative tools, the EU has taken a stronghold over eutrophication-relevant policy developments in its member states (Schumacher 2011a). More to the point, the EU showed increased interest toward the Baltic Sea region by adopting the first EU macroregional strategy, the Strategy for the Baltic Sea Region (EUSBSR) in 2009. The overall aim of the strategy is to save the sea from environmental degradation, connect the region, and increase prosperity through a number of actions and projects addressing the most relevant challenges and opportunities in the region, including eutrophication.

The HELCOM, in turn, covers the whole region: all coastal countries are contracting parties to the Helsinki Convention. Also other relevant governments (e.g., Belarus and Ukraine) are invited to participate or may apply for an observer status (interview with HELCOM expert, 2010). Over 130 “hot spots,” mostly related to inadequate wastewater treatment, were listed in a HELCOM Joint Comprehensive Environmental Action Program (JCP) in 1992, and many of them were eliminated during the following decade. Currently, the main tool of HELCOM is the Baltic Sea Action Plan (BSAP), agreed in 2007 by the member states to restore the good ecological status of the Baltic Sea by 2021 (HELCOM 2007). The BSAP introduces provisional, countrywise nutrient input reductions targets, which are based on the current nutrient input and the previous reduction efforts. The implementation of the BSAP is carried out through national implementation programs. In recent years, cooperation between the EU and HELCOM regarding the Baltic Sea protection has significantly increased (HELCOM expert, pers.comm. 2010). For example, the national marine strategies of the EU MSFD, as well as the environmental segment of the EU Strategy for the Baltic Sea Region, are based on the regionally agreed environmental goals and objectives (i.e., the HELCOM Baltic Sea Action Plan). In addition, synergies in the implementation processes of the three have been utilized across the region (e.g., Pihlajamäki et al. 2013).

Overview of the National Governance

The Baltic Sea coastal countries have their own national water and marine policies and legislations that regulate the Baltic Sea related issues in their territories. The national Baltic Sea protection efforts vary in respect of the ambition, the capacity, and experience of environmental administration, funding, and continuity (Jokela 2011; Dmochowska and Szaniawska 2011; Nechiporuk et al. 2011; Pihlajamäki 2011; Schönach 2011; Schumacher 2011b). Some of the countries have aggregated environmental protection strategies that include the Baltic Sea protection policies as one issue among other topics (Estonia, Latvia, Sweden) and others have designed documents targeting especially the

Baltic Sea/marine protection issues (Russia, Lithuania, Finland, Poland, Germany) (Pihlajamäki and Tynkkynen 2011b). These strategies include the goals expressed in the EU regulation and, to a varying extent, those of the HELCOM BSAP. National Implementation Programmes of the BSAP vary between the coastal countries remarkably (HELCOM expert, pers.comm. 2010; see HELCOM 2013a).

To characterize the Baltic Sea coastal countries in terms of the protection of the Baltic Sea, Finland and Sweden have often been referred to as "forerunners," whereas the former state socialist countries are considered "laggards" (Darst 2001). The huge but slowly shrinking gap in the living standards between Eastern and Western shores of the Baltic Sea has materialized in significant differences with regard to the implementation of HELCOM's recommendations (HELCOM 2003). Moreover, differences in socioeconomic, political, and administrative systems crystallize in societal activities such as cultures of public participation, these in turn conditioning the diffusion of new policy practices especially in Russia. The EU membership of the three Baltic States and Poland—the implementation of environmental *acquis commuanutaire*[3]—has naturally brought environmental conditions of these countries closer to those of the Nordic countries and Germany. The EU directives are transposed into the national legislation of each member state. The freedom of the member states in terms of directives' contents is limited, but national legislations can provide stricter requirements than the directive. For example, in Germany, the urban wastewater purification rates are higher than required by the UWWTD or even by the BSAP (Schumacher 2011b). Moreover, the directives do not explicitly define governance structures and processes; hence, countrywise solutions vary in the role of central agencies and the division of responsibilities between authorities (Pihlajamäki and Tynkkynen 2011b; Pihlajamäki et al. 2013).

Because Russia is perhaps the most important single actor in the current context, not least as it is not a member of the EU, we focus in this article on its national position vis-a-vis the Baltic Sea governance. The case study on Russia reveals that Russia's input into the Baltic Sea protection activities has been inconsistent because of past socioeconomic difficulties and political instabilities, including repeated reorganising of the environmental administration and blurred division of responsibilities between the federal and regional authorities. This has led to a lack of continuity in environmental policies (interview with a regional authority in Russia, 2009). However, as indicated by the interviewees, Russia has expressed a keen interest in promoting HELCOM as the main actor in environmental protection of the Baltic Sea; especially after the eastern enlargement of the EU to reduce the dominance of the EU in the Baltic Sea region. In a broad sense, Russia and the EU differ in their approaches toward the strategic comprehension of the environmental policy in the Baltic Sea. In spite of the diversity of declared goals of the "National Program of Measures to Improve the Health and Rehabilitation of the Baltic Sea ecosystem" (2012–2020), the Baltic Sea protection appears to be for Russian actors, the first and foremost, a purely technocratic problem, which can be solved by reconstructing wastewater treatment facilities in St. Petersburg, Kaliningrad, and Leningrad oblast regions (interview with a regional authority, Russia 2009; see also Nechiporuk et al. 2011).

[3] The entire body of European legislation, comprising all the treaties, regulations, and directives adopted by the European Union.

MAIN CHALLENGES OF THE GOVERNANCE OF THE EUTROPHICATION MITIGATION IN THE BALTIC SEA REGION

Drawing on the analysis of interviews and other data conducted within the PROBALT project, we identified four sets of challenges as the most serious ones hampering the effective governance of the eutrophication mitigation in the Baltic Sea. In the following, we explicate these challenges and provide some suggestions on how to overcome them.

The European Union Versus HELCOM

Our analysis reveals that the governing system of the Baltic Sea eutrophication mitigation is the first and foremost hampered by the absence of a supranational regulatory body, or a "primus motor" that would cover all counties in the catchment of the sea as well as other relevant actors. Currently, the two candidates for such a role are the EU and HELCOM. The EU directives play a decisive role in addressing the Baltic Sea eutrophication, but besides not including Russia, these directives unfortunately often fail to consider the unique characteristics of the Baltic Sea. The directives, for example, the UWWTD, are generally less strict than the HELCOM recommendations, and therefore, too lax to effectively combat eutrophication (HELCOM 2006). More recent directives, such as the MSFD and WFD, are more promising in this respect, as their implementation plans are drawn separately to meet the needs of specific marine and water areas. These directives allow, however, the member states under certain conditions to extend the target year to 2027 (WFD) and exceptions in reaching the target (MSFD). This produces an implementation delay that hampers the protection of the Baltic Sea (Schumacher 2011a). Furthermore, agreeing on a more stringent Baltic Sea protection plan within the framework of the EU is difficult if not impossible, as many of the member states, such as the Baltic states (Jokela 2011) and Poland (Dmochowska and Szaniawska 2011), are struggling to fulfill even the currently existing requirements. The EU Common Agricultural Policy (CAP) is also problematic in many ways. Although the EU agri-environmental payment scheme offers financial support to complete water protection projects, due to its inflexibility and long-term commitment requirements as well as laborious bureaucratic paper work related to it, some farmers are reluctant to apply for the same (e.g., interview with a scientist, Sweden 2011). For instance, in Sweden, funds are not being utilized in full (interview with a scientist, Sweden 2011).

Despite these challenges, our analysis indicates that the implementation of the EU directives is a top priority over the HELCOM recommendations in all EU member states (Pihlajamäki and Tynkkynen 2011b). This is the first and foremost point due to the existing enforcement power of the EU, i.e., the member states face significant sanctions if they fail to implement the various directives. The position of the coastal states toward HELCOM, in turn, is more multifaceted (e.g., interviews with two civil servants and one NGO representative in Sweden 2011; Dmochowska and Szaniawska 2011; Jokela 2011). HELCOM recommendations have been enforced to a varying extent in national policies and legislation of the coastal states. The main deficiency of HELCOM is that, contrary to the EU framework directives, sanctions for noncommitment of the HELCOM recommendations do not exist (HELCOM expert, pers.comm. 2010; VanDeveer 2011). This generates lack of commitment, and hence, recommendations put forth by HELCOM do not materialize effectively enough in national regulations, let alone in implementation. The BSAP as the main tool of HELCOM to manage eutrophication has been accused by NGOs for not including those ambitious actions originally included in the proposals of the plan, for not treating the countries equally, and for forgetting to cover socioeconomic aspects. More to the point, HELCOM is criticized for concentrating mainly on scientific activities and accumulating data instead of supporting the concrete implementation of the proposed measures (interviews with two NGO representatives in Sweden 2011; interview with a scientist in Finland, 2009).

On a more positive note, the greatest assets of HELCOM include the participation of all nine coastal countries, the possibility to address the whole catchment area, and its long history and distinguished role as a forum for the macroregional Baltic Sea protection. HELCOM has also resonance in Russia, where, as a non-EU member, HELCOM is the main transnational governing body for the environment of the Baltic Sea (e.g., interview with a scientist in Russia, 2009). As a major polluter and a geopolitical actor, Russia's interests need careful consideration. This implies that the position of the EU as the "primus motor" of Baltic Sea environmental protection is not self-evident, even if more stringent EU regulation that takes specific conditions of the Baltic Sea and the eutrophication problem into account is allowed to be in place.

Socioeconomic Differences and the Lack of Environmental Awareness

The historically rooted differences of the countries' socioeconomic situations and capacities are among the key challenges for effective governance of the Baltic Sea environment in general and eutrophication mitigation in particular. We argue that existing policies do not take these differences into account in an adequate manner. Above all, this applies to the HELCOM BSAP, in which the highest nutrient reduction requirements are set for developing economies in the region, namely Russia, Poland, Latvia, and Lithuania, leaving Finland and Estonia with the lightest burden. Thus, the minimized cost for implementation of the plan, calculated up to €4.7 million annually (Wulff et al. 2014), is very unevenly distributed compared with the GDP or other indicators of economic performance. This is regarded as an unfair division of burden and lessens the incentive for implementation, for example, in Poland (Dmochowska and Szaniawska 2011).

Another example of how socioeconomic differences affect the governance of eutrophication mitigation is provided by the agricultural sector. Before the 2004 EU enlargement, the intensity of agricultural production and the consequent use of fertilizers in, for example, Poland were moderate mainly due to poor economic conditions. However, the EU CAP has promoted intensified agricultural production throughout the region and is expected to result in substantial growth of the agricultural sector in Poland and subsequently increased nutrient leaching (Dmochowska and Szaniawska 2011). At the same time, the implementation of environmental measures to reduce nutrient run-off through the national agri-environmental programs (as part of the EU CAP) depend on the willingness and possibility of the state to provide co-funding from their national budgets (e.g., interview with an environmental authority, Finland 2011). In Poland, it remains yet to be seen how environmental protection will be guaranteed in the intensified agricultural production (Dmochowska and Szaniawska 2011).

With regard to the awareness concerning the problem of eutrophication, our analysis supports the findings of Flash Eurobarometer on Water (2009) and Ahtiainen et al. (2012), which suggest that eutrophication is perceived as the most severe environmental problem of the Baltic Sea in Finland and Sweden, but not in Germany, Poland, the

Baltic States and Russia. This can be explained by geographic, geopolitical, and historic-cultural reasons: Finland and Sweden have the longest Baltic Sea coastlines, economic activities concentrated along the coast and long traditions of Baltic Sea related livelihoods, especially recreation. In Russia, Germany and Poland, the geographic distances of the capital cities from the Baltic Sea downplay the national significance of the problems of the Baltic Sea. This is reflected in that public knowledge concerning the Baltic Sea eutrophication is somewhat poor and/or scientifically contested, and media attention is scarce (Dmochowska and Szaniawska 2011; Jokela 2011; Nechiporuk et al. 2011; Schumacher 2011b). In the former socialist countries, open access to information and public deliberation is a new aspect; therefore, NGOs and other actors have only relatively recently started to participate in the environmental protection of the Baltic Sea (Jokela 2011). At the level of the EU, the good environmental reputation of the northern European countries leads to the false impression of a good environmental status of the Baltic Sea (Schumacher 2011a).

Weak or pending environmental awareness poses a real threat to the target of achieving a good ecological status of the Baltic Sea. Growingly important instruments of environmental policy-making such as public pressure, everyday activism and environmentally friendly business culture all benefit from a higher environmental awareness. Truly effective policies can be planned only with the help of those actors whose actions are critical with regard to the problem (Haila 2008). Various stakeholders are also in the key position when searching for cost-efficient measures to decrease nutrient leakage. Enhancing cost-efficiency is closely related to the question of prioritization of policies. This, however, necessitates awareness on the problem and personal interest: the implementation of protective measures often means costs to be carried even by individual citizens, such as farmers or house owners. If not provided with additional funding and especially when combined with a lack of awareness, other expenditures may appear more pressing.

Inadequate Spatial and Temporal Specification of Policies

The existing governing system does not efficiently reach out to all sources of nutrient leaching along the coastal zones and in river catchments. This concerns agriculture in particular, as the magnitude of nutrient leaching varies significantly among the cultivated areas (e.g., interviews with one scientist, one local politician, one civil servant at MoA, and one NGO representative, Sweden 2011; interview with two scientists, Finland 2009). This implies that instead of implementing agri-environmental measures equally across the region, the measures should be focused where the benefit (i.e., the amount of nutrient reduction) is the greatest. In general, this refers to cost-effective practices that introduce spatially specific environmental measures. Temporal specification, in turn, implies the concentration of nutrient reduction efforts to sources from which the greatest benefit (nutrient reduction) can be achieved the quickest (interview with a scientist in Finland, 2009). Specification necessitates also a bottom-up approach focusing on specific situations and differentiating management practices with the strong involvement of relevant stakeholders (interview with one scientist and one local politician, Sweden, 2011; see also Haila 2008).

Based on our analysis, the existing policy instruments, especially those included in the CAP, do not facilitate effectively enough such spatial differentiation of policy instruments and forms of implementation and have thus led to inaccurate allocation of responsibilities and waste of funds targeted to protection. Instead of focusing the measures to those areas where the potential benefit is the greatest, the agri-environmental measures of the CAP are implemented equally across the region. Participation in the national agri-environmental programs is voluntary for the farmers and includes a certain degree of freedom in the selection of measures, which can also lead to an ineffective allocation of measures in respect of eutrophication sensitive areas, or in the worst case scenario, a complete lack of them (e.g., interview with one scientist, Finland 2009; interview with environmental authority, Finland 2011). More to the point, not only the EU regulation but even some national funding systems for water protection, e.g., in Sweden, do not take spatial differences into account carefully enough, and hence protective measures are not carried out cost-effectively (e.g., interviews of two civil servants at the Swedish Environmental Protection Agency, two NGO representatives and one scientist, Sweden 2011; see also Lundqvist 2004). To some degree, spatial and temporal inflexibility of impacts of measures is caused by inadequate follow-up and evaluation and malfunctioning feedback mechanisms (e.g., interviews with one local politician, one scientist and two civil servants at the Swedish Environmental Protection Agency, Sweden 2011). The best possible results are not reached if action cannot be readjusted when the follow-up information identifies improvement needs.

To advance temporal specification of policies, intermediate steps toward final goals that are connected to technological possibilities and would thus facilitate implementation of policies need to be defined (interview with a university scientist, Finland 2009). Such a temporal dimension is built in NEFCO's (Nordic Environmental Finance Corporation) suggestion to develop a nutrient trading system in the Baltic Sea (NEFCO 2008). Starting nutrient trading between point sources (e.g., urban wastewater treatment plants) would bring reductions in nutrient loads quickly in contrast to the inevitably slow progress achievable in agriculture (Ministry of Agriculture and Forestry of Finland 2010; Lankoski and Ollikainen 2011). Reduction of nutrient loads from urban wastewater treatment plants by using a trading mechanism would constitute roughly 70 % of the reduction targets set out in the BSAP (Hautakangas and Ollikainen 2011). This reduction is large and would, based on the consequent changes in water quality and algal blooms, provide an opportunity to reconsider and fine-tune the BSAP's targets. Actually, this is what the most recent 2013 HELCOM Ministerial Declaration urges: it is agreed in the Declaration that further upgrading of waste water treatment to fully implement the relevant HELCOM Recommendation will be prioritized (see HELCOM 2013b).

Insufficient Integration of Different Policy Sectors

Various activities throughout the catchment area (and beyond) either directly or indirectly affect the state of the sea. Therefore, the state of the Baltic Sea cannot be improved by focusing exclusively on marine and water protection, if all societal activities are not closely linked to protective activities. Some of the EU policies are often even contradictory, e.g., agricultural and environmental policies, suffering from the lack of proper integration (Kern 2011; Schumacher 2011a). In the EU, agricultural decision-making has taken place within a rather isolated policy network for many decades, and in many national cases strong farming lobbyists are against more stringent environmental policies while fearing for the loss of competitiveness (interviews of two NGO representatives, Sweden 2011). The CAP is not in synergy with the WFD and MSFD, instead the CAP gives counterproductive incentives to nutrient input reduction by encouraging farmers to increase both area under cultivation and intensity of production (e.g., interview with a scientist, Finland 2009; see also Lankoski and Ollikainen 2011). As a result environmental impacts of agricultural policy actually undermine the achievements of agri-environmental policy regarding water protection. Furthermore, the agri-environmental programs can be targeted toward a multitude of different environmental goals and there is no legal obligation to prioritize water protection (Guttenstein 2007). In fact, the Commission has even requested Finland not to increase the share of water protection related measures in its national program (interview with a scientist and a former representative of farmers union in Finland, 2011). Strong policy fragmentation calls for an exhaustive reform, which unfortunately the new CAP does not seem to be bring about.

A better integration of policy sectors presupposes the explication of interrelations between different policy areas, taking the specific spatial, temporal and administrative scales of the activities that are causing the problem as the starting point for policy integration. In addition, trade-offs and synergies between different policy, environmental and agricultural sectors (also sectors like transportation, energy, housing, fisheries) should be more systematically taken into consideration at every governance level. Positive effects—double benefits—could be expected both in regard to other environmental objectives (e.g., climate protection and biodiversity) and in terms of socioeconomic interests (e.g., improved drinking-water quality, cost savings by increasing fertilizer efficiency and improved conditions for the tourism and fisheries sectors) (interview with one local politician and one scientist, Sweden, 2011; Schumacher 2011a).

CONCLUDING REMARKS

The examination of the governing system of the Baltic Sea eutrophication mitigation reveals that the main challenges for more effective governance are rooted in the boundaries of different levels of the governing system and their interactions. Furthermore, historically rooted differences in socioeconomic circumstances, between the Nordic countries and Germany, and the former socialist states, Russia in particular (see Jahn and Kuitto 2008; Kern, 2011), pose yet another key challenge.

The existing governing system is a rather state-centric one (Kern 2011). The state-centricity is an imperative that cannot be forgotten, because there is no supranational governing body that would transcend the sovereignty of all countries in the catchment area. As brought up by some of the experts interviewed in the PROBALT project, one option to solve this problem would be a binding regional agreement that would contrary to the existing Helsinki Convention be fair, cost-effective and include mechanisms of sanctions for noncompliance. However, such an agreement may not be plausible given that the Helsinki Convention is already in place. At minimum, the governing system is in need of enhanced interplay between the existing institutions and policies (see Oberthür and Schram Stokke 2011). The EU Strategy for the Baltic Sea Region provides a good start, especially vis-à-vis the interplay between the EU MSFD and WFD and the HELCOM Baltic Sea Action Plan. However, action driven strongly by the EU excludes Russia. Furthermore, the dominant role of the EU in the Baltic Sea protection is not greeted by Russia, anxious to rebuild its former superpower status. Therefore, the HELCOM is more likely to continue to be an important actor also in the future, and its policies should be revised accordingly.

Furthermore, stakeholder engagement is a major consideration that should be taken into the core of any development not only to gain political legitimacy but also for the purposes of spatial and temporal specification. Without connecting with "on the ground" constituencies, the governance system is unable to effectively reach out to all sources of eutrophication in the catchment area and to correct scale discrepancies between the problem and policy instruments (Haila 2008). Improved stakeholder participation would encourage a change from the use of direct top-down regulations to the introduction of incentive-based flexible instruments and individual voluntary efforts to protect the sea (see Hammer et al. 2011). But increasing public participation is not an easy task and cannot be carried out artificially on top of existing procedures. At the core of enhancing broad stakeholder participation and legitimation of policies is wide public acceptance and desirability of the goals. This necessitates awareness of the problem at all levels. Awareness can be raised by increasing the publicity and media attention concerning the problem of eutrophication. Events like the Baltic Sea Action Summits are very important in this respect; also environmental education plays a key role especially in the long term.

In this article, we did not analyze the role of subnational actors, although especially the EU legislation is often implemented at local and regional levels (Kern 2011). More to the point, nongovernmental actors for the governance of the mitigation of the Baltic Sea eutrophication were left out of the scope of this article. This was because the focus of the PROBALT project was on the formal governing system. It should be noted, however, that subnational actors as well as nongovernmental actors have a growing role in policy making and also in the implementation of already negotiated policies. Following from this notion, a number of conclusions with regard to future research needs can be drawn. From the viewpoint of policy analysis, it would be important to focus sustained inquiry not only on the ways in which spatial and temporal specification of policies could be carried out, but also on how policy integration could be organized across policy sectors and levels and actor groups in a way that encourages participation and the inclusion of bottom-up perspectives in policy-making. Last but not least, to guarantee the requirement of visibility of the problem and to increase knowledge on it, all sort of research should pay special attention to the communication of results to the wider public also in the future.

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The challenge of bridging science and policy in the Baltic Sea eutrophication governance in Finland: The perspective of science

Mia Pihlajamäki[1] and Nina Tynkkynen[2]

Abstract

This paper examines the views of scientists on intricacies of scientific knowledge that affect science—policy interface in the Baltic Sea eutrophication governance in Finland. The analysis demonstrates that these intricacies can be divided into five categories: (1) uncertainty of knowledge concerning ecological processes, (2) heterogeneity of knowledge, (3) societal and political call for (certain) knowledge, (4) contingency of the knowledge that ends up taken as a baseline for decision making and further research, and (5) linkages of knowledge production, processing and communication to particular characteristics of individual researchers and research societies. By explicating these aspects, the paper illustrates the ways in which scientific knowledge concerning eutrophication is human-bound and susceptible to interpretation, thus adding on to the uncertainty of the Baltic Sea environmental governance. The aim is, then, to open up perspectives on how ambiguities related to science—policy interface could be coped with.

Keywords: eutrophication, environmental governance, science—policy interface, knowledge production, the Baltic Sea, Finland

Introduction

Extended eutrophication is regarded as one of the most serious environmental risks for the Baltic Sea. A multitude of protective policies and measures have taken place since the early 1970s but the problem of eutrophication of the Baltic Sea has not yet been solved. We argue that complexity of risk governance concerning eutrophication is not confined to the inadequacy of scientific research, or to problems in adjusting national governance structures to the implementation of scientific recommendations. Rather, it is rooted in the challenges of multi-level governance, regionality, and, as this paper addresses, knowledge—policy interface.

A number of scholarly works discuss knowledge—policy interface in fisheries management in the Baltic Sea (e.g. Peuhkuri 2004; Wilson 2009), or the work of the Baltic Marine Environment Protection Commission HELCOM in general (Aps et al. 2009). For a number of reasons, also eutrophication is an interesting case to scrutinize from the point of view of knowledge—policy interface. Eutrophication was recognized as a large-scale environmental risk for the Baltic Sea in the late 1970s (Elmgren 2001), and can be positioned in between "old", bound, and post-modern, diffuse environmental problems (Peuhkuri 2004). On the one hand, symptoms of eutrophication are clear and easily perceived by water users, as the water gets algaeic and slimy as a result of eutrophication. On the other hand, there are uncertainties concerning the determination of causal relations of the problem; in addition, many aspects of the problem are provable by scientific examination only.

As regards the Baltic Sea eutrophication governance, challenges of knowledge—policy interface are rooted in certain qualities of (scientific) knowledge. Leaning on the understanding of knowledge as a socially constructed human product formulated in interaction with the physical world (e.g. Bloor 2004), we argue that scientific knowledge is limited, controversial, bound, uncertain, socially conditioned, and constantly under change. This gives room for different interpretations of what “the facts” are, and, further, for the politicization of knowledge. In addition, material conditions, structures, forms and practices determine processes of knowledge production, processing and communication. The aim of this paper is to illustrate the ways in which human endeavor engages with the ideas of scientific knowledge concerning eutrophication, thus posing challenges to the Baltic Sea risk governance. We do this illustration by scrutinizing the views of Finnish scientists on knowledge—policy interface related to the Baltic Sea eutrophication governance in Finland[1]. By tying our examination to certain recent policy debates, we address the main research question: What kinds of intricacies of (scientific) knowledge that affect science—policy interface in the eutrophication case do the scientists identify? By this explication we aim also to open up perspectives of how ambiguities related to knowledge—policy interface could be coped with. These perspectives are discussed in the concluding part of the paper.

Methodological underpinnings and materials

Our research draws on the argument that scientific knowledge is not a transcendent mirror of reality but both embeds and is embedded in social practices, identities, norms, conventions, discourses, instruments and institutions—in all what we refer to as social (Jasanoff 2004). As a loose background for our understanding of the nature of knowledge as socially constructed one might thus refer to the academic field of science studies. As Demeritt (2006: 454-455), who has published on the articulation of scientific knowledge with power and climate policy, puts it,

> “this otherwise heterogeneous body of academic scholarship is united by its agnostic stance towards scientific truth and its emphasis on the socially contingent manner in which the objects of science are constructed and knowledge about them is socially validated”.

We do not touch here the philosophical or methodological debates internal to that field (to get an overview, see Sismondo 2004), but let the data advocate for us. As a loose interpretive framework, science studies beg for illustration rather than proof (cf. Jasanoff 2004).

As a result of our analysis, we introduce categorizations of aspects of knowledge that scientists find out problematic for knowledge—policy interface in the case. The categories are derived inductively from the empirical data by applying qualitative content analysis. As this method indicates, we have first developed a deep understanding of the data, then classified, and finally conceptualized it into new kinds of categorizations.

Our data consists of 18 in-depth interviews of eutrophication experts (scientists hereafter) working for universities and sectoral research institutes in Finland (see next section). The interviews were conducted during the fall 2009. For the purposes of our study it was crucial to find those scientists that have actively participated in policy debates concerning eutrophication. First interviewees were chosen on the basis of our own experience on the issue. After that we followed the so called "snowball method" which implied that interviewees named all possible experts and specialists on the issue of our interest that he/she thought we should take an interview with. After some 15 interviews no new names to be interviewed popped up. The majority (13 of 18) of our interviewees were from sectoral research institutes, only 5 from universities, which more or less corresponds with the share of eutrophication experts between these institutions. Most of the interviewees had their background in marine (or other natural) science; no social scientists were included in the group of interviewees except for a couple of economists. This is because there basically are no social scientists studying the Baltic Sea eutrophication in Finland. As some of the interviewees asked for anonymity, we refer to the interviews in this paper only by giving the date of the interview, and the information whether the interviewee represents a university or a sectoral research institute. When referring to the interviews in the text, the abbreviation RU indicates the representative of a university, while the abbreviation RS refers to the representative of a sectoral research institute.

The interviews followed thematic guidelines, but only very loosely. The main themes of our discussions with the interviewees were agriculture, wastewaters of urban and dispersed settlements, and internal nutrient load, because these issues are usually mentioned as the most important nutrient sources contributing to eutrophication, and, moreover, because these topics have recently been under public debate in Finland.

Eutrophication governance in Finland

Main policies and actors

EU directives, national laws and national, regional and local policies regulate the use of Finnish coastal and inland waters in order to combat eutrophication. By and large, these regulations set nutrient (phosphorous and nitrogen) reduction targets. National policies and measures are guided by Finland's Programme for the Protection of the Baltic Sea (2002), which presents the actions needed to meet the Water Protection Targets to 2005 (1998), and the Water Protection Policy Outlines to 2015 (2006). The latest addition to the national policies is a Government Report on Challenges of the Baltic Sea and Baltic Sea Policy published in 2009. Since 2007, HELCOM’s Baltic Sea Action Plan (BSAP) works as an umbrella for national policies that in Finland are generally more stringent than HELCOM requirements. Although national eutrophication policies are relatively ambitious, the targets are not easily met. Looked from the political perspective, failure to meet nutrient reduction targets is largely due to conflicting interests of different sectors, the environmental and agricultural in particular, and, consequently, to insufficient (implementation) instruments, in some cases even the complete lack of them.

The main actors of eutrophication governance in Finland are researchers; officials in the Ministries of the Environment and of Agriculture and Forestry and at the Finnish Environment Institute; members of parliament responsible for relevant legislation, and members of local governments and administration (especially) in coastal regions.

Although it is difficult, if not impossible, to estimate the number of scientists focusing on the Baltic Sea studies in Finland, it can be noted that the size of this group is rather small, and natural science is heavily emphasized. Eutrophication research is polarized into two main groups. One group of researchers works at universities, mainly at the Universities of Helsinki and Turku. The other group works for sectoral research institutes Finnish Environment Institute SYKE, operating under the Ministry of the Environment, and MTT Agrifood Research Finland (subordinate to the Ministry of Agriculture and Forestry), the main Finnish research institute in the field of agricultural and food research and agricultural environment research. A number of eutrophication researchers of the first group work for Centres for Economic Development, Transport and the Environment (*Elinkeino-, liikenne- ja ympäristökeskus, ELY,* before 2010 regional environment centres, *alueelliset ympäristökeskukset*). The Finnish Institute for Marine Research subordinate to the Ministry of Transport and Communications was closed down in 2008 when its functions were transferred to Finnish the Environment Institute and Finnish Meteorological Institute[2].

Although sectoral research institutes have a direct link to policy making because of their subordination to the Ministries of the Environment (SYKE and regional environmental centres) and of Agriculture and Forestry (MTT), also certain university researchers are regularly heard by politicians and officials. In their work of preparing policies, drafting new legislation and the like, the Ministries officials hold workshops and hearings where certain experts and stakeholders are invited to participate. For example, in the preparation of the Government Report on Challenges of the Baltic Sea and Baltic Sea Policy, the Environment Committee (in charge of the preparation) heard a variety of actors including politicians, officials, actors from the private sector, NGOs, and researchers (see Environment Committee 2010). Later in this paper, in section *"Linkages of knowledge production, processing and communication…",* we scrutinize practices of interaction between researchers and policy makers in more detail.

Recent debates related to eutrophication governance

To understand related policy debates, we need to have a look at the basic dynamics of the Baltic Sea eutrophication and Finland. The annual nutrient load from Finland to the Baltic Sea in 2000–2006 was on average 2 600 tons of phosphorus and 50 000 tons of nitrogen (Ministry of the Environment 2009). Agriculture is the most significant single source of both nutrients: 62% of total phosphorus and 57% of the total nitrogen input. Other sources of diffuse load are dispersed settlement (12% of P, 3 % of N) and forestry (6% of P, 4% of N). The largest loads from point sources, 7% of total phosphorus and 18% of total nitrogen input, originate from municipalities, while other sources (industry, fisheries etc.) cover less than 5% of total loads (Ministry of Environment 2009). In addition to diffuse and point sources, the catchment area receives atmospheric deposition of nitrogen equivalent of 18% of the total nitrogen, and 6% of the phosphorus (Finnish Environment Institute 2010). One (increasingly) significant source of phosphorus is internal load, i.e. the release of phosphorus from sea bottom sediments in anoxic conditions[3].

Although it appears generally accepted that both external nitrogen and phosphorus emissions should be reduced in order to effectively combat eutrophication, the debate concerning eutrophication governance is shaped by the main question about the dynamics of nutrient enrichment in the sea, and the role of different nutrients as causes of eutrophication. Some scientists have suggested that in order to cut down summertime toxic algae blooms, nitrogen loads should not be limited (e.g. Håkanson and Bryhn 2008)[4]. If this was the reality, all efforts should be concentrated on restricting the phosphorus input, and forget about the nitrogen. Other experts (incl. most of our interviewees) emphasize that both nitrogen and phosphorus reductions are essential in order to combat eutrophication due to interconnected cycles of oxygen, phosphorus and nitrogen (see Vahtera et al. 2008).

The main topics of discussion concerning the Finnish eutrophication governance are related to agriculture, nitrogen removal in urban wastewater treatment, and the treatment of wastewater in dispersed settlements. The document Water Protection Policy Outlines to 2015 states that "the most important objective is to reduce nutrient pollution, particularly from agricultural sources. A target has been set to reduce agricultural nutrient loads by at least a third of their average level over the years 2001-2005 by 2015." (Ministry of the Environment 2007) In a report on nutrient reductions from agriculture National Audit Office of Finland estimated that the current actions are insufficient to meet the 30% reduction requirement by 2015. The report as well as the Government Report from 2009 both pinpoint that the reason behind the failure to take sufficient actions lies in the way agri-environmental aid is currently implemented. The goals and targets of protection and agricultural policies (especially the EU Common Agricultural Policy CAP) are conflicting and thereby resulting in lower reduction than set by the target. The reduction potential from agriculture lies within two policy instruments; the agri-environmental aid and the Government Decree on the restriction of discharges of nitrates from agriculture into waters (931/2000). In order to reach the 30% reduction target, the implementation of the former needs to be revised. Partly because of the emphasized role of agriculture for the socio-economic development of the rural areas in Finland, linked to the strong position of the Centre Party (former Agrarian Party or *Maalaisliitto*) in the Finnish government, farmers have traditionally been somewhat treated with kid gloves in Finnish politics. Therefore, it has been relatively difficult to establish more stringent environmental policies to control agricultural activities, no matter the various research reports (and the public) that have constantly called for them (e.g. Jokinen 2000). However, while many researchers and policy actors stress the importance of the reduction of nutrient input from agriculture, others feel it to be too difficult (albeit important), and therefore suggest that, above all, efforts should be concentrated elsewhere, such as improved wastewater treatment as it provides “an easy way to get results” (RU 5.11.2009).

In addition, Finnish nitrogen politics has been under debate. It has been criticized as well by a group of scientist, the Finnish media (e.g. *Helsingin Sanomat* 18.11.2009) as by the European Commission. The EU’s Urban Waste Water Directive (91/271/EEC) was adopted in 1991. It requires the minimum of 70% reduction of nitrogen of wastewater collected in agglomerations of more than 10 000 population equivalent. In Finland, on average only 56% of the nitrogen is removed at wastewater treatment plants (Santala and Etelämäki 2009). In 2005, 18 wastewater treatment plants out of the total 89 (with agglomeration of more than 10 000) were removing over 70% of the nitrogen, and 15 were waiting to be improved (Pietiläinen ed. 2008). In 2007, the Commission sued Finland over failure to require more stringent treatment of nitrogen, but the case was dismissed by the Court of Justice in 2009. Finland’s argument was that nitrogen originating from inland wastewater treatment plants does not contribute to the Baltic Sea eutrophication. Still, some actors call for more resolute urban wastewater treatment and nitrogen removal when it comes to the Baltic Sea eutrophication policies in Finland. A crucial question characterizing this debate is: Is nitrogen retained in rivers and lakes, or is it flushed through to the sea?

Recently, the treatment of wastewater in dispersed settlements has formed perhaps the most heated topic of public debate related to eutrophication in Finland. Since 2004, the treatment of this wastewater has been regulated by the Onsite Wastewater System Decree (542/2003). The Decree sets minimum standards for wastewater treatment and planning, construction, use and maintenance of treatment systems. According to Finland’s Environmental Protection Act

(86/2000), wastewater in areas not connected to any centralized sewerage system must be treated so that there is no risk of polluting the environment. The Decree has been criticized by a number of scientists and the general public as well because it introduces compulsory actions to all areas not connected to urban wastewater treatment system, regardless of the location of the area with respect to the Baltic Sea or surface waters in general.

Finally, the role of internal load—crystallized mainly in the question whether the nutrient reductions should be made inland or at the sea—has been debated over in Finland, in the media in particular (e.g. *YLE* May 7, 2009; *Helsingin Sanomat* February 24 and 28, 2010). A rising topic of discussion, although not yet highly popularized, is the impacts of climate change on eutrophication.

Multiple faces of the Baltic Sea eutrophication science

In the analysis we extrapolated the intricacies of (scientific) knowledge and science—policy interface in the Baltic Sea eutrophication case into five categories. Some of these categories refer to ontological qualities of knowledge, while some are exterior and material. Some of the categories refer to the internal workings of science, whereas others to science's relations with the outside world. Therefore, the categories are overlapping and by no means commensurate. Also the strength of the linkages between the different categories varies. Still we think that this kind of classification can be made for analytical purposes.

The categories are here referred to as aspects of scientific knowledge that affect knowledge—policy interface in the Baltic Sea eutrophication governance in Finland. These aspects are the following: (1) uncertainty of knowledge concerning ecological processes, (2) heterogeneity of knowledge, (3) societal and political call for (certain) knowledge, (4) contingency of the knowledge that ends up taken as a baseline for decision making and further research, and (5) linkages of knowledge production, processing and communication to particular characteristics of individual researchers and research societies. In the following we discuss each aspect and some of their possible implications to the science—policy interface.

Uncertainty of knowledge concerning ecological processes

The uncertainty of scientific knowledge concerning ecological processes related to eutrophication stems first and foremost from the nature of these processes. Processes involve interdependencies, randomness, and variable and cross-cutting temporal and spatial scales that are difficult, in some cases even impossible, to predict and to systematize by science. In the Baltic Sea eutrophication case, the effects of climate change on the problem of eutrophication were mentioned as a general example of such uncertainty. In many cases, the uncertainties seem to be due to the margin of error embedded in scientific research. In addition, despite the fact that the Baltic Sea is often referred as one of the most extensively studied seas in the world, there still exists a constant need to know more about diverse dynamic processes and emergent phenomena. One such issue is internal nutrient cycle as explained by one of the interviewees:

"…if you search for journal articles on nutrient release from the bottom sediments, you don't find many articles, although (internal nutrient cycle) is one of the key issues. (…) It is one of those issues that requires further research" (RS 20.10.2009)

Many interviewees expressed their concerns over the implications of various uncertainties for risk governance.

"We know exactly that nutrients cause eutrophication. Therefore, in order to combat eutrophication we need to reduce nutrient input. After this it gets more complicated. (…)We simply don't know how the Baltic Sea reacts to decreased nutrient loads, for example how long it takes for the sea to return to any given reference point, or to what kind of reference point we can realistically aspire to." (RS 12.11.2009)

Uncertainty was seen to have further influence on the linkage between science and policy, since uncertainty related to the scientific knowledge opens up an opportunity for possible opposition. It enables directing the focus of public discussion towards uncertainties, thereby undermining the main message conveyed by a certain research result. The unknown and uncertain points can easily be raised into the discussion without any scientific back-up, whereas their neutralisation requires scientific evidence and argumentation. This has happened also in Finland, where one politician has argued that instead activities onshore, eutrophication prevention efforts should be concentrated to the sea (offshore) to diminish the internal load.

”No matter what the scientific community says (…) there is always some opposition, and people easily believe the opposition. Scientific knowledge is often questioned by asking whether other possibilities could exist. This makes the scientific community look less convincing. You can see it in that some politicians randomly take up arguments discussed 10 or 15 years ago, and use them, although the scientific community is no longer considering the argument relevant and right.” (RU 26.10.2009)

Heterogeneity of knowledge

This second aspect of our categorization implies that there are different definitions and interpretations concerning the problem of eutrophication and its solutions also within the scientific community. Scientific knowledge, by nature, tends to leave room for interpretation, which means that same results can be interpreted very differently depending on the perspective. Differing definitions of the problem can also be explained by different indicators used to measure (certain elements of) the problem. One interviewee explained:

“When you choose the right time and spatial scale, you can in principle find the most suitable results for you within the very same data. This means that based on the same data, you can either say that nitrogen should or should not be reduced.” (RS 6.11.2009)

As commonly acknowledged by Finnish scientists and experts, there are a number of questions related to the Baltic Sea eutrophication that the scientific community does not agree upon. In some, but nearly not all, cases the disagreements stem from uncertainty. Among disagreed questions are, as the policy debates well reflect, the scope and influence of internal nutrient load, the role of phosphorous versus nitrogen for the problem of eutrophication, and the magnitude of nutrient load from inland waters to the Baltic Sea eutrophication. Regarding the debate on the role of phosphorous versus nitrogen for the problem of eutrophication, one interviewee representing the academia commented that

” Everyone agrees that we need to reduce phosphorus input, but regarding the need for nitrogen reductions there have been some bloody battles.” (RS 26.11.2009)

In regard to the nitrogen removal in waste water treatment plants, experts had differing views on whether nitrogen is actually retained in rivers and lakes, or whether significant amounts of it are flushed through to the sea. This problem is linked with uncertainty and the need for further research, as often is the case when interpretations conflict.

In certain international meetings, researchers have claimed for a “common voice” of the Baltic Sea researchers in order to “better get the message through” to policy makers at various levels. The idea is that, resembling the International Panel for Climate Change (IPCC), the Baltic Sea researchers should unite themselves and establish a united view on the various environmental problems of the Baltic Sea. True, there is the International Council for the Exploration of the Sea (ICES) that provides the Helsinki Commission (HELCOM) with scientific information and advice (e.g. Aps et al. 2009). However, only a very limited number of Baltic Sea environmental researchers participate in the work of that Council. Otherwise, no such common view or voice for the Baltic Sea scientists exists. As regards to eutrophication, some interviewees supported the idea of forming a “common voice”, to exist at least among the Finnish researchers, while some of them did not actually like it. Instead, they considered that differing views are only for good:

"… some people think that the nature of the research process is such that once a certain issue has been studied for a while, all researchers agree on it. In my opinion this kind of an agreement would put a stop to the dynamics of research: Initially, every motivated researcher aims to prove prevailing understandings wrong."(RS 12.11.2009)

In any case, differing interpretations of the essence of the problem lead to varying nominations for the possible solutions of the problem. For example, the phosphorous versus nitrogen question leads to definitional struggles over whether protective efforts should be concentrated on the reduction of phosphorus, or whether the reduction of nitrogen is needed as well.

Consequently, scientists hold differing views on the effectiveness of current protection policies and policy instruments, too. In most cases, the existence of varying and sometimes contradictory scientific knowledge implies that societal actors (media, politicians, officials, the public…) can choose which interpretation to take up:

"… if the proposed solution is inconvenient, politicians don't believe it and they go and find another opinion about it." (RU 26.10.2009)

Societal and political call for (certain) knowledge

As probably everywhere else, the societal and political call for knowledge directs the research carried out in national research institutes and universities also in Finland. This is due to the evident dependence on national and international project funding. Moreover, sectoral research institutes, such as the Finnish Environment Institute and the MTT Agrifood Research Finland that are funded by the Finnish Ministry of the Environment and the Ministry of Agriculture and Forestry need to concentrate on issues that political and administrative bodies regard as relevant.

”Some questions come from ministries, so they do direct research. Good example is the Baltic Stern – project[5], which did not come from the Finnish ministries per se, but still the initiative stemmed from the political side. I don’t believe that researchers could have figured out that it is the thing to do right now.”. (RS 13.11.2009)

The societal and political call for knowledge is partly defined through the priorities of wider society, but particularly by the media, policy makers, administrative bodies and institutional structures themselves. The role of the public and media in defining what is and what is not interesting was pointed out by many of the interviewees:

“The role of phosphorus and nitrogen is important, because the spring bloom is caused by nitrogen input, and spring happens to be the most productive period out of the year. Significant proportion of the spring bloom sinks to the bottom thereby initiating oxygen depletion. But the spring bloom is not interesting for the media, because people don’t go to their summerhouses in the spring and the water is cold. (Thus, the public does not perceive the problem of eutrophication in spring.) (RS 12.11.2009)

The implications of the call for certain knowledge were considered, in the worst case, to weaken the possibilities for doing basic research and, potentially, to divert the focus of research from what is not yet known to what already is known.

Contingency of the knowledge that ends up taken as a baseline for decision making and further research

By this aspect of scientific knowledge we refer to the fact that not all knowledge ends up to the decision making system, and thus “returns” to the focus of further research (see the previous point) in a logical way. Quite the contrary, when scrutinized from close range, many issues and definitions seem virtually randomly chosen. To a certain extent, the first two aspects—the uncertainty and heterogeneity of knowledge and the room for maneuver that they leave—

explain this. In addition, simplified definitions of the problem and its possible solutions are needed to communicate the issue effectively to wider audiences. Media contributes to this aspect of knowledge by playing an important role in communicating science news to the public and raising environmental issues to the public and political debate. Sometimes the problems raised up by media also seem quite randomly chosen.

"You represent certain opinion in the media, and journalists want to find someone who represents the opposite opinion. This gives the reader the impression that the opinions go fifty-fifty to both sides. Kind of the same as in climate change discussions, although in reality about 99 percent believe in climate change and 1 percent doesn't."(RS 20.10.2009)

"…it can be a complete randomness what the media picks up. The media channels that problem through to wider audiences, which all of a sudden makes the problem interesting from the political point of view" (RS 5.11.2009)

In politics and administration, some sort of generalizations and simplification are always needed, whilst they may lead to different kind of distortions. In many cases the generalizability of research results can be questioned. One interviewee gave an example of this problem:

"We don't know enough about nutrient input from agriculture. We've studied drainage areas in Southern Finland, but we haven't studied Northern or central Finland. Our studies are carried out in certain areas, but how do we know whether they work in other areas as well?" (RS 20.10.2009)

"I simplify, although I wouldn't believe the simplification, just because that is what (the politicians and the media) expect from us."(RS 12.11.2009)

There are examples in the Baltic Sea eutrophication case where simplifications and generalizations may be perceived as generally accepted facts and end up as a baseline for certain policies. Examples from our data include the reference point to good ecological status of the Baltic Sea, which is quite arbitrarily defined but anyway taken as a main goal for nutrient reduction and other protective measures (RU 23.10.2009). Another example of this kind of a simplification is the idea that 20 percent of the farms are responsible for 80 percent of the nutrient load from agriculture in Finland, particularly favored among those politicians who call for more stringent nutrient reduction requirements for agriculture.

”I've used this particular (80/20) simplification myself (…) I only meant to make the point that not all fields and farms are equally polluting. But the ratio is not based on anything, it's an urban legend.”(RS 20.10.2009)

Linkages of knowledge production, processing and communication to particular characteristics of individual researchers and research societies

As the preceding two sections demonstrate, it is first and foremost the linkages of knowledge production, processing and communication to particular characteristics of individual researchers and research societies that define what kind of research the particular researcher is able to conduct. In our study it appeared that, for instance, not all scientists are able to access all national databases. This sets restrictions to the kind of knowledge individual researcher can possess.

"…we have to believe what is told to us because we don't have the rights to access the *Vahti*-database[6]. In one joint project I was able to take a look at the database and found out new things. If this was public knowledge the situation would be very different…" (RU 5.11.2009)

Moreover, these linkages seem to depend predominantly on personal contacts and networks between researchers and policy-makers. It appears that only certain scientists and experts are in fact consulted and heard in policy making. This holds particularly true if we compare researchers representing universities to those representing sectoral research institutes.

”Researchers at sectoral research institutes are better informed than us in the academia and they are actually consulted. Ministries do not listen to us. We are heard only if we shout loud enough…. but another difference is that we have the freedom to shout whereas researchers at the sectoral research institutes cannot say what they think.” (RU 5.11.2009)

But the personality of the researcher also matter, even at the sectoral institutes, as the following excerpt illustrates:

“For some reason, I rarely deal with ministries, whereas some of my colleagues meet them weekly. (…) The history of the person, as well as his or her ability to present clear opinions matters. They (ministries) want someone who highlights what is known, rather than someone like me who highlights uncertainties.“ (RS 20.10.2009)

Obviously, the attitude of researchers towards their role in communicating research results to wider audiences is also crucial. One interviewee noted that when researchers popularize their work to the wider public, colleagues might think that they promote themselves rather than their work and consider them as less credible researchers (RU 23.10.2009).

As a result of these intricate linkages, only certain interpretations of certain researchers are heard in policy-making. Listening to only certain scientist can potentially be misleading, since scientists are not experts on everything.

“During an interview they don’t ask whether you really know something about the subject or whether you simply are presenting your thoughts based on your research background and general knowledge”. (RS 26.11.2009)

Perspectives of coping with science—policy interface(s)

In this paper we have identified various aspects of knowledge that intricate science—policy interface and described the ways in which the aspects manifest in eutrophication governance in Finland. Our illustration demonstrates that in this case, and by extrapolation also in any other case of environmental risk governance, ideas of science are constructed by human endeavor and thus fundamentally human achievements (cf. Jasanoff 2004). Moreover, our study indicates that while scientific knowledge is in many ways susceptible to uncertainty and human interpretation, it is also politics-bound even without direct involvement to politics and policy-making.

Accordingly, we believe that many uncertainties and complexities related to the Baltic Sea risk governance are rooted in the aspects of knowledge that we have explicated. On the basis of our analysis we want to, therefore, open up perspectives related to (1) the integration of science and policy, (2) wider understanding of the concept of knowledge, and (3) the development of research agendas concerning Baltic Sea risk governance.

First, in terms of integrating science and policy to abate uncertainty and complexity in Baltic Sea risk governance, the recognition of multiple faces of scientific knowledge production and communication challenges assumptions of universal science and expert rationality. The linkages between science and policy are far more intricate than research programmes and noble declarations of the policy relevance of science often tend to presume. This idea offers a rationale for serious deliberation concerning the objectivity and neutrality of science, and making various linkages between science and politics/society consciously more transparent. This involves the revelation of all sorts of liabilities and, more importantly, opening up diverse practices of knowledge—policy interaction to enable extensive and equal participation of researchers, regardless of institutional position, in governance efforts to manage uncertainty.

Second, if taken as a starting point the fact that (even) scientific knowledge is multidimensional and society bound, thus unable to offer absolute truths and solutions, the position of so called “laypersons” and their expertise—the experience and knowledge of those stakeholders that are involved, for example farmers or those who suffer from eutrophicated waters most—becomes more significant for Baltic Sea risk governance. Research concerning environmental governance has already for long acknowledged the role and potential of local knowledge for policy making (see e.g. Davis 1996), whether the knowledge is scientific or any other kind. The good ideal of integrating local knowledge has, however, proven difficult to be put to use. We suggest that making of various linkages between science and society consciously more transparent and clear would facilitate public participation in Baltic Sea risk governance by helping to break up the culturally powerful position of scientific knowledge that often obscures what would be valuable in lay knowledge and expertise (cf. Pellizzoni 1999).

Finally, consciousness about the multiple faces of knowledge opens up scope for further research in the framework of the Baltic Sea studies. It challenges the biased research programmes that focus largely on the role of natural science for governing environmental risks. Namely, taking the ideas about social embeddedness of science presupposes social scientific research to be permeably integrated in research settings, instead of adding a small separate social dimension. For instance, to deeply understand the logic of science—policy interface, it would be of crucial importance to scrutinize practices, forms and settings through which science and policy intersect in various contexts. Also the role and knowledge of "lay persons" more carefully into account in Baltic Sea governance entails social scientific research. Our analysis also shows, however, that the often repeated sentence about the profusion of scientific knowledge on the Baltic Sea environment is not the whole truth: to come to grips with uncertainty, more research on ecological processes and causal relationships is also needed in the Baltic Sea case.

To conclude with, the value and interest laden character of environmental issues, such as the eutrophication of the Baltic Sea, implies that these issues cannot be captured by any unambiguous scientific set of facts. Even in issues of unanimous scientific understanding, scientific interpretations are usually challenged by other, competing views on the issue. Therefore, scientific knowledge is inevitably only one component in policy making and risk governance. More importantly, and what we have tried to illustrate in this paper, these forces also affect the construction of scientific knowledge itself, whether the scientific community wants it or not.

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Notes

[1] This paper is part of the PROBALT project, funded by the BONUS Baltic Organisations Network for Funding Science EEIG. At this stage of our project, we concentrate on understanding scientists' perspective. In latter stages of the project the scope of study will be broadened to perceptions of other actors of eutrophication governance in Finland. For practical reasons, our focus is on Finland.

[2] A couple of our interviewees currently working for SYKE used to work at the FMI. Despite critical voices that before the reform doubted that the reform would radically worsen the state of the marine research in Finland, our interviewees seemed to have adjusted by now.

[3] Any given year the magnitude of phosphorus release can be several times larger than the external load, but in the long-term the net release is smaller (HELCOM 2009).

[4] Håkanson and Bryhn (2008) argue that nutrient reductions should concentrate on phosphorus, because i) of the implications of uncertainties related to nitrogen cycle to the outcome and cost-effectiveness of nitrogen abatement, ii) the possibility that lower nitrogen concentrations may increase the risk of cyanobacterial blooms, iii) laboratory experiments provide scant information for management decisions for real aquatic systems, and iv) in long-term, phosphorus is limiting primary production.

[5] Inspired by the "The Economics of Climate Change - The Stern Review" (2007), the Swedish and Finnish Ministers of Environment jointly called for a Stern-like review of the Baltic Sea.

Following this call, a couple of Stern-related studies on the Baltic Sea were initiated in both countries.

[6] Database for control and nutrient load (Valvonta ja kuormitustietojärjestelmä *VAHTI)* is part of the environmental protection database of the Finnish environmental administration.

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Food security and safety in fisheries governance – A case study on Baltic herring

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Food security and safety in fisheries governance – A case study on Baltic herring

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ABSTRACT

One of the objectives of the EU Common Fisheries Policy (CFP) is to increase the contribution of fisheries to fish food availability and self-sufficiency. Still, the use of catch is often a secondary concern in fisheries governance and management – or not a concern at all – while the focus is on harvesting. This paper examines how the use of forage fish for human consumption can be increased within the limits of sustainability, using Baltic herring as a case study. Baltic herring contains high levels of dioxins and the human consumption is very low: the catches are mostly used for industrial purposes. The paper uses a participatory backcasting exercise to define a desirable future vision for the use of Baltic herring catch and to develop pathways of actor-specific governance actions to increase the use of the fish as a safe-to-eat food. The results reveal that increasing the contribution of forage fish, such as Baltic herring, to food security entails a paradigm shift in fisheries governance that involves 1) inclusion of well-defined objectives for catch use in the EU CFP and the related regional multiannual plans, 2) broadening the scope of the MSY-driven governance and management to one that addresses catch use, and 3) proactive catch use governance.

1. Introduction

The recently reformed EU Common Fisheries Policy (CFP) calls for increased contribution to food security while "paying full regard" to food and feed safety to decrease the dependence of the EU fish and seafood market on imported products [14]. The growing demand for fish in the EU [19] has been met mainly by importing fish from non-EU countries, including developing countries, and increasing aquaculture production [17,44,65]. These are of concern, because the former may weaken food security in the poorer regions of the world [2], and the latter has adverse effects on the marine environment [27,61]. In addition, many fisheries around the world have been exploited at intensities that have driven fish stocks far below the maximum sustainable yield (MSY) levels [3]. At the same time, small pelagic species, the largest group in capture fisheries, have been used primarily for industrial purposes [20,62], despite the repeated call by the UN to prioritize the resource for human consumption [21,24,25].

The reformed EU CFP raises food security as a new issue to address and to aim at in fisheries governance. However, it identifies aquaculture as the only strategy to increase food security, while the contribution potential of small pelagic forage fish that have been underutilised from the perspective of food security is not mentioned. Instead, the European Parliament and Council have emphasized that "all fishery products landed, including those that do not comply with common marketing standards, may be used for purposes other than direct human consumption" [15]. This indicates that currently there is no interest to govern the use of the catch at the EU level and that the trend of reducing wild captured fish into feed is likely to continue unless the issue is more explicitly addressed.

At least two explanations can be identified for the apparent limited interest in governing the use of the catch. First, fisheries governance has evolved from the need to control the use of common-pool resources in an ecologically sustainable manner [28,41,43]. The MSY principle, which aims to restore and maintain fish abundance above the levels that can produce the largest yield [14], has been the main tool to govern harvesting [18,39]. Owing to the over-riding aim of fisheries governance to maximise the harvest in an ecologically sustainable way (see e.g. UN Law of the Sea, EU CFP, UN Sustainable Development

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Goals) and the narrow definition behind the MSY principle, many other issues and objectives, such as food security, are not explicitly addressed by the fisheries governance [52]. Second, commercial fishing has been treated as business activity that is largely driven by economic objectives [56] and therefore fisheries governance has tended to rely on market-based mechanisms and self-organising fishers to maximise economic growth [6]. Although the use of the catch can be affected by governance mechanisms that are imposed on the fisheries sector, such as food safety requirements, trade policies [64], and sustainability certifications [47], catch use is ultimately determined by market conditions, i.e. demand, costs and revenue [56], which Stephenson et al. [59] have considered largely uncontrollable by fisheries governance and management.

The aim of this paper is to examine how food security and safety issues could be integrated in fisheries governance. The paper defines food security as "physical availability of food, economic and physical access to food, food utilisation, and stability of the three dimensions over time" [23]. Food safety refers to the quality of the product, namely that the fish is safe to eat [16,25]. The paper uses the governance of Baltic herring (*Clupea harengus*) fisheries as a case study to explore how the contribution of forage fish to food security could be increased. Baltic herring has been regarded as an abundant and sustainable resource [33,34], but as the majority of the catch is used for industrial purposes, the species has a great contribution potential to food security. After the collapse of the Baltic cod stock in the late 1980s, Baltic herring and sprat have been the main commercial catch species in terms of volume in the Baltic Sea [73]. However, the relative importance of Baltic herring varies between the nine Baltic Sea riparian countries: while all nine countries have a herring fishery, the largest annual herring quotas have been allocated to Finland and Sweden, circa 40% and 20% respectively [33,34].

The paper is structured as follows. First, a background of the use of Baltic herring catch and food security and safety in fisheries governance is provided. The methods section describes a participatory backcasting method that was applied to define a desirable future state for the use of Baltic herring catch and to create pathways of actor-specific governance actions towards concrete acknowledgement of food security and safety in fisheries governance [54]. This is followed by a discussion on how to increase the contribution of Baltic herring to food security within the limits of sustainability from the perspectives of the abovementioned obstacles for catch use governance, namely the aquaculture-driven food security policy, the MSY-driven fisheries governance and management, and the market-driven catch use governance.

2. Background

2.1. The use of the catch

Baltic herring has been a traditional source of food in many Baltic Sea countries, but over the past few decades the demand for it as food has decreased to an all-time low [26,42] and instead, the majority of the catch has been fed to fur animals or reduced to fishmeal and oil [33,38]. In Finland, for example, around two thirds of the catch have been used to feed fur animals since the 1980s [57,58]. One plausible explanation for the decreased demand for Baltic herring as food is related to the simultaneously increased demand for and supply of farmed salmon and rainbow trout, and canned tuna [26,40,42]. In addition, Baltic herring is consumed mainly by elderly people [26,40], which implies that in the future the demand is likely to decrease further unless the demand for herring products amongst younger people begins to increase. The use of the catch is also affected by the conventional and largely-accepted focus of the Baltic herring fleets on targeting herring primarily for industrial purposes [38]. This decreases the availability of Baltic herring suitable for human consumption.

From the food safety perspective, the potential to use Baltic herring for human consumption is restricted due to high concentration levels of dioxins, which often exceed the maximum allowable level established by the European Commission for food and feed [10]. Dioxins are persistent organic pollutants (POPs) that accumulate in the fatty tissue of herring and are known to have adverse impacts on ecosystems and human health [1,30]. The dioxin concentrations have been decreasing from their peak in the 1970s, but the problem still remains in many parts of the sea [71]. Currently, herring from the southern and western parts of the Baltic Sea is considered to be compliant with the regulation, while large herring[1] from the northern and eastern parts, is likely to exceed the maximum allowable dioxin level [9].

As a result of the dioxin regulation [10], the EU Member States are not allowed to place fish that exceeds the maximum allowable level of dioxins on the EU food market. However, Finland, Sweden, and most recently Latvia, have been granted an exemption to place such fish on their national markets, providing that they inform consumers of the related health risks [13]. The main arguments behind the exemption request in Finland and Sweden include cultural importance of Baltic herring, health benefits related to fish consumption and the need to protect fishermen's livelihoods [1]. The exemption is particularly crucial from the Finnish perspective, because the nation's most important commercial fishery operates mainly in the Gulf of Bothnia [46], where the dioxin concentrations are the highest, but also since the traditional Finnish herring dishes are made exclusively of large herring.

The other Baltic Sea countries, which could also apply for the exemption, but have chosen not to, have implemented alternative strategies. For example, in Estonia, where the majority of the catch is used for direct human consumption, the strategy is to target small, safe-to-eat Baltic herring to gain access to the EU market [7]. Whereas in Denmark, the majority of the Baltic herring catch is used for industrial purposes [8]. Russia, the only non-EU member state in the Baltic Sea region and therefore the only country unaffected by the dioxin regulation, has been a significant buyer of Baltic herring intended for direct human consumption. In mid-2014, the exports to Russia came to halt as a result of the sanctions between the EU and Russia related to the crisis in Ukraine. This share of the catch has been since used mainly for industrial purposes [46]. The fish fed to fur animals is not limited by the regulation, but the feed used in aquaculture is. However, over the past decade the removal of dioxins from the fishmeal and oil during the production process has become cost-efficient, and therefore, the use of Baltic herring as feed in aquaculture has been increasing [58].

2.2. Food security and safety in fisheries governance

Baltic herring fisheries are governed in a multi-level setting. Within the formal governance system, decisions on fisheries management and regulations are made at the EU level and their implementation is carried out at the national level. In addition, there are two regional bodies: the Baltic Sea Fisheries Forum (BALTFISH), which is a platform for cooperation between the EU Member States in the Baltic Sea region on fisheries management, and the Baltic Sea Advisory Council (BSAC), which is a stakeholder forum.

The management of Baltic herring fisheries is realised via the EU CFP and the related multiannual plan for the stocks of Baltic cod, herring and sprat [13]. These policies do not address the use of the herring catch explicitly. This has not always been the case: between 1977 and 1998, the direct fishing and landing of herring for purposes other than human consumption was prohibited in the EU on the basis of overexploitation and declining herring stocks [11,12]. Thus, if there is political will, the EU enforcement power could be harnessed also to enhance the contribution of Baltic herring to food security.

In the absence of formal top-down arrangements, bottom-up initiatives have emerged to enhance the use of fish as food in a sustainable way. The Marine Stewardship Council (MSC) is an international

[1] For ICES subdivision 28.1 the limit for large herring is 21 cm, for other subdivisions it is 17 cm.

non-profit organisation, which works together with fisheries, scientists, and seafood producers and brands to certify sustainable fisheries. In the Baltic Sea, the Western Baltic spring spawning herring fishery has been certified to the MSC standard in 2015, while the Finnish herring fishery was entered into the assessment in early 2017. Similar certification, provided by the Aquaculture Stewardship Council (ASC), is available for farmed fish, such as Rainbow Trout, and it entails that the fish used as feed is MSC certified. Other examples include: the John Nurminen Foundation's Local fish project, which combines nutrient recycling and increased fish food availability and self-sufficiency by bringing domestic cyprinid fish to plates; the WWF sustainable fish guides, which help consumers to make responsible choices when purchasing seafood products; and the work of the Finnish Pro Fish Association, which aims to increase public awareness of domestic fish products.

3. Material and methods

A participatory backcasting method [48,54,55] was used to develop concrete suggestions to increase the use of Baltic herring as food. The backcasting exercise was arranged as part of a two-day expert workshop on the dioxin problem of Baltic herring organised in Copenhagen, Denmark, in February 2016. Eleven fisheries and dioxin experts, representing fishermen, producer organisations (both food and feed), researchers, administration, and non-governmental organizations,[2] were engaged to produce recommendations and paths to achieve a desirable future point [36,49,54,55].

Backcasting is a normative scenario method that can be useful to study transformations to a more sustainable world [55,69]. The rationale behind the method is to work backwards from a desirable future state to the present, in order to identify actions needed to reach the desired state, and to assess its feasibility and implications [53,54]. Backcasting scenarios can be policy-relevant when they connect long-term objectives to short-term decisions and actions [32]. Thus, they can facilitate achieving policy objectives by determining concrete stakeholder-specific actions and steps for that. Stakeholders and scientists are often engaged in the backcasting exercise to co-produce the normative scenarios and recommendations [5,55,72]. Therefore, a heterogeneous group of experts was invited to the workshop [31,63] to identify 1) governance actions to increase the use of Baltic herring for food, and 2) actors capable of executing the actions by moving beyond current state and "business-as-usual" trajectories [70]. The focus of both the workshop and its analysis was on "who should do what" rather than "who said what", in order to identify a diverse set of actions and actors to address the question, also beyond the stakeholder groups involved in the workshop.

The backcasting exercise comprised three main steps. First, the experts were asked to define future visions for the use of the Baltic herring catch and the dioxin problem of herring. The suggestions were deliberated, and it was agreed that the main vision to be used in the exercise was to increase the use of Baltic herring for human consumption significantly by 2040. This particular end-point was considered suitable for this purpose as it was close enough to the present time for the issue to remain relevant, and far enough to allow changes to take place. The research team further divided the vision into three more specific subtargets for the backcasting exercise based on the suggestions and deliberations: 1) 35% of the total Baltic herring catch is used for human food in Baltic Sea countries, 2) 40% of the total Baltic herring catch is exported and consumed as human food, and 3) dioxin level in Baltic herring used for human food decreases to a safe level. Second, the experts were divided into three parallel working groups to develop paths and milestones to reach each target, respectively. This was followed by the third step, which was to identify stakeholder-specific governance actions that are needed to reach the milestones and the ultimate target. The discussions were supported and structured by backcasting tables into which the actions, and the actors needed to support their execution, were recorded. The discussions were also tape-recorded and transcribed after the workshop to ensure that material not included in the tables was also part of the analysis.

For the purpose of this paper, the collected material was analysed from the perspectives of 1) ensuring that the dioxin problem is under control (food safety), 2) increasing the use of Baltic herring for human consumption (food security), and 3) division of responsibilities between actors. In order to enhance the credibility of the results, the empirical material was triangulated [63] with secondary material, including empirical material from the other sessions of the workshop,[3] literature, policy documents and statistical databases. The results are presented in the next section.

4. Results

4.1. Pathways to get the dioxin problem under control

> "Dioxin is a killing factor. (…) Dioxin is the bottleneck for further development of markets." Representative of a fishermen's organisation, Sweden

The experts considered getting the dioxin problem under control as a prerequisite for increasing the contribution of Baltic herring for the food security objective. Although exports outside the EU are not restricted by the dioxin regulation, exporting fish that does not meet the EU's own safety criteria was considered an unsustainable and unethical strategy in the long-term as awareness and social responsibility grow. Therefore, a set of pathways relating to how to get the dioxin problem under control were created. These are presented in Fig. 1 and the key actions include: 1) using small, safe-to-eat herring for human consumption, 2) developing fisheries management strategies to decrease the dioxin levels in Baltic herring, 3) dealing with dioxin sources, 4) changing dioxin risk management and 5) reducing the overall dioxin exposure by reducing the dioxin risk of other foods. These are complementary to each other and provide a way to deal with the dioxin problem at different timeframes ranging from immediate to long-term (2040).

In the short term, the key action identified by the experts to get the dioxin problem under control was to sort the catch and use small, safe-to-eat Baltic herring for direct human consumption. It was stressed that this action could increase the contribution of Baltic herring to food security significantly, owing to the large abundance of small under 17 cm herring in the catch (see e.g. [7,51]). To increase this share further, it was suggested that fisheries could employ size-selective fishing to target explicitly smaller fish by using certain mesh sizes and fishing closer to the sea surface (see also e.g. [51]). However, employment of size-selective fishing on a larger scale was noted to require further development of methods and practices.

> "This is what we do in Estonia, we sort out 10% and the rest complies with the regulation. This means that 90% we can use for human consumption. (…) This is one of the most efficient ways to do it (to increase the supply of compliant herring on the market)." Representative of food safety authority, Estonia

Increasing the use of large, non-compliant Baltic herring as food was also seen as possible within safe limits. The rationale for this was twofold. First, it was noted that the Finnish and Swedish dioxin risk

[2] The experts were from Finland, Sweden, Denmark and Estonia, because the workshop was carried out as part of the BONUS GOHERR research project, which focused on these four case study countries.

[3] In addition to the backcasting exercise, roundtable discussions were organised on four main topics: 1) the implications of dioxins to herring fishing sector, 2) global prospects for Baltic herring fishery, 3) dioxins as a public health problem, and 4) consumers' fish-eating habits.

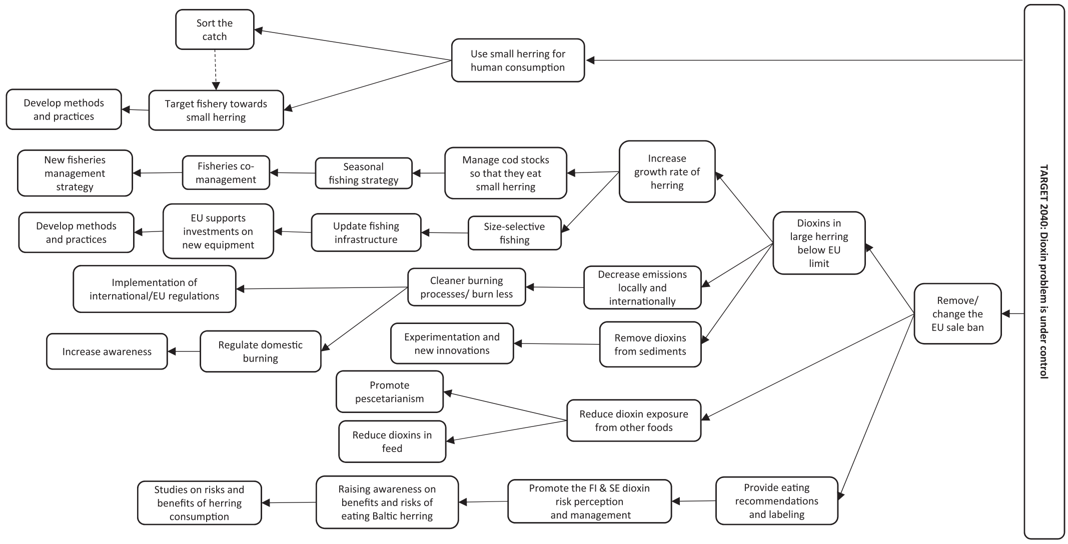

Fig. 1. Pathways developed by the experts to get the dioxin problem under control by 2040.

perception and management, which allows the consumption of large Baltic herring based on public dietary recommendations, could also be adopted by the other EU countries [25,67]. This was considered plausible, since the risks relating to dioxin exposure are subject to great uncertainties and the maximum levels for dioxins in Baltic fish are ultimately set through political decision-making processes, which as Assmuth and Jalonen [1] have pointed out involve "value judgement, conventions and pragmatism". Such change in dioxin risk management could open access for all Baltic herring products to the EU market and therefore lead to increased consumption. Second, it was argued that in Finland and Sweden, where the exemption is applied, and people consume mainly large Baltic herring, the consumption in general is so far below the recommended maximum intake that it could be increased manifold within safe limits. According to Tommila et al. [66], such an increase could replace circa 10% of the imported fish in Finland.

> "There should be information (in stores and restaurants) about the advice and if people see that once a week is ok for large part of the population, then I would believe that they'd eat more. So there is already potential to increase the consumption now within the current dioxin problem." Representative of food safety authority, Sweden

In the long term, the key actions identified by the experts were to change and ultimately remove the EU sale restriction. Three sets of pathways relating to this were created. First, it was stressed that the dioxin sources need to be addressed in order to decrease the dioxin levels in Baltic herring to a safe level. Reducing long-distance and local emissions was considered the most important action but exploring the feasibility of removing dioxins from the Baltic Sea sediments was also suggested (see also [71]).

Second, the experts suggested that the Baltic Sea fish stocks could be managed in a way that reduces dioxin levels in Baltic herring. The rationale behind this was that the faster the herring grows the less the dioxins accumulate (see also [45]). Thus, the growth rate of herring could be increased by removing small herring extensively and thereby allowing the juveniles to grow faster (ibid. [46]). It was suggested that this could be done by 1) managing Baltic cod fishery to increase predation on small herring, or 2) size-selective fishing. The former was noted to entail stricter regulation on the Baltic cod fishery in order to allow the stocks to grow, but this was expected to be an unpopular action due to the implications to the cod fishery. The latter option was therefore considered more suitable as it is a more technical issue and regards the Baltic herring fisheries alone, although the technical feasibility of the action was contested (see also [74]).

Third, it was suggested that the dioxin risk related to Baltic herring could be reduced by reducing the human exposure to dioxins caused by other food stuffs. The experts pointed out that this could be done either by promoting low-meat and low-dairy diets or by reducing dioxins in animal feed.

> "Intake of dioxins of a vegetarian, let's say lacto-ovo-vegetarian, is much, much, lower than regular consumer's. If you eat fruits and vegetables you decrease consumption of animal products and that will have a good effect on dioxin intake. Everyone should be vegetarian and dioxin would then not be a problem." Representative of food safety authority, Sweden

4.2. Pathways to increase the use of Baltic herring as food

The pathways to increase the contribution of Baltic herring to food security are presented in Fig. 2. They include actions to increase the use of Baltic herring as food and fish feed, and also actions to establish the production of fishmeal and oil for direct human consumption. Regarding the first one, the pathways culminate in accessing the fish food markets, which was not considered to be affected only by the dioxin problem, but also by limited supply of Baltic herring suitable for human consumption and low demand in the Baltic Sea region.

Increasing the supply was believed to necessitate structural changes within the fishing industry. More precisely, the experts called for a shift from feed to food-directed fishing, which was acknowledged to require investments in on-board freezing equipment in large vessels or increased use of small vessels that land their catches locally and regularly, thereby guaranteeing a continuous supply of Baltic herring suitable for human consumption.

> "Because the Finnish vessels fish where they do, there's no point for the big vessels to go out for one day and come in and freeze for human consumption. They stay out for a week. This means that the first, second and third trawl are for fishmeal and the last trawl for

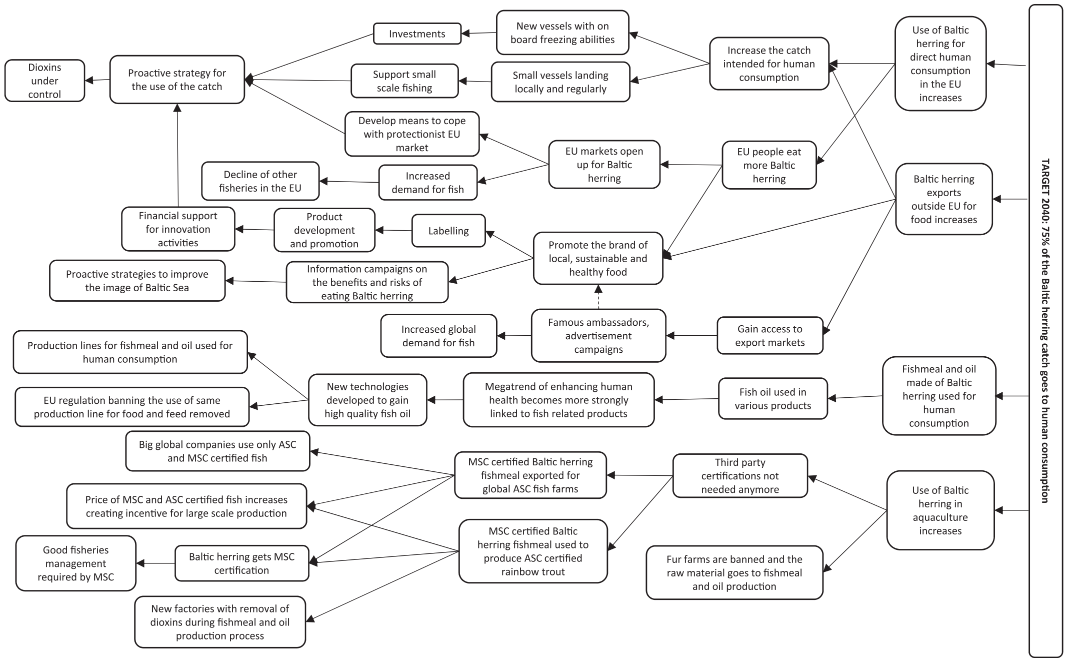

Fig. 2. Pathways developed by the experts to increase the contribution of Baltic herring to food security by 2040.

human consumption.” Representative of a fishermen's organisation, Estonia

“Then we have a problem with the structure of the industry. They (vessels) tend to be very large ones and landing bulks in Skagen (Western Danish coast). We need small vessels landing locally and regularly.” Representative of a fishermen's organisation, Sweden

Implementation of such structural changes, although necessary to meet the target, was considered risky as long as the market for Baltic herring food products is underdeveloped and there are uncertainties relating to the demand. However, the experts were optimistic that the demand could be increased through the following actions: 1) investing in the development and promotion of new and traditional products made of both small and large Baltic herring, 2) using certifications and other labelling as marketing tools to brand and promote local, sustainable and healthy Baltic herring products, and 3) creating strategies and information campaigns to improve the image of Baltic herring as well as the Baltic Sea, which was noted to suffer from a poor image as a sea with many environmental problems.

In addition, creating and developing markets for Baltic herring in and outside the EU were called for. The European fish market was viewed as very competitive and protective of the existing market shares, and therefore carefully planned strategy was suggested to open the market for Baltic herring. The fish markets outside the EU were noted to provide a huge potential for increasing the use of Baltic herring as food due to increased demand for fish and the current poor state of many wild captured fish stocks. For example, the Estonian fisheries representative noted that the demand in China is already “so huge that we must combine from all the Baltic to satisfy”, but he continued that gaining access to large export markets, such as the Chinese market, can be a slow and bureaucratic process.

“If you want to export you have to be approved by different authorities so it takes a lot of time (to create an access on the Chinese market), two years.” Representative of a fishermen's organisation, Estonia

Owing to the dioxin problem, reducing Baltic herring to dioxin-free fishmeal and oil was considered an important way, especially in the short term, to increase the contribution of Baltic herring to food security. The identified actions to develop domestic and export markets included new factories that are able to remove dioxins from the product and the use of certifications that indicate the environmental and social responsibility of seafood production. The growth potential of fish feed made out of Baltic herring was thought to be restricted by the high and steady demand from the fur industry. In contrast, the experts stressed that there are synergies between direct human consumption and aquaculture production if the by-products from food processing (e.g. the waste that remains after filleting) are used in feed production (see also e.g. [20]).

“My vision is that the whole catch goes to human consumption and only the filleting waste goes to meal and oil industry.” Representative of a fishermen's organisation, Finland

Finally, actions to create a market for Baltic herring fishmeal and oil for human consumption were identified. These included responding to the growing demand for healthy fish products, and investing in new production lines or, alternatively, revising regulations to allow the production of fishmeal and oil for human consumption in the same production line as for feed.

“The Danish factories don’t produce fishmeal and oil for human consumption, because of the legal regulation. They are not allowed to use it. Because they are considered by-products. Completely same factories in Peru can produce for human consumption, but not in Denmark. But they are trying to change it. It should be the products, the quality of the products that decides whether it can be used or not.” Representative of fishmeal and oil industry, Denmark

Table 1
Actor-specific governance actions developed by the experts to get the dioxin problem under control and to increase the contribution of the Baltic herring fisheries to food security by 2040.

	Governance Actions	Policy	Markets	Civil society	Science
Actions to get the dioxin problem under control	**Use small herring for human consumption**	Sorting to be made mandatory.	Campaigns to promote the consumption of healthy fish.	Campaigns to promote the consumption of healthy fish.	Assessment of area-specific percentages that need sorting out.
	Manage the Baltic Sea fish stocks to decrease the dioxin levels in Baltic herring	Make herring grow faster by increasing quota for herring or reducing quota for cod.	Decision to target small herring (size-selective fishing).		Technical feasibility, and socio-economic and environmental impacts of size-selective fishing, increased fishing pressure and increased predation.
	Deal with dioxin sources to decrease input to the Baltic Sea	Political decisions and investments. Implementation of existing regulations and control. Public campaigns on raising awareness.	Development and implementation more efficient dioxin removal processes.	NGO campaigns to raise awareness, public pressure to act or not to act.	Scientific evidence on the role of different sources and how they could be reduced.
	Change dioxin risk perceptions	Adoption of Finnish and Swedish dioxin risk perceptions and management in other EU countries.	Promote new dioxin risk perception and management.		Dioxin risk and benefit analysis.
	Reduce dioxin risk by reducing dioxin exposure from other food	Policy integration to promote healthier diets and climate mitigation (more vegetables and fish, less dairy and meat).	Promotion of healthy food choices.	Campaigning based on science.	Research on health, climate and other impacts of different foods.
Actions to increase the contribution of Baltic herring fisheries to food security	**Increase the amount of herring used for human consumption in EU**	Financial support from the EU and states to develop new products and promote the brand. System guaranteeing that the products entering the market are safe to eat.	Development and marketing of new products, promotion of traditional products. Investments and innovations from market actors (mainly food industry).	Developing image of local, healthy and sustainable products. Fisheries related voluntary organisations disseminating and advertising the products. MSC certification.	Involved in developing new products. Health studies. Develop methods to reduce oxidating (aging) of the product.
	Increase the amount of herring exported outside of EU for food	Good international relations with other countries.	Creating new trendy products and active marketing.	Ecolabels and certifications important competitive advantage, promoting the image and brand of Baltic herring. Ambassadors to promote the products.	Market studies to scan opportunities. Health studies to communicate potential risks and benefits. Socio-cultural value studies to find consumption patterns.
	Certification (MSC/ASC) of herring products	Implementation of multi-species management plan, support fisheries to adopt certificates and science to assess and develop standards.	Decision to apply for and use certifications. Financial investments.	Power of consumers to choose products, open and inclusive certification processes.	Certification assessments, audits and development of standards.
	Use fishmeal and oil made of Baltic herring for human consumption	Removal of by-product restrictions. New EU rules and regulations.	Developing the market.	MSC certification.	Studies relating to quality, monitoring and health.
	Increase the use of Baltic herring in aquaculture	Good management required by the MSC certification.	Use certifications to increase use of herring in aquaculture production.		

4.3. Actor-specific governance actions

The actor-specific governance actions identified by the experts are summarised in Table 1. As demonstrated by this summary, several actors can play a meaningful role in the implementation of the identified actions needed to reach the targets. The responsibilities of the formal fisheries governance system would include revising policies (e.g. making sorting compulsory) and providing financial support to actions implemented by the other actors. However, the identified actions cannot be implemented only by the fisheries governance system. For example, actions from the health sector would be needed to revise the food safety regulations. Similarly, to deal with the dioxin sources, actions from the environmental sector, in collaboration with the polluters, would be needed.

The actions relevant for market actors, such as the fishing and food industry, would be mostly related to the investments needed for product development and marketing, although their role as lobbyists was also acknowledged. Civil society's role in implementing the identified actions would be first and foremost related to improving the image of Baltic herring and providing certifications. Science would be needed to increase understanding on the risks and benefits relating to fish consumption, and also to explore the potential socio-economic and environmental impacts of the suggested actions such as size-selective fishing.

5. Discussion

The results of the paper show that there are multiple ways to increase the use of Baltic herring as safe-to-eat food. The developed pathways comprise direct and indirect ways to contribute to food security in the EU and globally, both in the short and long-term. This implies that the use of the catch is not as uncontrollable as perhaps previously thought [59]. Based on the results, the paper identifies three main shifts needed to support the integration of food security and safety in fisheries governance: 1) from an aquaculture-driven food security policy to one that also defines targets and measures for forage fish that have been underutilised from the perspective of food security, 2) from the narrow MSY-driven fisheries management and governance to a broader perspective that addresses what happens to the catch after landing, and 3) from a market-driven approach to proactive catch use governance to increase demand and supply within the limits of sustainability.

First, the trend of reducing wild captured fish to feed is likely to continue as long as the EU CFP defines aquaculture as the only strategy to increase fisheries' contribution to food security. Such a narrow strategy ignores the well-established need for both wild captured fisheries and aquaculture to meet the growing demand for fish as a source of food [20,65]. The results of this paper support the idea that from the food security perspective there are synergies rather than trade-offs between the use of the catch as food and in aquaculture [18]. More to the point, the results demonstrate that defining shared future visions and targets for the use of the Baltic herring catch among different stakeholder groups and jointly identifying pathways towards them, can be useful for maximising the contribution of the fishery to the food security objective. In practice, the implementation of the co-produced targets and actions entails that they are mandated and formally collected to the policy system or that similar deliberations are arranged within the system. According to the Green Paper [4] related to the EU CFP reform, poorly-defined management objectives had hampered the implementation of the previous EU CFP and achieving its targets. Therefore, this paper argues that owing to the universal food security principles [14,25], objectives and measures to increase the use of forage fish as food should also be defined in the EU CFP and especially in the related regional multiannual plans.

Second, broadening the scope of fisheries governance towards a system that considers food security, and thereby also food safety aspects more explicitly, would be needed to support the implementation of a catch use related food security objective. A wider perspective on fisheries governance could also have positive implications for achieving the other fisheries management objectives. For example, the use of the catch does not affect the ecological sustainability of the stock as long as harvesting is considered to be sustainable. Instead, prior studies have found that the inclusion of ethical issues such as food security in fisheries governance can enhance ecologically sustainable harvesting [22,37]. Moreover, increasing the use of Baltic herring for human consumption can have positive impacts on employment and income as it could create more processing jobs in the fishing sector and as the fish sold for human consumption has been of higher economic value than that sold for industrial use [42]. Increasing the competition between the different uses of forage fish might also improve the profitability of fishing [62].

However, breaking the path dependency relating to feed-directed fishing might be particularly difficult, not only because of the many obstacles to increasing the use of Baltic herring as food, but also due to the recently increased opportunity to use Baltic herring as dioxin-free feed in aquaculture. The latter alone has increased the contribution of Baltic herring to food security indirectly and improved the viability of the herring fishing industry [58]. The willingness of the fishing industry to invest in structural changes and product development could also be decreased by the narrowing monetary gap between fish sold to industrial use versus food [42], and the fewer restrictions concerning feed production. In this scenario, the dioxin problem could be accepted as it is, without further efforts to manage or solve it. This tendency to remain on the current governance path is supported by previous research, which has shown that diversion from it is one key challenge in the implementation of cross-sectoral, ecosystem-based management in the Baltic Sea region [29].

Third, proactive catch use governance would be needed to increase the supply of safe-to-eat fish on the food market in a sustainable manner and to create demand for species that have been less valued as food. The presented study demonstrates that collaboration and deliberation between fisheries, public health and environmental authorities and experts on the inclusion of food security and safety issues in fisheries governance is likely to yield practical solutions for dealing with the dioxin problem of Baltic herring and increasing its use as food. This finding is somewhat contrary to a previous study that has demonstrated less successful inter-sectoral collaboration between fisheries and environmental sectors owing to conflicting rationalities [60]. One possible explanation for this difference is that regarding the use of Baltic herring catch, there appears to be a shared interest across policy sectors to increase its use as food and to facilitate this, to develop different ways to enhance its safety.

The results do not support the idea of strict top-down regulation of catch use, but instead, they suggest possible actions and decisions that could be taken by the formal governance system at the EU and national levels as well as by the fishing industry, science and the civil society to support their implementation. Fundamentally, these actions are related to increasing the supply of Baltic herring suitable for human consumption and creating demand for it. Their implementation involves financial risks and therefore, as long as the demand remains low, there might be little incentive to increase the supply. However, changes in demand have previously reflected changes in the marine ecosystem and thereby food availability [35]. This implies, given the growing demand for fish and seafood [18] that increasing the availability of safe-to-eat Baltic herring products on the fish food market could also increase the demand.

Examining the results from the perspective of multi-level governance, it was surprising that the experts did not address the potential role of the regional policy and governance level in the implementation of the identified actions. This might be because, on the one hand, food security and safety related issues have been traditionally dealt with at the EU and national levels, and on the other hand, because the role of the two institutions, the BALTFISH and BSAC, between the EU and national level governance system has been perceived as ambiguous and lacking in authority in fisheries governance [50,68]. Yet, the implementation of the EU CFP calls for nested governance systems that are able to deal with regional specificities and support collaboration between the Baltic Sea countries and policy sectors on fisheries management and to engage stakeholders in fisheries governance [29,50,60]. Indeed, collaboration between the Baltic Sea countries might also be useful from the food security perspective, for example, when dealing with the bureaucracy relating to accessing large export markets and ensuring that there is sufficient supply of safe-to-eat products. The latter is of special importance, owing to the spatial heterogeneity of the dioxin problem and varying national quotas and fishing areas. Therefore, in order to maximise the supply of safe-to-eat Baltic herring on the EU fish food market, it might be useful to consider catch use governance at the regional level. However, further work is required to explore how to reorganise the governance system to support the inclusion of food security in fisheries governance.

Some limitations regarding the feasibility of the results remain. Mainly, owing to time limitations at the workshop, the side-effects of implementing the identified actions were not discussed explicitly, although many of the related challenges and benefits were mentioned during the discussions. Therefore, for example the potential negative environmental side-effects of size-selective fishing [74] were not discussed and further studies are needed to determine the feasibility of the action. However, since the majority of the Baltic herring catch currently comprises small herring, there is already potential to increase the availability of herring suitable for human consumption by sorting the catch. Finally, increasing the use of Baltic herring as food could have implications to fur industry, but these were not discussed. From the food security perspective, using imported fish as feed to fur animals, instead of Baltic herring, might not be a sustainable and ethical solution. Thus, the integration of food security and safety aspects in fisheries governance entails holistic planning.

6. Conclusions

This paper has studied the integration of food security and safety issues in fisheries governance to increase the contribution of fisheries to the food security objective in a sustainable manner. The paper argues that owing to the increasing demand for fish as food and the universal ethical principles encouraging the prioritisation of the use of wild captured fish for human consumption, there is need for a paradigm shift in fisheries governance. This involves defining the EU CFP food security objective more explicitly also in relation to forage fish that has been underutilised as food, as well as widening the scope of fisheries governance to address the use of the catch. The shift also implies confronting the traditional, reactive approaches to fisheries catch use governance and management. Using Baltic herring as a case study, the paper has demonstrated that even a fishery with multiple problems, such as the dioxin problem, low demand, and limited supply of fish suitable for human consumption, could increase the contribution of the resource to food security, both in the short and long term. However, owing to the multi-sectoral nature of food security and safety issues, collaboration between different stakeholders, policy sectors and across different policy levels are needed to facilitate the inclusion of food security and safety issues in fisheries governance.

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Forage Fish as Food: Consumer Perceptions on Baltic Herring

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Abstract: Using fish resources for food supply in a sustainable and efficient way requires an examination of the feasibility of prioritising the use of forage species. The present paper deals with the issue from the consumer perspective. Using Baltic herring as a case study, the role of sociodemographic determinants, the drivers and barriers of Baltic herring consumption are investigated in four Baltic Sea countries, based on an internet survey. The drivers and barriers of Baltic herring consumption are compared to those relating to Baltic salmon, to identify the main differences in consumer perceptions on species that are primarily used as feed and food. The present paper concludes that prioritising forage species primarily for human consumption calls for proactive catch use governance, which (1) acknowledges the species- and country-specific intricacies of forage fish consumption, (2) improves the availability of safe-to-eat fish on the market, and (3) provides consumers with sufficient information on the species (e.g., the type of herring and its origin), the sustainability of the fisheries, and the related health risks and benefits.

Keywords: catch use governance; fisheries; sustainable food system; dioxins; internet survey

1. Introduction

Ensuring the nutrition of the growing world population in a sustainable and climate-friendly way is one of the greatest challenges in the 21st century [1,2]. Fish, a rich source of protein and beneficial fatty acids, minerals, and vitamins, is viewed as an important part of a sustainable diet and a possible substitute for livestock meat [3–5]. However, using fish resources for food supply in a sustainable and efficient way, involves their prioritisation for human consumption [6–8]. This calls for systematic catch use governance [9–11].

To date, the use of different fish species for human consumption (versus industrial uses, e.g., feed) has been largely determined by demand and supply [12,13]. As a result, some species are fully utilized, and others, especially small pelagic fish, are underutilized as food [8,14]. In the Baltic Sea region, the case study area of this paper, the consumer demand for Baltic salmon and cod is high, but the supply is limited by the poor state of the stocks [15,16]. This market niche is largely filled by imported and farmed fish [17]. In contrast, herring is one of the most abundant fish species in the Baltic Sea, but the consumer demand is low and the majority of the catch, (3650 t in 2017) is used to feed fur animals and farmed fish [16,18]. For example, only around 3% of the Finnish Baltic herring catch is used as domestic food [19].

Stakeholders across the fisheries, public health, and environmental sectors have a common interest in prioritising the use of Baltic herring for human consumption [11,20]. The producer price of Baltic herring sold for human consumption is higher than that of fish sold for feed [21]. A shift from feed- to food-directed fishing is also expected to create new jobs, e.g., by increasing the degree of processing [11,14,22]. Thus, increasing the consumption of Baltic herring would support the livelihoods dependent on the Baltic herring fishery and thereby the viability of coastal communities. From the public health perspective, the consumption of Baltic herring is beneficial, as it is a good source of omega-3 fatty acids and vitamin D, thus helping, e.g., to decrease the risk of cardiovascular diseases [23,24]. Furthermore, using local herring resources for food is a more environmentally sustainable option, compared to imported or farmed fish [25,26].

However, prioritising the use of Baltic herring for human consumption is challenging as structural and institutional barriers limit its availability for human consumption. Owing to the apparent low consumer demand, the current fisheries and public health policies and practices advocate for the reduction of the fish to fishmeal [11]. This practice contributes to food supply indirectly and is also supported by the stakeholders, who find it more acceptable than using the fish to feed fur animals [20]. Thus, due to the increased demand for Baltic herring in aquaculture, the fishers may not be willing to invest in the structural changes needed to shift from feed- to food-directed fishing without increased consumer demand [11,22]. In addition, the practice of using Baltic herring as feed in aquaculture is reinforced by a dioxin problem and the related food safety policies. Since 2001, the European Commission has restricted the use of large Baltic herring from certain parts of the sea for human consumption in the EU countries due to high dioxin levels [27,28]. The dioxins can be removed during the fishmeal production process and therefore the problem does not prevent the use of the fish in aquaculture. This implies that a proactive catch use governance is needed to increase the contribution of Baltic herring to food supply.

Recent studies have addressed the contribution potential of Baltic herring to food supply from the perspectives of the governance system, relevant stakeholder groups and key policy sectors [11,29,30]. These studies call for collaboration between the fisheries sector and the public health sector to jointly develop policies that address food security and safety issues at different governance levels. In addition, multiple governance actions to increase the use of Baltic herring for human consumption have been identified [11]. However, designing strategies and policies for the use of a fish resource also necessitates an understanding of the associated consumer perceptions, which is the premise of this study. Several studies have focused on the contribution potential of forage fisheries to food security [10,14,31–33] and on fish consumption attitudes in general [34–37]. Yet, consumer perceptions towards the consumption of healthy, abundant, and sustainably fished forage species that, like Baltic herring, are often underutilized as food, have not been explored. Although the low demand for Baltic herring is often explained by the consumers' preference towards farmed salmonids [19,23], the role of other factors, including the dioxin problem and availability of the fish, is more uncertain.

Using Baltic herring as a case study, this paper explores the consumption of forage fish from the consumer perspective and discusses the implications of the results to catch use governance. More specifically, the results of an internet-based survey, which was conducted in four Baltic Sea countries (Denmark, Estonia, Finland and Sweden) in 2016, are examined. The main research questions are: (1) how sociodemographic determinants explain Baltic herring consumption, and (2) what are the drivers (enablers) and barriers (restrictions) of Baltic herring consumption? The examined drivers and barriers included in the survey were identified based on the literature [34–39] and the authors' own research [40,41].

In this paper, drivers and barriers for the consumption of Baltic herring are compared to those relating to Baltic salmon, to examine the main differences in consumer perceptions towards underutilized and fully utilized species. A comparative analysis provides an interesting point of departure for three reasons. First, herring and salmon are among the most important fish species in the Baltic Sea: herring, in terms of catch volume [16], and salmon, as the "king of fishes" [41,42]. Second, both species are caught by the countries of this case study, albeit in different quantities: Finland and Sweden land over half of the total Baltic herring and salmon catches [15,16,18]. Third, the two species share the dioxin problem, but still, the whole Baltic salmon catch is used for human consumption.

The following section provides a short background on cultural differences in fish consumption and the management of the dioxin problem between the surveyed countries. The survey material and its analysis are described in Section 3. The results are presented in Section 4 and discussed in Section 5 from the perspectives of country-specific intricacies, drivers and barriers, and the implications of the results for catch use governance. The conclusions are provided in Section 6.

2. Baltic Herring and the Surveyed Countries

Fish consumption is a social phenomenon, which depends on its broader environment [43], and therefore fish consumption traditions vary between the countries of this case study. Denmark, Estonia, Finland, and Sweden (the surveyed countries) land together circa 70% of the total Baltic herring catch [16,18], but the use of the catch as domestic food is low [21,23,44,45] (Table 1). For example, in Finland, the per capita consumption is only 0.3 kg per year [22]. In Estonia, where fish consumption is the lowest, compared to the other countries surveyed, due to lower purchasing power, cheap species such as Baltic herring are most commonly consumed [46–48]. Despite this, the supply of food-directed Baltic herring exceeds the Estonian demand, and therefore, the majority of the herring catch is exported [45]. Fish consumption in Denmark, Finland and Sweden depends more on imported and farmed species [21,49,50], although in Denmark, the consumption of North Sea herring, their most important catch species, is also common [49]. These indicate that the domestic consumption of Baltic herring could be increased in all of the four countries in a sustainable way by using a larger share of the catch for domestic consumption.

The use of Baltic herring for human consumption could also be increased from the food safety perspective. Currently, all sizes of Baltic herring from the Western and Southern Baltic Proper are considered safe-to-eat, and only large over 21 cm herring from the Gulf of Riga and over 17 cm herring from other sea areas are suspected to exceed the maximum allowable dioxin levels [28]. The surveyed countries have adopted different strategies for dealing with dioxin regulation. In Denmark and Estonia, only safe-to-eat herring is placed on the food market. The Estonian herring fishery targets small (under 17 cm) Baltic herring [51,52], and the Danish fishery lands Baltic herring for human consumption only from a limited area [44]. In Finland and Sweden, large herring from the Bothnian Sea and the Northern Baltic Proper, where the dioxin levels are the highest, is traditionally used as food. These two countries have therefore applied for an exemption to place herring that does not meet the food safety criteria on their domestic markets. In these two countries, consumers are advised to limit the consumption of Baltic herring to a level that is considered safe [53,54], but in practice, the average consumption is far below it. In Sweden, the national health authority has found that people are not very familiar with the eating recommendations, despite the information campaigns [23]. This indicates that the dioxin problem is not the main reason restricting the consumption of Baltic herring.

Table 1. Overview of fish consumption and Baltic herring fisheries in the surveyed countries.

Features of Interest	Denmark	Estonia	Finland	Sweden
GDP per capita (2017) [48]	57,400 USD	20,200 USD	45,900 USD	52,900 USD
Consumption of fish (2016) [47]	24.7 kg/per capita/year	16.0 kg/per capita/year	19.5 kg/per capita/year	26.4 kg/per capita/year
Baltic herring catch in 2017 and percentage of the total catch [16,18]	15,000 t (4%)	41,000 t (11%)	134,000 t (37%)	65,000 t (18%)

Table 1. *Cont.*

Features of Interest	Denmark	Estonia	Finland	Sweden
Primary use of the Baltic herring catch [16,44,45]	Industrial	Food (export)	Industrial	Industrial
Most consumed species [21,46,49,50]	Salmon and North Sea herring	Herring (Baltic and North Sea) and sprat	Salmon and tuna	Salmon and cod
Strategy to deal with the dioxin problem [44,52–54]	Use only herring from areas where the maximum dioxin level is not likely to exceed that required for human consumption.	Target small (under 17 cm) herring, which is unlikely to exceed the maximum allowable dioxin level for human consumption.	Exemption. Advice: children and persons at the fertile age to limit Baltic herring and salmon consumption to one to two times per month.	Exemption. Advice: children and women at the childbearing age to limit consumption to two to three times per year and other consumers to ones a week.

3. Material and Methods

The data used were from an internet-based survey [55,56] that was conducted at the end of 2016. The survey focused on consumers' eating habits relating to Baltic herring and salmon in the four Baltic Sea countries: Denmark, Estonia, Finland and Sweden. The questionnaire (Supplementary Materials S1) was designed, and the results were analysed by the authors, but the survey was administered by a professional market research company, called Taloustutkimus Oy, which established an internet panel in 1997. The survey company recruited over 500 consumers from each country (total 2117) to respond to the survey questionnaire, which is above the required sample size for generalising the results for each surveyed country (with a 95% confidence level and 5% margin of error) [56]. The survey targeted the adult population, i.e., 18 years or older.

The survey questionnaire comprised 32 questions, including sociodemographic questions and questions relating to fish consumption, in general, and to Baltic herring and salmon in particular. The questionnaire was translated into the national language of the countries surveyed (Finnish, Swedish, Estonian and Danish). The country and gender of the respondents were provided directly by the internet panel and were not included in the questionnaire.

Only those respondents who reported their general fish consumption were asked follow-up questions about their Baltic herring and salmon consumption and were included in the analysis presented in this paper. As the survey focused specifically on the consumption of herring and salmon originating from the Baltic Sea, a distinction had to be made in the questionnaire between Baltic herring and herring originating from elsewhere, e.g., the North Sea or North Atlantic, as well as between the salmonids (Baltic and Norwegian salmon, farmed salmon, and rainbow trout). Regarding herring consumption, the respondents that reported eating one type of herring were asked explicitly whether they consume Baltic herring. Concerning Baltic salmon, the respondents were asked to indicate which salmonids they consumed from a list. In addition to the analysis presented in this paper, the survey was conducted for the purpose of a risk–benefit analysis [57], and therefore only part of the survey results is included in the present paper.

The data analysis was conducted using the R-program (version 3.5.1, http://cran.r-project.org). As the survey was conducted using an internet panel, rather than a random sample from the general population, the respondents were not fully representative of the actual population distributions of the countries (Table 2). Therefore, the respondents were weighted based on the actual ages, genders, and region distributions of each country to produce representative population results. For the purpose of the analysis, the respondents were divided into two age groups: below and above 45 years. This division was determined in reference to the Finnish and Swedish national health authorities' recommendations for risk groups relating to the limitation of Baltic herring consumption, which are, in their strictest form, targeted at children and women at the fertile age. As for purchasing power, qualitative categories were used instead of quantitative ones to facilitate a comparison of the countries.

Table 2. Statistics of the survey population in each country (DK = Denmark, EE = Estonia, FI = Finland, SE = Sweden).

Sociodemographic Categories	Country			
	DK	EE	FI	SE
Number of respondents	506	505	597	503
Females (%)	49	54	45	48
>45 years (%)	69	45	71	61
Purchasing power: Very low (%)	5	2	7	3
Low (%)	16	19	15	13
Sufficient (%)	35	44	43	35
Good (%)	26	27	25	29
Very good (%)	13	7	8	15
Excellent (%)	5	2	2	4
Education: Primary education (%)	14	3	7	9
Secondary education (%)	30	43	44	49
Lower-level college (%)	32	22	27	18
Higher-level college (%)	24	32	22	24

The analysis comprised four main parts. First, descriptive statistics, namely, frequency analysis and cross-tabulation, were used to determine the share of the fish consumers that consume Baltic herring. The data for the analysis was drawn from three questions (Q) relating to whether the respondents eat, at least sometimes, (a) fish (Q7), (b) some type of herring (Q20), and (c) Baltic herring (Q21).

Second, logistic regression analysis was conducted to examine whether Baltic herring consumption can be predicted based on certain sociodemographic features (age, gender, country, education and purchasing power, Q2–Q4). The analysis compared the sociodemographic features of those who reported Baltic herring consumption (Q21) with the rest of the respondents. A regression analysis was conducted for the whole sample to determine the differences between the surveyed countries, specifically to determine the impact of the other sociodemographic factors in each country.

Third, the drivers and barriers of Baltic herring consumption were explored by asking the respondents to select up to three most important reasons for eating (Q27) or not eating (Q28) Baltic herring. The reasons related to taste, affordability, healthiness (vs risks), habit, cooking, traditions, environmental friendliness, and the way in which the fish were caught. Descriptive statistics were used to analyse the data. However, only those who reported that they eat some type of herring, but not Baltic herring (Q21), were directed to respond to the question on the reasons for not eating (Q28). Thus, the results do not include the perceptions of those who do not eat any type of herring. The rationale behind this was that unravelling the factors constraining specifically Baltic herring consumption, including, for example, the dioxin problem, requires that the analysis focuses exclusively on Baltic herring. This resulted in a low number of responses among the Danes and Estonians, and therefore, these two countries were omitted from this analysis. In addition, a logistic regression analysis was conducted to explore whether people from some of the surveyed countries were more likely to eat Baltic herring because of one of the four most common reasons ("it tastes good", "it is healthy", "it is inexpensive, or it is easy to cook"). Other reasons were not considered, because the responses were too few.

Fourth, factors affecting Baltic herring and salmon consumption were compared by analysing responses relating to whether the respondents eat salmonids (Q10), and specifically Baltic salmon (Q11), and the three most important reasons for eating or not eating Baltic salmon (Q17–Q18). Descriptive statistics were used to analyse the data. The results were compared to those relating to herring. In addition, a comparative analysis on how changes in certain determinants would influence the consumption of (a) Baltic herring (Q29) and (b) Baltic salmon (Q19) was conducted. The respondents to this question comprised those who reported that they eat Baltic herring and salmon, respectively. The reasons related to changes in price, availability, the state of the stocks, the chemicals in the fish, authorities' recommendations, the availability of ready meals, cooking suggestions, and information on the products. Seven ordered response levels were used in the questionnaire, but for the analysis, the three levels on both sides of the neutral response were combined to simply indicate either an increase or decrease. The responses from the four countries were combined to focus the analysis on the comparison between the two species.

4. Results

4.1. Baltic Herring Consumption in the Surveyed Countries

The majority of the population in all of the four countries consumed fish in general (Denmark 91%, Estonia 96%, Finland 90%, and Sweden 93%). The share of fish consumers in the surveyed countries who ate Baltic herring at least sometimes are shown in Figure 1. The share of the population that ate Baltic herring at least sometimes was the largest in Estonia (62%) and Finland (54%), and the smallest in Sweden (42%) and Denmark (25%). However, 45% of the Danish and 24% of the Estonian fish consumers did not know the origin of the herring they eat. In Sweden and Finland, the ignorance relating to where the herring that they eat comes from was the lowest: 17% and 13%, respectively. The fractions of fish consumers that eat some type of herring, but not Baltic herring, was the largest in Sweden (16%) and the smallest in Estonia (1%).

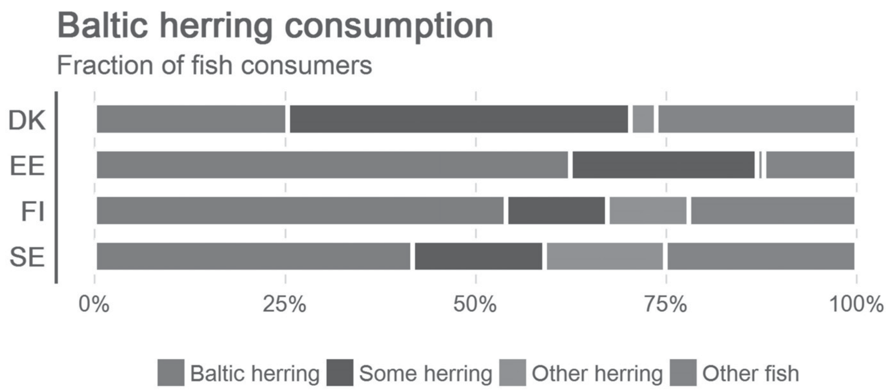

Figure 1. Baltic herring consumption among fish consumers in the four countries of the case study. Baltic herring: people who eat Baltic herring; Some herring: people who do not know the type of herring they eat; Other herring: people who eat another type of herring, but not Baltic herring; Other fish: people who eat fish, but not herring. This figure does not include those who do not eat any fish.

4.2. Sociodemographic Features of People Who Consume Baltic Herring

Compared to the Finns, the Estonians were statistically more likely, and the Swedes and the Danes less likely to eat Baltic herring ($p < 0.001$) (Table 3). In Denmark and Finland, consumers over 45 years of age were more likely to consume Baltic herring than consumers under 45 years of age. Consumers in the older age group were 1.86 times more likely to eat Baltic herring in Denmark ($p < 0.05$) and 2.46 times more likely in Finland ($p < 0.01$) than the younger age group. Education also predicted Baltic herring consumption in both of these countries. The probability of Baltic herring consumption increased by 1.50 times in Denmark and 1.54 times in Finland ($p < 0.05$) at each education level. Thus, the higher the education level, the more likely the consumers were to eat Baltic herring. Purchasing power predicted Baltic herring consumption only in Finland, where the probability of Baltic herring consumption increased by 1.33 times at each level of purchasing power ($p < 0.05$). In

Estonia and Sweden, the impacts of the studied determinants on Baltic herring consumption were not statistically significant.

Table 3. Determinants of Baltic herring consumption in the surveyed countries. Country-specific logistic regression analysis by age, gender, education and purchasing power; odds ratios (95% confidence intervals).

Country	Ages > 45	Male	Education	Purchasing Power
Denmark 0.28 (0.22–0.37) ***	1.86 (1.01–3.49) *	1.73 (0.94–3.27)	1.50 (1.09–2.08) *	1.05 (0.81–1.38)
Estonia 2.04 (1.58–2.64) ***	1.61 (0.53–5.89)	1.02 (0.39–2.66)	1.58 (0.91–2.92)	1.16 (0.69–2.02)
Finland (1)	2.46 (1.41–4.41) **	1.25 (0.72–2.18)	1.54 (1.08–2.24) *	1.33 (1.02–1.76) *
Sweden 0.64 (0.49–0.82) ***	1.75 (0.87–3.55)	1.26 (0.64–2.54)	1.35 (0.92–2.06)	1.35 (0.97–1.89)

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Education and purchasing power were assumed to be linear.

4.3. Key Factors Affecting Baltic Herring Consumption

The most common reason to eat Baltic herring in all four countries was that it was considered to taste good (27%–34%) (Figure 2). In addition, it was perceived healthy (Denmark (24%), Finland (17%), Sweden (13%), Estonia (9%)) and inexpensive (Estonia (14%), Sweden (13%), Finland (12%), Denmark (3%)). The least common reasons in all four countries related to catching the fish oneself (0–2%) and the environmental/climate friendliness of the choice of Baltic herring consumption (0–3%).

Figure 2. Percentages of reasons for eating Baltic herring.

Compared to the Finns, the reason people from the other countries consume Baltic herring was more likely to be that it was considered to taste good ($p < 0.01$– $p < 0.05$). Moreover, the Danes were more likely ($p < 0.01$), and the Swedes ($p < 0.05$) and the Estonians ($p < 0.001$) were less likely, to eat Baltic herring than the Finns, because of the perceived healthiness. Finally, the Finns were more likely to consume Baltic herring than the Danes, because they consider it inexpensive ($p < 0.001$). There was no statistically significant difference between the countries relating to eating Baltic herring because it is easy to cook.

The top three reasons among those who eat some herring, but not Baltic herring, in Sweden were that the consumers did not like the taste (32%), were not used to eating it (17%), and were worried about the possible health risks caused by the harmful chemicals in it (16%) (Figure 3). The most common reasons in Finland were that the consumers were not used to eating it (19%), did not like the taste (17%), or because it was not easily available (16%). Only 8% of the Swedes and 3% of the Finns chose not to eat Baltic herring, because they were worried about the sustainability of the stocks.

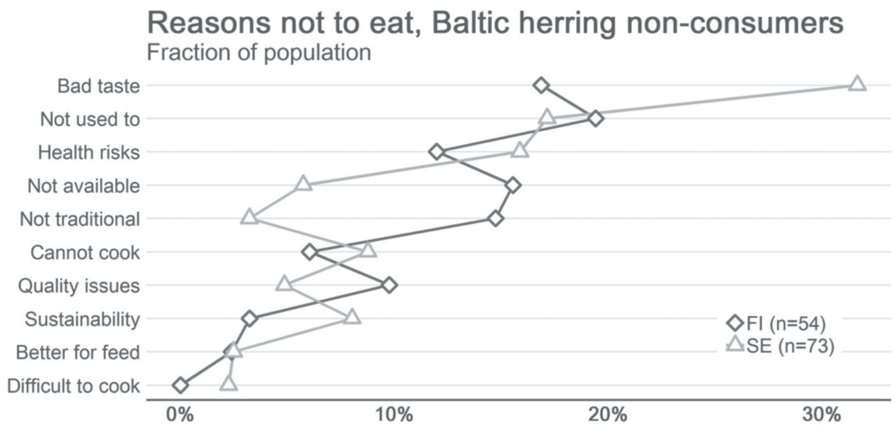

Figure 3. Reasons for not eating Baltic herring. Denmark and Estonia were omitted, because they had less than 20 observations.

4.4. Comparing Baltic Herring and Salmon Consumption

Compared to herring, salmonids were more commonly consumed in the four countries of this case study. Over 90% of the population, in these countries, consumed salmon or trout at least sometimes. Compared to Baltic herring, Baltic salmon was less commonly consumed: about 10%–16% of population in the surveyed countries consumed Baltic salmon sometimes. Similarly to Baltic herring, many consumers (over 30% of the Danes to 10% of the Finns) reported not knowing what salmon species they consumed.

The most common reasons for eating Baltic salmon were the same as for Baltic herring, namely that it was considered to taste good (over 30% of the Baltic salmon-consuming population in all of the four countries) and to be a healthy choice (from 18% in Sweden to 30% in Denmark) (Figure 4). The main differences between the consumer perceptions on the consumption of the species were that in contrast to Baltic herring, inexpensiveness and disliking the taste were uncommon reasons for eating Baltic salmon, whereas expensiveness (20%–31%) was an important reason for not eating Baltic salmon (Figure 5). Poor availability was a more common reason for not eating Baltic salmon (23%–36%) than Baltic herring. However, the possible health risks caused by the harmful chemicals in the fish was reported as an important reason for not eating either species, especially in Sweden.

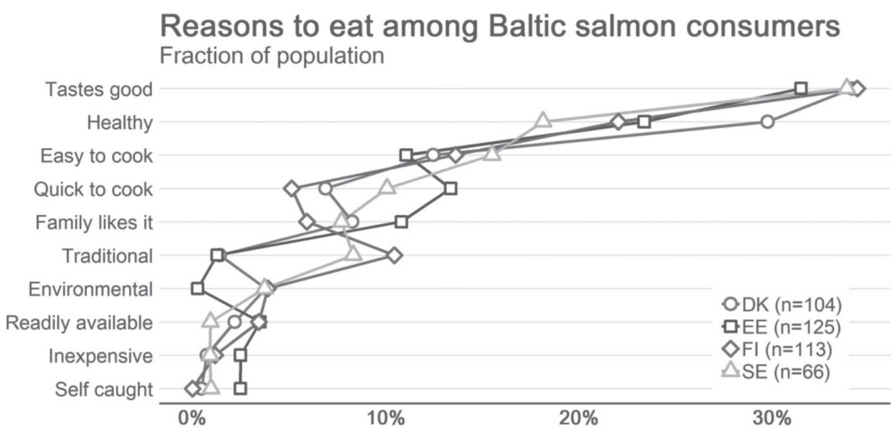

Figure 4. Reasons for eating Baltic salmon.

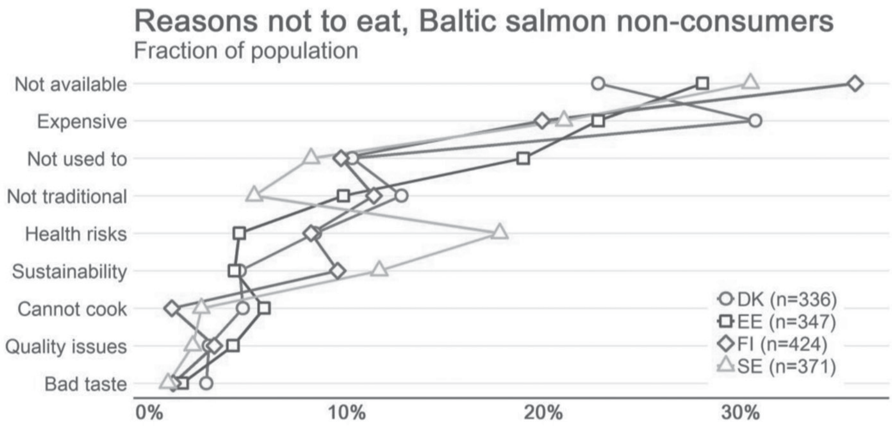

Figure 5. Reasons for not eating Baltic salmon.

The top five most important determinants for increasing the consumption of Baltic herring and that of salmon were the same (Figure 6). Over half of the population identified a lower level of chemicals in fish (59%) and better availability (52%) as determinants that would increase the consumption of Baltic herring. Other popular determinants included an improvement of the stocks (ecolabelling) (47%), lower price (41%) and better information (e.g., package markings or in the store) on the catch date, area, fisher and/or the processor (40%). The two main determinants that were reported to decrease the consumption of both species were a higher price and if the national food safety authorities publish a recommendation to limit consumption.

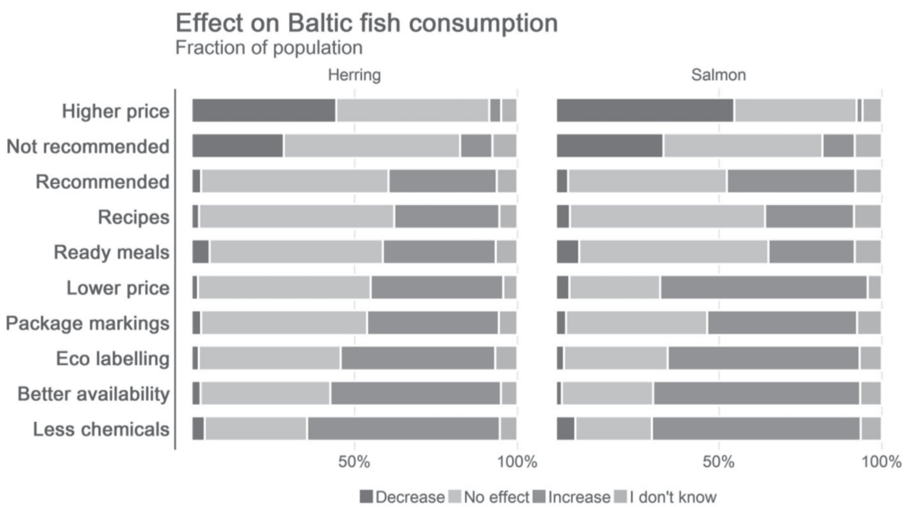

Figure 6. The influence of different determinants on potential changes in Baltic herring and salmon consumption.

5. Discussion

5.1. Country-Specific Intricacies

The results show that the majority of fish consumers in the surveyed countries eat some type of herring at least sometimes. Including those consumers who were not sure what type of herring they eat, suggests that over half of all fish consumers in these countries eat Baltic herring at least sometimes. In other words, less than half of the fish consumers do not eat Baltic herring at all. This indicates that the low overall demand for Baltic herring as food relates to the consumption behaviour of both those who do not eat herring at all and those who do but only rarely.

With respect to the first research question (sociodemographic determinants), differences between the countries were found. As expected, Baltic herring is most likely eaten in Estonia, the only surveyed country where the herring catch is used primarily for human consumption and where herring consumption is the most common (see Section 2). The results also suggest that the Swedes are more reluctant to eat Baltic herring than the Finns, which may relate to the difference in risk perceptions and dioxin risk management between the two countries, namely that fish consumers in Sweden have been advised to eat Baltic herring more rarely than in Finland [53,54]. Although previous studies suggest that consumers' awareness of the advice is low, the results of this study show that the Swedes are more concerned about the health risks related to Baltic herring and salmon consumption than the consumers in the other surveyed countries.

One unanticipated finding was that age and education predict Baltic herring consumption in Denmark and Finland, but not in Estonia and Sweden. This is supported by another finding, namely that the health benefits relating to Baltic herring consumption are also a more important reason in Denmark and Finland compared to Estonia and Sweden. Consumers who are most aware of and interested in the health benefits of fish consumption, are usually highly educated and older [35]. The study also found that purchasing power predicts Baltic herring consumption in Finland. This is intriguing, as the general view has been that the Finns consider Baltic herring as a "common people's fish" and one that has a poor image as food [21]. Yet, the Finns eat Baltic herring most often in lunch restaurants [39], which could explain the findings as people with a higher purchasing power, often corresponding with age and education, are generally more likely to eat in restaurants. Furthermore, the Finnish public health authorities have advised young people to limit the consumption of Baltic herring [53], which may have contributed to the identified age gradient. Whereas in Sweden, advise to limit Baltic herring consumption has been provided to the whole population [54], which may explain why the Baltic herring consumers are a more heterogeneous group in Sweden compared to Finland. As for Estonia, Baltic herring is among the most commonly consumed fish species [45] and considered the "national fish" [21], which could explain its consumption across all sociodemographic groups.

Fish consumers, especially in Denmark and Estonia, are poorly aware of the type of fish they eat. In these two countries, North Sea herring is among the most consumed species, which can explain this uncertainty. While North Sea herring is larger and fattier than Baltic herring, it may be difficult to notice the difference, especially if the fishes are consumed e.g., as chopped and pickled.. Another possible explanation for the ignorance of the Danish fish consumers is a linguistic one, namely, that the names for Baltic and North Sea herring are completely different in Finnish ("silakka" and "silli", respectively), Swedish ("strömming" and "sill") and Estonian ("räim" and "heeringas"), whereas in Danish, similarly to English, the only difference in the names is the region from which the fish comes ("østersøsild" and "sild"). Thus, it could be that, in Denmark, both types of herring are commonly called simply "herring" (sild), whereas in the other countries, a distinction between the two is more obvious.

As for Baltic salmon, the reported uncertainty concerning the type of salmon consumed seems smaller, but as the other results of this survey demonstrate, a note of caution is due here. Over 15% of Estonians reported that they eat Baltic salmon, which is more than in the other surveyed countries. This is highly unlikely, as Estonian fishermen land only around 2000 salmon per year, which is significantly less than in the other three countries. In addition, other Baltic Sea countries cannot sell Baltic salmon to Estonia due to the dioxin regulation, and it is therefore expected that Baltic salmon is more rarely available in Estonia than in the other countries of this case study. One possibility is that consumers confuse Baltic salmon with Baltic Sea trout or rainbow trout farmed in the Baltic Sea, or even with salmon farmed in Norway.

5.2. Drivers and Barriers

Regarding the second research question (the identification of the drivers and barriers relating to, e.g., the availability, price, taste, healthiness, harmful toxins, environmental issues, and cooking, of Baltic herring consumption), the study found that the main drivers of Baltic herring consumption (taste preference and health considerations) correspond with those of Baltic salmon consumption as well as fish consumption in general [37]. Some of the main barriers for Baltic herring and salmon consumption are also the same, e.g., the health risks and poor availability. The latter is not surprising regarding Baltic salmon, as it is available only rarely, locally and in small quantities. However, it is surprising that in the two largest fishing nations, Finland and Sweden, a poor availability is also a common reason for not eating Baltic herring at all. This suggests that the dominance of feed-directed fishing in these two countries constrains the use of Baltic herring for human consumption.

Although some of the drivers and barriers for Baltic herring and salmon consumption are the same, some differences also exist. While disliking the taste of Baltic herring is one of the main reasons for not eating it, disliking the taste is not a relevant factor restricting the consumption of Baltic salmon among fish consumers, which explains the popularity of salmonids as food. A dislike of the taste of Baltic herring seems to be a more common reason for not eating it in Sweden than in Finland. This could be due to the traditional Swedish Baltic herring product, called "surströmming", which is a strong-smelling fermented dish. Another difference between the reasons behind Baltic herring and salmon consumption is the respondents' perception on the price of the fish, which seems to be a driver for Baltic herring consumption but a barrier for Baltic salmon consumption. In contrast to Baltic salmon, Baltic herring is widely considered an environmentally friendly and sustainable source of food [11,20]. Yet, the results suggest that environmental friendliness is a more common reason to eat Baltic salmon than Baltic herring. This may relate to the popularity of salmonids in general as food choice and the common perception that fish is an environmentally friendlier option compared to livestock meat. Nevertheless, this indicates that fish consumers in the countries of this case study are poorly aware of the ecological state of the fish stocks.

The results regarding the main barriers for increasing the consumption of Baltic herring among those who already eat it at least sometimes (chemicals (dioxins) found in fish and poor availability) are encouraging from the perspective of prioritising the use of Baltic herring for human consumption. First, it seems that dioxins are not keeping the majority of fish consumers from eating Baltic herring (and salmon), but lower levels of dioxins in the fish entering fish food market could have a positive effect on the quantities consumed. Second, the results indicate that fish consumers would eat Baltic herring in greater quantities if it were more readily available. Third, the results suggest that sustainability certificates and environmental labels, similarly to many other factors, i.e., package markings, lower price, ready meals and a health authority's recommendation to eat it, would have a positive effect on the consumer demand.

5.3. Implications for Catch Use Governance and Limitations

Based on the results, six main implications for catch use governance are identified. First, the results support proactive catch use governance that prioritises the use of Baltic herring as food. Strategies are required that acknowledge both consumer groups, namely fish consumers who do not eat Baltic herring at all and Baltic herring consumers who eat it rarely. However, these consumers do not constitute a homogeneous group across countries. Instead, Baltic herring consumption is embedded in country-specific conditions (e.g., sociodemographic differences and fish consumption traditions), which are shaped by different values [20], fishing practices and risk perceptions [11,29]. These country-specific intricacies imply that there is a need for country-specific strategies or at least a strategy that acknowledges the diversity across the region.

Second, the availability of Baltic herring on the fish food market needs to be improved. This is supported by the contemporary literature which identifies the poor availability of sustainable food products on the food market as a common obstacle for their consumption [58,59]. Additionally, encouraging examples from the recent years exist as some forage species, e.g., the Atlantic herring, have been successfully redirected to human consumption [33]. These imply that increasing the consumer demand necessitates a gradual increase in the supply of Baltic herring on to the domestic food markets.

Third, although many consumers seem to like traditional Baltic herring dishes, others do not or are not used to eating them. Therefore, development of new products is required. Accordingly, stakeholders have identified product development as one of the key actions to increase the use of Baltic herring for human consumption [11]. In Finland, the development of a new boneless heat-and-eat product, tentatively called "pulled herring," has already begun [60].

Fourth, the governance system must ensure that Baltic herring entering the market is safe-to-eat. The results suggest that a shift from the ambiguous management of the dioxin problem to a unified one, which ensures that only safe-to-eat Baltic herring is placed on the market, would improve the image of Baltic herring as food and thereby increase its demand. Currently, the Danes and Estonians have only herring that is considered safe-to-eat on their domestic markets, but the image of Baltic herring as fish containing harmful chemicals still seems to restrict consumption. Concerns about the health risks of Baltic herring consumption seem to be a limiting factor also in Finland and Sweden. In addition, the potential to increase Baltic herring consumption in these two countries is limited by the food safety recommendations. Thus, opting to continue on this exemption-driven path might be counter-productive for the fishery, as it sustains the image of Baltic herring as harmful for human health. In addition, from the public health perspective, using only safe-to-eat Baltic herring for human consumption would maximise the health benefits [23].

Fifth, the multiple barriers for Baltic herring consumption suggest that improved information is needed about the fish species, their origin, the environmental and climate effects of their consumption, and the ecological state of the stocks as well as the benefits and risks of the fish for human health. This is supported by previous research which argues that transforming consumption behaviour requires comprehensive information of individuals' fish consumption choices [61]. In this case, providing more comprehensive information necessitates collaboration between the fisheries sector, the environmental sector and the public health sector, and the stakeholder groups that promote sustainable fish consumption.

Sixth, collaboration between the Baltic Sea countries could help maximising the availability of Baltic herring suitable for human consumption in the most cost-efficient way. Based on the results, affordability of Baltic herring is one of the key drivers for its consumption. Thus, if proactive catch use governance leads to increased consumer prices, this could, in turn, negatively affect consumer demand. One solution for improving the cost-effectiveness of the required actions is regionalised Baltic Sea-level catch use governance. For example, primarily prioritising the catch that is already safe-to-eat for human consumption.

One limitation of the study is that, regarding drivers and barriers, it focused only on those consumers who reported that they eat some type of herring, while those who did not were left out of the analysis. Thus, the results do not comprise the views of the fish consumers who have chosen not to eat Baltic herring, nor do they reveal the factors affecting herring consumption more broadly. Because of this, the number of respondents who were asked about the drivers and barriers of Baltic herring consumption is, in many cases, low, and the results should be interpreted with caution. However, given the apparent similarities between the identified drivers and barriers of Baltic herring consumption and fish consumption in general [37], the authors argue that, by examining Baltic herring consumption specifically, some conclusions can be drawn that are applicable beyond the scope of this single species. For example, it is reasonable to assume that the main reasons for eating or not eating forage species in general are related to liking or disliking the taste, the availability of the fish, consumption habits and the perceived health benefits and risks.

6. Conclusions

The present paper has demonstrated the feasibility of prioritising forage species, such as Baltic herring, for human consumption from the consumer perspective. However, owing to the multifaceted barriers for consumption (e.g., poor availability, dislike of taste, and health risks related to harmful chemicals in fish), using forage species primarily as food calls for proactive catch use governance, which (1) acknowledges the species- and country-specific intricacies of forage fish consumption, (2) improves the availability of safe-to-eat fish, and (3) provides consumers with sufficient information on the species (e.g., the type of herring and its origin), the sustainability of the fisheries, and the health risks and benefits. Addressing these issues necessitates collaboration between relevant sectors and stakeholder groups.

Supplementary Materials: The following are available online at http://www.mdpi.com/2071-1050/11/16/4298/s1, S1: Questionnaire of eating habits of wild Baltic salmon and Baltic herring. To support transparency, the original data and all the results are available online: http://en.opasnet.org/w/Goherr:_Fish_consumption_study.

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