Master's thesis

NTNU
Norwegian University of Science and Technology
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Torgrim Westerdahl

Tides of Knowledge

A deconstruction of knowledge production and practices: The case of ICES' ecosystem overviews

Master's thesis in Organization, digitalization, administration and work
Supervisor: Michael Grothe-Hammer
Co-supervisor: Kurt Georg Rachlitz
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Sammendrag

For samfunnets respons til sammenhengende og gjenstridige problem faller det et betydelig ansvar på samfunnets vitenskapelige organisasjoner. De må forsyne politiske beslutningstakere med handlingsrettede råd for en bærekraftig styring av marine økosystem. Dette gjør det høyst relevant å forstå hvordan disse vitenskapelige organisasjonene produserer den kunnskapen vi setter vår lit til.

Denne masteroppgaven utforsker derfor hvordan Det internasjonale havforskningsrådet (ICES) praktiserer kunnskapsproduksjonen av økosystem oversikter. Dermed et bidrag til forståelsen av kunnskapsproduksjon og av ICES. Denne masteroppgaven anvender en praksis teoretisk perspektiv for å utføre en dekonstruksjon av produksjonen av økosystem oversikter. Blant den relevante litteraturen om kunnskapsproduksjon presenterer Borie et al. (2021) et teoretisk rammeverk som kan benyttes for å analysere vitenskapelige organisasjoners kunnskapspraksiser. Masteroppgaven forsøker derfor også å teste dette rammeverkets overførbarhet til produksjonsprosessen av økosystem oversikter i ICES.

Dette er en kvalitativ studie som samler inn empirisk data gjennom relevante dokumenter og intervju med representanter involvert produksjonen av økosystemoversikter i ICES. For å analysere dataen benytter jeg en Gioia inspirert metode, som resulterer i en kartlegging av kunnskapspraksisene som samsvarer med det teoretiske rammeverket, i tillegg til opprettelsen av andre organisatoriske praksiser. Funnene viser at de fire kunnskapspraksisene avgrensing, standardisering, representasjon og offentlige praksiser praktiseres under produksjonen av økosystemoversiktene. I tillegg viser funnene at det praktiseres andre organisatoriske praksiser som nettverkpraksiser sammen med tilretteleggende og interne kommunikasjonspraksiser. Jeg argumenterer for at disse praksisene samlet sett utgjør en konstellasjon av praksiser som stimulerer til ICES sin ambisjon om å praktisere en stabil og kontinuerlig forbedring av produksjonsprosessen. Videre argumenteres det for at en helhetlig forståelse forutsetter at man anerkjenner hvordan praksisene preges av gjensidig påvirkning og avhengighet.

Abstract

For society's response to interconnected and wicked problems, a significant responsibility falls on society's scientific organizations to provide policy-makers with actionable advice for the sustainable governance of marine ecosystems. This makes it highly relevant to understand how these scientific organizations produce the knowledge we rely on.

This master's thesis therefore explores how the International Council for the Exploration of the Sea (ICES) practices the knowledge production of ecosystem overviews. Thus, a contribution to the understanding of knowledge production and of ICES. This master's thesis applies a practice theory perspective to perform a deconstruction of the production of ecosystem overviews. Among the relevant literature on knowledge production, Borie et al. (2021) present a theoretical framework that can be used to analyze the knowledge practices of scientific organizations. The master's thesis, therefore, also attempts to test the applicability of this framework to the specific production process of ecosystem overviews in ICES.

This is a qualitative study that collects empirical data through relevant documents and interviews with representatives involved in the production of ecosystem overviews in ICES. To analyze the data, I use a Gioia-inspired method, which results in a mapping of the knowledge practices that correspond to the theoretical framework, in addition to the creation of other organizational practices. The findings show that the four knowledge practices scoping, standardization, representational and public practices are practiced during the production of the ecosystem overviews. In addition, the findings show that other organizational practices, such as networking practices, are practiced together with facilitative and internal communication practices. I argue that these practices collectively constitute a constellation of practices that stimulate ICES' ambition to practice a stable and continuous improvement of the production process. Furthermore, it is argued that a holistic understanding of the practices requires recognition of their reciprocal influence and interdependency.

Acknowledgments

I would like to express my gratitude and appreciation to all those who have contributed to my completion of this thesis. This thesis represents the finalization of my two years at NTNU, Trondheim and the master's program in Organization, Digitalization, Administration, and Work.

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Torgrim Westerdahl
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Abbreviations

ADG	Advice Drafting Group
ACOM	Advisory Committee
EAG	Ecosystem Assessment Group
EBM	Ecosystem-Based Management
EG	Expert group
EO	Ecosystem Overview
ICES	International Council for the Exploration of the Sea
IEA	Integrated Ecosystem Assessment
IEASG	Integrated Ecosystem Assessment Steering Group
SCICOM	Science Committee
ToR	Terms of Reference
WG	Working group

1 Introduction

1.1 Contextualization

Today's landscape of societal and environmental challenges can be characterized by complex wicked problems of a highly paradoxical nature. Marine ecosystems play a critical role in regulating the climate, storing carbon, and supporting economies worldwide. (Groenevald, 2020) However, these ecosystems are under increasing pressure from human activities such as overfishing, pollution, habitat destruction, and climate change, which threaten the health of marine ecosystems. These ecosystems are crucial not only for marine life but also for human welfare. They support economic activity, provide food and employment, serve as transport routes, and are essential for global biodiversity. Paradoxically, the human-induced stress that these ecosystems are subject to will, without mitigation, jeopardize the livelihoods of people dependent on the ocean for food, employment, and cultural identity. Ocean governance and managers in coastal geographies face severe challenges to the sustainability of marine ecosystems. (UN, 2021)

This context paints a picture consisting of complex and interconnected challenges that require a holistic and cross-sectoral approach. (Constanza, 1999) Sector-specific measures are no longer effective, as they may often cause negative repercussions for other ecosystem components. (European Commission, 2015) To tackle these interconnected challenges, society is urging policymakers to implement collective action as a response to these challenges. Inevitably, such a response requires a coordinated effort across societal functions, including an important effort by the scientific community. To support holistic policies, policymakers rely on scientific organizations to provide the necessary advice and produce the knowledge base for sustainable governance. (Arkema et al. 2006) The immense responsibility attributed to scientific organizations makes ground for the argument this thesis put forward; because of the potential impact knowledge production has on the future of sustainable ocean governance, I argue that it is crucial to understand how knowledge is produced.

Sustainable management of marine ecosystems involves balancing the needs of the environment with those of human societies. This requires an understanding of the complex interacting factors that affect marine ecosystems and an approach that considers both environmental and socioeconomic aspects. (Costanza, et al., 1998) As a response to the need for holistic approaches to informed decision-making processes, ecosystem-based management (EBM) evolved as a strategy to tackle the complex and interconnected challenges society faces. EBM addresses entire systems as a whole, rather than through sectoral strategies, and focuses on managing resources in a way that considers the entire ecosystem, including human activities and their impacts. (Arkema et al. 2006)

However, EBM requires extensive and detailed knowledge of marine ecosystems, including the social, economic, and environmental factors that affect them. Making favorable decisions about the management of marine ecosystems in a highly complex

and interconnected context, it requires an adequate level of knowledge and understanding. This responsibility of providing policymakers with knowledge and advice falls on scientific organizations capable of establishing holistic advice substantiated by scientific validity. However, scholars such as Boesch argued that it would entail challenges to the scientific community because of its complexity. (1999)

Due to the complex and extensive landscape that EBM entails, there was a need for a scientific approach capable of handling the enormous amount of data and knowledge, and importantly, communicating it effectively. Consequently, integrated ecosystem assessment (IEA) emerged as a framework to organize science and provide a practical approach to how the ecosystem-based approach should be designed and implemented. IEA uses scientifically based methods to evaluate the state of marine ecosystems and provide advice on management measures that can contribute to sustainability. Levin et al. define an IEA as a "formal synthesis and quantitative analysis of information on relevant natural and socioeconomic factors, in relation to specified ecosystem management objectives." (Levin et al. 2009)

As the scientific community faces a demand for holistic approaches and advice to societal challenges, science itself becomes increasingly complex and transdisciplinary.(Cummings and Kiesler, 2014) The scientific community must be capable of providing the knowledge that decision-makers are receptive to and able to act upon. As scientific organizations adopt and apply new methods to produce knowledge in response to grand challenges, the use of transdisciplinary and holistic approaches is incorporated. This further creates an expanding scientific complexity that also challenges the understanding of how scientific organizations produce knowledge.

In consequence, without understanding how the scientific community operates, how would society be able to retrace the rationale behind policies? This calls for a greater understanding of the knowledge production in the scientific organizations, which society entrusts with providing decision-makers with actionable knowledge. Among these organizations entrusted with the mandate to provide decision-makers with scientific advice is the International Council for the Exploration of the Sea (ICES).

ICES plays a pivotal role in science-policy interface providing the necessary scientific advice that informs sustainable ocean governance and management, making ICES a highly interesting epistemic community by definition. (Haas, 1992) ICES was formally established in 1902. Since then, the organization has embraced a range of main activities and its mandate now involves the collection and analysis of data on marine ecosystems, research on fisheries resources, and the formulation of scientific advice and recommendations to support the sustainable management of the marine environment. The organization can be considered a network comprising researchers, experts, and decision-makers from member states collaborating on scientific marine-related challenges to provide the best available scientific knowledge, promoting sustainability in the oceans. The organization and network consist of nearly 6000 scientists, 700 marine institutes, and 20 member nations. (figures from ICES’ website, 2024)

In line with the rise and demand for EBM and IEAs, this has become a cornerstone in ICES' approach to managing marine resources.(Clay et al., 2023) Over the last decade, ICES has introduced and established the production of Ecosystem Overviews as a contribution to the IEA approach. Traditionally, ICES advice has primarily focused on

providing assessments and recommendations for the management of, for example, individual fish stocks (Wilson, 2009), often isolated from other environmental and human-induced factors. Ecosystem overviews, however, involve a holistic examination of marine ecosystems, where research incorporates considerations of the complex interdependencies between ecosystem components and human activities. (ICES, 2022) ICES' Ecosystem Overviews provide assessments of the status and trends in marine ecosystems, integrating data on ecosystems with human pressures and socioeconomic considerations. These overviews are designed to support EBM by offering a broad perspective on the health and resilience of ecosystems, helping decision-makers understand the impacts of various activities and make better-informed decisions. (ICES, 2020) This leads to the question, how are the ecosystem overviews produced?

1.2 Scope and research question

This research is conducted as part of and as a contribution to the research project Meta-organizations' Role within the Field of Ocean Governance. Participation in this project provided me access to existing data that sparked an interest in this field. In combination with a personal interest in transdisciplinary coordination for sustainability, knowledge production became particularly interesting subject. Based on the reasoning presented in the contextualization, scientific organizations are entrusted with the significant responsibility of producing the knowledge that constitutes the foundation for policy decisions. Given this substantial responsibility, it is crucial to understand how the knowledge we rely on is produced by expert organizations. The research question of this thesis is as follows:

How does ICES practice the knowledge production of ecosystem overviews?

The scope and purpose of this research are to explore how holistic knowledge products are produced within scientific organizations through the deconstruction of the involved practices. Thus, contributing to the research on knowledge production through a case study of ICES' production of ecosystem overviews. Moreover, it tests the theoretical framework of knowledge practices applicability to the case of ICES. Which will be elaborated on in the theory chapter. (See chapter 3)

1.3 Thesis outline

This thesis consists of seven main chapters. First, an introduction and contextualization, which also presents the purpose of the research and the research question. Then follows the second chapter, which is a brief review of existing relevant literature and research. This leads to the thesis' theoretical foundation for the research in Chapter 3, where the relevant practice theoretical framework is presented. Chapter 4 covers the methodological approach of the research, which includes an explanation of the methodological choices and approaches used to establish the empirical basis. The empirical findings are presented in chapter 5. With the theoretical and empirical foundations in place, these two are combined in the thesis' analysis and discussion in chapter 6, before concluding in chapter 7. At the end of this thesis, you will find a literature list and an appendix section

2 Literature review

Drawing upon perspectives from Science and Technology Studies (STS) and sociology, knowledge production in epistemic communities is a process that involves the production of policy relevant knowledge through scientific methods and practices. (Haas, 1992) In the search for new knowledge fueled by the investigative nature of science, scientific knowledge production is continuously expanding on existing knowledge and producing new knowledge by relying on an approach of scientific methods.

Moreover, knowledge production in scientific organizations is shaped by various social, cultural, and institutional factors that influence the direction, priorities, and outcomes. Scholars such as Knorr-Cetina (1982), emphasize the role of shared norms, values, and practices that characterize different disciplinary fields or research traditions, in shaping knowledge production within scientific communities. These factors influence researchers' methodologies, modes of reasoning, and shaping the production and validation of scientific knowledge.

At its core, knowledge production is the production of new ideas, theories, and findings through systematic research. This process involves the application of scientific methods, such as data collection and analysis, to explore and understand phenomena, social dynamics, or technological innovations. Latour and Woolgar (1979) in "Laboratory Life," knowledge production within scientific organizations is situated within laboratory settings, where researchers engage in collaborative and iterative practices to advance scientific understanding. However, the situated context of scientific organizations is changing as argued by Cummings and Kiesler.(2014) A notion that potentially would entail repercussions for modern scientific organizations and their practices. In the case of ICES and the production of ecosystem overviews, it arguably symbolizes a shift in knowledge production within ICES towards a more holistic approach in pursuit of developing and enhancing EBM.

Knowledge production in scientific organizations is characterized by a dynamic relationship between stability and change.(Kuhn, 1962) The scientific community is constantly contesting established theories, and methodologies, leading to changes in scientific knowledge and practices over time. As discussed by Kuhn (1962) in "The Structure of Scientific Revolutions," scientific progress is constituted through a dynamic in which old frameworks are replaced by new ones in response to emerging evidence or theoretical developments. Knowledge production in scientific organizations is a dynamic and socially embedded process that involves the generation, dissemination, and validation of new knowledge within specific social and institutional contexts.

Cummings and Kiesler argue that the nature of science is undergoing profound transformations due to technological innovations and changes in organizational practices. (2014) The emerge of new technologies, methods, and collaborative platforms has contributed to changes in the way scientific research is conducted, communicated, and evaluated. These changes have facilitated new modes of collaboration, data sharing, and interdisciplinary research. The changing nature of knowledge production is also argued

by Gibbons et al. (1994), who characterizes organizational knowledge production in two modes. Essentially, Gibbons et al. point out that Mode 1 includes a disciplinary approach and excludes the practical applicability of the produced knowledge. Mode 2, on the other hand, emphasizes the practical applicability of knowledge, social context, and interdisciplinarity. (Gibbons, et al. 1994)

In this context, knowledge production in scientific organizations is increasingly characterized by practices and networks that transcend traditional disciplinary boundaries and organizational hierarchies. Scientists collaborate across geographic locations, disciplines, and institutional affiliations, leveraging technology to share data, resources, and expertise. (Cummings and Kiesler, 2014). This shift towards collaborative and networked modes of knowledge production has arguably significant implications for the organization and governance of scientific research, challenging traditional modes of operation and practices.

They further highlight the role of organizational structures and processes in mediating the impact of change on scientific knowledge production. They argue that effective knowledge production requires alignment between organizational goals, structures, and technologies, as well as support for adaptive and flexible organizational practices. Scientific organizations should encourage innovation, collaboration, and practices while mitigating potential risks and challenges.(Cummings and Kiesler, 2014)

Wilson's paradoxes of transparency address a central element of scientific organizations' role as the science-policy interface; in particular, Wilson highlights the tension between the ideal of transparency and the practical challenges of achieving it in the science-policy interface. For instance, two paradoxes one can derive from Wilson’s work are 1) the difficulty of the balancing act between the need for specialized knowledge through expertise and producing accessible and understandable knowledge for an audience of non-experts. 2) the paradox of uniformity; realizing and recognizing the challenges of complex systems, making it challenging to apply standardized methodologies and inclusion of diverse participation from perspectives and disciplines. (Wilson, 2009) This notion is further enforced by Cummings and Kiesler’s argumentation that increased complexity in scientific organizations calls for higher levels of coordination and requires a composition that fosters multi- and interdisciplinary practices. (2014)

Cummings and Kiesler argue that scientific research has undergone organizational changes (2014). They highlight three prominent challenges in the transition to interdisciplinary research. 1) The increasing temporal speed of work and pressures on the synchronization of activities, 2) an increasing number of parallel projects affecting researchers' ability to dedicate and focus, and 3) an increasing need for coordination, collaboration, and monitoring (Cummings and Kiesler, 2014). Since the production of ecosystem overviews is noted to be characterized as highly transdisciplinary (Clay et al. 2023), it can be argued that these challenges also exist for the development of ICES ecosystem overviews. With that assumption, it becomes particularly relevant to map the practices underlying the production of interdisciplinary ecosystem overviews. (ICES, 2024)

In Linke et al.'s article,(2023) the focus lies on request formulation, knowledge synthesis, peer review, and advice production, as well as ten principles underlying the production of advice from ICES. This article provides a foundation for understanding the main elements

of knowledge production in ICES through a systematic review of the advisory process. It presents an overview of the production of ICES's four forms of advice. However, the article seems to provide little detail on the various practices resulting in the different types of advice. Based on the arguments presented in the article, it suggests further research that delves into the individual categories of ICES advice. As the authors point out, the overviews form part of a governance agenda or ecosystem-based management that is still evolving.(Linke, et al. 2023) Considering that this product and its overarching strategy is still developing, it quickly becomes a highly interesting subject for further investigation. Particularly from a practice-theoretical perspective, as there is currently uncertainty regarding who should initiate the processes and take responsibility or ownership to drive them forward. Based on this point, it can be argued in favor of the importance of gaining a deeper understanding of the internal knowledge practices that contribute to establishing the basis for future development.

Clay et al. (2023) provides a fundamental and necessary understanding of the IEA's role and history. The research is based on the conceptual approach to IEA. The choice of a conceptual approach highlights a central element that is not apparently visible in ICES Integrated Ecosystem Assessment Steering Group's problem-formulating practices: their conceptual approach. It thus leads to a central question regarding ICES's own practices and conceptualization of those practices, as they seemingly lack a clearly defined approach. Furthermore, the article concludes, among other things, with the need for a clearly defined problem formulation through conceptual visual representations. Moreover, the article makes an important distinction which is necessary to emphasize in this context: the overviews are an adaptive process of continuous development. Through feeding the process with new knowledge, the cycle will continuously be updated. (Clay et al. 2023) Furthermore, Clay et al. (2021) build on Levin et al.'s work (2009) which formulates key steps to integrated ecosystem assessment, which includes "scoping, indicator development, risk analysis, management strategy evaluation and ecosystem assessment." (Levin et al., 2009)

Wenzel (2017) provides an insightful historical exploration of the organizational changes ICES has undergone until 2009. He argues that a crucial cause of the changes for ICES was motivated by the need to ensure the organization's legitimacy. An argument is founded on the same factors Cummings and Kiesler (2014), Gibbons et al. (1994) and Wilson(2009) refer to; the increasing need to adapt to external societal expectations and requirements. If so, the incorporation of a holistic approach such as IEA, leads changes in the institutional structure of ICES, which argues in favor of exploring how it affects the organization's epistemology and practices. Moreover, Wenzel argues that ICES incorporation of IEA cannot be understood solely by institutional structures. (Wenzel, 2017) By this notion, I would argue that it is favorable to apply new approaches to better understand the processes of ICES.

A significant part of the background for this research is based on a paradox addressed by authors such as Wilson's paradoxes of transparency. (2009) Science employs a range of methods, techniques, and tools to present both undisputed and disputed truths about the world. These approaches are specifically designed to maintain and uphold scientific transparency. Yet, the practices governing the scientific community are, to varying degrees, challenging for outsiders to comprehend. With that in mind, this thesis hopes to contribute to enhancing the understanding of the context-specific approaches and practices deployed by ICES to produce knowledge.

In their research, Fuller et al. focus on network structures and connectivity among ICES IEA groups. Their findings indicate that while IEA groups become more connected over time, they generally exhibit limited interactions across different groups. The research highlights that the scientists involved in IEA groups are highly specialized within their respective fields and rarely participate in other groups. Additionally, the analysis points out that ICES' use of workshops significantly contributes to their ability to maintain networks.(Fuller et al.,2023) These results open up an interesting path for further investigation into how the disciplinary backgrounds of group members influence their inclusion, as well as how interaction and communication among different ICES groups are practiced. Fuller et al.'s research represents an important contribution to understanding the dynamics within a network-based research system, yet it also opens up opportunities for further studies. Specifically, it raises questions about how these dynamics are maintained and evolve as a result of various practices.

The literature review is a result of two factors: reviewing literature lists of already known and relevant literature identified through the preparation for this study. Secondly, systematically searching relevant literature linked to the topic. It included search words and criteria for inclusion such as: knowledge production, ICES, integrated-ecosystem assessment, multidisciplinary science and epistemic communities.

3 The theoretical perspective

3.1 Practice theory

Practice theory has developed into an attractive approach in modern organizational studies, particularly for analyzing organizing as a social process. According to Nicolini, "practice theories do more than just describe what people do. Practices are, in fact, meaning-making, identity-forming, and order-producing activities." (2013) This perspective, based on the work of Giddens and Nicolini, (1984, 2013) emphasizes that practices are not just actions but are crucial in shaping meanings, identities, and social orders. Among practice theorists, there appears to be a relatively shared understanding that a practice is an interplay between two essential and interdependent factors: embodied actions and material objects such as tools and space. The interaction between these two must be in place for practices to be enacted. (Nicolini, 2013; Giddens, 1984) The relationships between agency in the form of actions and, for example, organizational structures, and how these influence each other. (Nicolini, 2013)

When a practice is enacted, it is crucial to note that it is not a singular action. A fundamental premise of practices is that they are characterized by a certain continuity. Practices will either be reproduced or not. (Giddens, 1984) Practices that are reproduced over time maintain continuity and stability. This continuity allows practices to be described as both stable and dynamic. The dynamic aspect arises because practices also adapt and change in response to other practices or changes in human or material conditions. Therefore, there exists an idiom of stability and change inherent in the nature of practices. To understand this idiom of stability and change related to practices, the concept of durability is used. (Nicolini, 2013)

Durability refers to how practices are reproduced over time and how they can be understood as constant change and evolution. A practice's durability can be understood through various aspects, among them the interdependency of practices. Although practices can be considered isolated, unique, and situated, the interconnection between practices must be acknowledged. The relationship between a set of practices is an essential aspect of understanding how individual practices achieve durability (Nicolini, 2013). Durability is argued to be a result of a practice reinforcing or influencing other practices, contributing to a larger configuration that ensures a practice's reproduction as part of the whole. It is precisely this interconnection between practices that cause both stability and change. For example, a change in material objects, such as new tools, leads to changes in the conditions for a practice; reproduced practices must, therefore, adapt to new conditions. Or with new practitioners, there will be other changes in the execution of practices. Such dynamics imply that as a practice changes, it creates ripple effects for other interconnected practices.

A challenge of a practice-theoretical approach is that it often results in isolating and reducing practices to objects and units that can be analyzed, while their interconnectedness and dependency may be overlooked. (Nicolini, 2013) The core of the challenge lies in the concept of practices and their ambiguity, can practices really be

distinguished from each other? Omer and Roberts (2022) address this issue and argue that this can be done through the practice's material elements. Leading to the question of where one draws the line between different practices.

3.2 Theoretical framework of knowledge practices

This section will present the theoretical framework applied to the deconstruction of ICES' knowledge practices, involved in the production of ecosystem overviews. In the article "Knowing like a global expert organization: Comparative insights from the IPCC and IPBES," (Borie et al., 2021) the authors present a comparative analysis of IPCC and IPBES and their knowledge practices. Relying on existing literature, the authors have categorized knowledge practices into four overarching practices to describe institutional epistemologies. Which refers to the organizational context the practices are situated in and can stabilize within. (Borie et al., 2021) A categorization such as the one applied in the framework creates the necessary boundaries to overcome the challenge of distinguishing one practice from another.(Omer and Roberts, 2022) With regard to the purpose of this research, the same definition of an institution is applied as used by Borie et al. in their article. Specifically, Kuus' definition states that an institution encompasses both a formal organizational structure and a more dispersed structure of informal practices. (Kuus, 2020)

The knowledge practices are scoping, standardization, representational, and public practices.(Borie, et al., 2021) The relevance of the framework to this specific context can be argued through a crucial point highlighted by the framework's creators; namely, that the knowledge practices behind well-known products are rarely scrutinized and thereby encourages further exploration of the knowledge practices of scientific products (Borie et al., 2021). As a result, the application of this framework to the case of ICES production of overviews intends to test its current applicability without adapting the practices beforehand. In summary, the table below summarizes the theoretical knowledge practices applied in the thesis. The column to the right presents examples of elements that aggregate the four knowledge practices on the left-hand side of the table. Following the table, there will be an elaboration of what the framework entails.

Table 1: Theoretical framework (Borie et al., 2021)

Knowledge practices	Elements of knowledge practices
Scoping practices	Participation Assumptions about valid knowledge
Standardization practices	Conceptual frameworks Guidelines Modes of futuring Strategies for coordination and harmonization
Representational practices	Argumentation Consensus/dissensus Visuals and models
Public practices	Communication Data sharing

3.2.1 Scoping practices

Borie's framework provides insights into how scoping practices are central to shaping the trajectories and outcomes of scientific research. The scoping practices refer to the activities, strategies, and processes the organization applies to define and navigate the realms of their scientific research. In the case of Borie's work (2021), it entails for instance participation and assessing valid knowledge. Which includes the practices that the organization employs in order to establish the practices for inclusion and exclusion of participation and knowledge.

These practices involve the systematic identification of parameters, as well as the mapping of epistemic landscapes of the disciplines involved. It is often linked to the term boundary objects, which refers to artifacts or concepts that aim to facilitate communication and collaboration across diverse communities and disciplines. (Star and Griesemer, 1989) Defining scoping practices involves practices that ensure shared understanding and consistency across the involved disciplines. (Borie et al., 2021)

Scoping practices guide researchers in defining the scope of their scientific work, selecting appropriate boundaries for their knowledge production within organizational settings. These parameters assist the process of ensuring shared understanding across a heterogeneous scientific community. More concretely, it involved practices such as geographical scope in terms of what geographical scale the research will apply to. For instance, defined ecoregions or national and international scales and which disciplines should be included or excluded. Additionally, the inclusion of new knowledge, and peer-reviewed knowledge, what knowledge is deemed relevant and valid to be included in the scientific scope. In terms of inclusion or exclusion of disciplines and new knowledge, the scoping encompasses the frames for which disciplines can or should be included. Thereby affecting the scientific development, as argued by Ford (2011)

3.2.2 Standardization practices

The standardization practices encompass practices of processes and guidelines aimed at ensuring consistency, such as facilitation for ensuring a coordinated effort towards overarching objectives. (Borie et al., 2021) It can be identified as conceptual frameworks, modes of futuring, guidelines, and strategies. The common denominator is creating a shared overarching understanding or problem formulation and achieving a common and shared understanding contributes to the unison production of knowledge. Within the boundaries of a scientific organization, developing and implementing standardized activities and tools helps to ensure consistency, reliability, and reproducibility in scientific practices. These practices aim to establish uniformity and compatibility across the organization, allowing and facilitating replication and validation of scientific work. A notion which, according to Wilson (2009) is challenging balance. On an operational level, standardization practices can include the adoption of common measurement techniques, data formats, and quality control procedures, as well as the formalization of consensus-driven standards and guidelines within groups. It also refers to the standardization through establishing overarching conceptual frameworks, which allows the formulation of a shared problem formulation and understanding. By promoting consistency, standardization practices enhance the trustworthiness and credibility of scientific knowledge, but they also assist in aligning and coordinating the organization's work. This can happen through the formalization of strategies and plans.

3.2.3 Representational practices

Representational practices firstly involve the visual aspect of knowledge practices. Leading with the question of how scientific organizations visualize and textualize in order to communicate, analyze and interpret research concepts. These practices involved the use of diagrams, mapping, and models to visualize data, as well as the construction of narratives, arguments, and explanations to convey scientific insights and theories.

The latter practices of narratives and argumentation lead us over to the second aspect of representational practices; argumentation and consensus. Borie's framework builds on Montana's work in relation to consensus and dissensus on questions such as: Who has the final say in the validation process, and who can object? Moreover, what practices are in place to resolve potential disagreements? (Montana, 2017, Borie et al., 2021) All are relevant questions, which are answered by disseminating the representational practices of and scientific organization. The representational practices play a crucial role in mediating scientific knowledge between experts and non-experts, facilitating the communication of complex research to diverse audiences. By employing representational practices, scientific organizations can improve the accessibility, clarity, and persuasiveness of their research outputs, contributing to broader public understanding. (Borie et al., 2021)This leads over to the fourth and final knowledge practice: public practices.

3.2.4 Public practices

Practices related to the public sphere involve interaction, communication, and engagement with external actors and society in general.(Borie, et al., 2021) These may include stakeholders, member states, and communities outside the scientific community. These practices revolve around the organization's outreach and communication efforts aimed at fostering dialogue, collaboration, and mutual understanding as the science-policy interface, or more broadly, the interface between scientists and non-scientists. It also refers to the level or mode of information control imposed by the scientific organization, affecting the research's transparency and the scientific narrative. (Hilgartner, 2000) Public practices may include the publication of scientific reports, as well as science communication initiatives designed to promote scientific information to mobilize public awareness and engagement. By doing so, the organization enhances its transparency, accountability, and inclusivity by interacting with the public sphere. In the sense of transparency to both non-scientific and scientific communities, the organization's data sharing becomes a relevant example of public practice that fosters transparency.(Wilson, 2009) In summary, public practices contribute to building trust and legitimacy in science, as well as enhancing the relevance and impact of scientific research on society.

4 Methodology

This chapter will explain the research design and research method used to answer the research question. This is to ensure that the research meets requirements for transparency. The chosen methodology is the result of an assessment of what can best address the research question. First, the research design and method are presented. Then, the scope and narrowing of the research. Followed by data collection and related themes connected to interviews and documents. Next, an overview of the data structure and analysis. Finally, there is also an overview of research ethics and quality.

4.1 Research design

The research design has an explorative nature, as its purpose is to generate new insight into a particular phenomenon through a single case study of the production of ecosystem overviews. Van Thiel define a case study as "a research strategy in which one or several cases of the subject of study are examined in an everyday, real-life setting" (van Thiel, 2022, p. 87). One of the main challenges with a single case study is that it involves only one case, affecting the robustness and generalizability of the research (Yin, 2018). Although the study includes three individual ICES working groups in addition to secretariat and steering group, it is not a multiple or comparative case study; rather, the three working groups ensure a satisfactory sample size. The case is the ecosystem overview production process, which will be further described section 4.3.

4.2 Research method

This research uses a qualitative method to best answer the research question. Within qualitative research, there are several alternative approaches to generating data, such as interviews, document analysis, and observations. (Tjora, 2017, van Thiel, 2022) In this context, semi-structured interviews have been conducted in combination with a simplified document analysis. Details about these two methods will be explained further in their dedicated sections.

The reason behind the methodological choice is the result of an assessment where it was most logical to choose an approach that allowed and emphasized the informants' own perspectives and experiences of knowledge practices and knowledge production. In addition, the simplified document analysis could potentially add further value where the interviews might fall short. Yet, the methodological approach of this research lacks the ability to identify practices beyond what can be discovered by interviews and reviewing documents. This is of course a weakness of the research. However, it does open the floor for further research where the scope might allow further exploration through deeper explorative methods, including observation over time.

4.3 Scope and delimitations

Due to the complexity of the topic and the size of ICES, it was necessary to establish certain limitations for the scope of the research. Based on discussions with supervisors and contacts in ICES, it was decided that an appropriate approach would be to delimit the research based on ICES's existing products and geographical regions.

A key parameter for the scope of the thesis is the choice of specific ICES product or advice. The decision is primarily based on a central aspect highlighted in the contextualization of the theme related to holistic approaches to scientific advice and research. Based on points from the literature review, there is a demand for change and to some extent a transformation towards more holistic ocean governance. Against this backdrop, it became particularly relevant to examine ICES's production of ecosystem overviews. Since these overviews can be characterized as interdisciplinary products developed to provide an overview of the ecosystem's condition. It includes a selection of relevant natural science disciplines and is carried out by what can be considered experts from various fields distributed across a set of geographical ecoregions.

This decision entails that the research will be conducted within three already established ecoregions. These regions refer to ICES's division of responsibilities or zones. In discussions with ICES, it became clear that the three proposed regions share central characteristics related to size and development. However, there are certain differences that extend beyond their geographical affiliation. For instance, these groups differ in their temporal position in the process. While some groups have contributed to developing the basis for ecosystem overviews, others have been tasked with updating existing overviews. A key criterion was, therefore, that the included working groups had participated in either one or more of the three processes of revising, updating, or expanding one or more ecosystem overviews.

Despite the geographical scope based on the three working groups, it was appropriate to include perspective from a strategic level. It was therefore decided to include the perspective of the steering group and secretariat on the development and process of ecosystem overviews. This expansion of the research scope provides an overarching perspective that allows for a deeper insight into the anchoring and formalization of practices. Later, this combination of overarching strategic level and operationalized level will be central to answering the research question.

The scope of the research can, therefore, be specified as follows: the focus area and case are on the production process of ICES's formal and published ecosystem overviews. It consists of three ecosystem overview working groups. In addition to overarching perspectives from IEASG and the secretariat. Overall, this scope provides the research with an approach that includes data from different organizational perspectives, which mitigates the risk of excluding relevant data sources because of limited insights into the strategic or operational levels.

It is important to note that the selection of informants and the recruitment process may have impacted the data. All informants were chairs of their respective working groups, which might influence their perspectives compared to other participants with less responsibility. However, these informants were chosen for their detailed knowledge of the process and organization. Recruitment was facilitated through a contact person, whose judgment on suitable informants was crucial. This method ensured the inclusion of informants with substantial insight into the production process.

The informants' diverse backgrounds and experiences might influence their perspectives on the process, which can be a strength when examining an interdisciplinary phenomenon. The selection of working groups based on the contact person's recommendations could also affect the data, given their understanding of relevant groups to study. Nonetheless, relying on the contact person's expertise proved beneficial due to the need for an in-depth understanding of the process.

A significant difference among the working groups, not initially apparent, was their specific roles with ecosystem overviews. Interviews revealed distinctions in whether groups were responsible for updating, revising, or expanding the ecosystem overviews. Some informants had been involved from the beginning, while most participated in updates or revisions. This variation could influence their perspectives on the production process.

Including informants from working groups, IEASG, and the secretariat was crucial for a comprehensive approach, covering multiple levels. Considering the production process entails all levels, and within various organizational bodies, excluding strategic levels would weaken the analysis of the practices involved in the production process.

4.4 Data collection

The following section will elaborate on the methods applied in the data collection. The methods include five semi-structured interviews, in addition to three included documents. This section will also provide a presentation of interviewees and included documents.

4.4.1 Description of project

Since this research was conducted as part of the research project "Meta-organizations' Role within the Field of Ocean Governance," it brought some advantages related to the data foundation. As established in the section on the research's purpose, there was access to an existing base of interviews, which were only used initially to establish prior knowledge. It must, therefore, be made clear that no data from the already conducted interviews have been included in this research. This is because they either did not meet the criteria for inclusion or lacked relevant information to answer the specific research question. In sum, the existing data foundation served as a significant source of inspiration for both the preparation phase and the research question.

4.4.2 Interviews

The five interviews were conducted between 02.02.2024 and 08.03.2024. The duration of each interview fluctuated but exceeded one hour; the exact duration can be seen in Table 3.

The interviews were initiated by introductions and elaboration on the purpose of the research. To ensure effective time management, for both the interviewee, my co-supervisor Kurt Rachlitz and myself, we were both were present in the interviews. The reason for both of us being present in the interviews is based on our respect for the interviewees' time and capacity to participate in research interviews. Even though the interviewees were greatly welcoming to the idea of participating in interviews, we realized that their availability and capacity to participate in several interviews would be limited. To ensure the success of the greater scope of the project as a whole, it was decided that both of us would participate in the interviews. It would ensure that this thesis gained a sufficient level of data for the analysis, at the same time as allowing my co-supervisor to gain access to additional data material that could be beneficial to his individual research. Since the interviewees are relevant sources of data for both our projects, we decided to coordinate the interviews to ensure precise and insightful knowledge about the involved practices. Although having two interviewers may affect the dynamic of the interviews, it did allow us to gain valuable insights, and an observing party which could provide additional question, otherwise overlooked.

Of the five interviews, two interviews were conducted as group interviews as they involved two representatives for the ICES working groups. (See table 3) Although group dynamics among multiple interviewees can influence the data collected, with certain participants dominating the conversation or others feeling inhibited to share their perspectives. The experience from the interviews rather indicated that the group setting enriched the level of depth of the answers. Having multiple interviewees allowed for a diverse range of perspectives, experiences, and insights through dialogue, which enriched the level of detail in the data. The group context allowed the interviewees to elaborate in greater detail as they could complement and fill in any gaps in each other's answers. It spurred a dialogue and interaction between the interviewees which allowed them to discuss and create reflexivity. Which helped generate new insights that may not have been mentioned in individual interviews.

The main challenge aside from its potential impact on the data quality, is related to the allocation of time. Conducting semi-structured interviews with multiple participants requires significant time; as highlighted previously, the duration of the interviews surpassed the time set aside for each interview. However, the interviewees were asked when the hour passed if they had time and were willing to continue the interview.

Besides the allocation of resources, the challenge of confidentiality needs to be addressed. As participants may feel less comfortable sharing sensitive or personal information in a group setting due to concerns about confidentiality or fear of judgment from other participants, potentially limiting the data quality. However, in this context, the questioning nor data does not rely on the interviewees' willingness to share information of a sensitive or personal nature. Rather, the interview context allowed and stimulated an atmosphere for reflection. This would give the interviewees the opportunity to freely discuss and share their experiences throughout their involvement in the production of the ecosystem overviews.

The three remaining interviews were conducted with one interviewee present in each, one was with a working group, the two others with the overarching perspective. In comparison to the three previous interviews with working groups, all shared the same interview guide. However, these two were conducted with the aim to achieve insights into the overarching levels of the ecosystem overview's development and practices.

The fact that the three interviews did not involve multiple interviewees did impact the interview dynamic. The most obvious effect was the level of detail and insight, which now relied solely on an individual's perspective and experience. In the context of achieving detailed information about the overarching strategies and perspectives on knowledge practices, it did not cause any significant consequences. The most noteworthy effect was that the dynamic of the conversation led to being driven by either the interviewee's own narrative or the interviewer's questions based on the answers provided.

As elaborated on during the thesis' reliability and validity section, the quality of the interview may be limited by the researcher's level of preexisting insight and knowledge of the phenomenon. In comparison to interviews with multiple interviewees, interviews with only one interviewee rely heavily on the interviewer's ability to identify and apply the appropriate follow-up questions to navigate the interview in the most yielding direction. In contrast, for interviews with two interviewees, the interaction between the two interviewees generates new knowledge that would otherwise become discovered.

4.4.3 Interview guide

Before the interview process was conducted, an interview guide was created to establish the basis for the interviews. (See appendix 1) The rigidity of the interview guide can vary (Tjora, 2021).The interview guide was intended to serve only as a guiding document to ensure consistency throughout the interviews, but with fundamental questions. The questions were designed to initiate an open and relaxed conversation and ideally comprehensive and open responses from the informants. There was variation in which questions were asked and when during the different interviews, and follow-up questions not included in the interview guide were also asked depending on the responses and what the informants discussed. In several instances, informants answered multiple questions without the need for specific questions related to a particular topic.

The interview guide has three main parts—Tjora refers to the three phases of an in-depth interview: introduction, main part, and conclusion (2021). In this case, it was adjusted to include an introduction with a background question, followed by a section with practice-related questions based on theory, and finally a part with alternative questions that could delve deeper if time permitted. It is important to note that the questions were formulated without theoretical terminology in mind to ensure clear communication and shared a common understanding of the question. This hopefully allowed them to respond through their own terminology and describe their perceptions according to their own understanding.

4.4.4 Documents

Due to the nature of the research, it became apparent that certain documents relevant to the production process of the ecosystem overviews should be included as they potentially could shed light on elements that the interviews were limited to elaborate on.

As a result, the strategic choice to include the documents that interviewees refer to during their interviews was made. In consequence it leads to the inclusion of data and findings from documents that would provide greater detail to the research. However, the challenge of evaluating which documents to include or exclude remains. To mitigate this challenge, the reasonable decision was to rely solely on the documents the interviewees identified, characterized as significant and referred directly to during the interviews.

The argument behind this decision is based on the vast selection of documents produced within ICES. Within the scope of this thesis, it became apparent that the sample would have to be strategically selected based on the criteria that the documents help to provide greater detail to the elements that the interviewees identified and addressed. Therefore, it led to a compiled list of included documents which was then included in the data.(see table 2)

Moreover, the theoretical framework includes elements such as visualizations, models, and concrete objects. To accurately deconstruct ICES practices, it became necessary to include the documents and their content in the analysis. During the interviews, the necessary visualizations and models were referred to as parts of relevant documents.

Table 2:ICES documents

Document name	Reference
ICES Framework for Ecosystem-Informed Science and Advice (FEISA)	(Roux and Pedreschi, 2024)
Advice on ecosystem services and effects	(ICES, 2022)
ICES Ecosystem Overviews Technical Guidelines	(ICES, 2023a)
Definition and rationale for ICES ecoregions	(ICES, 2023b)

4.4.5 Presentation of interviewees

To preserve the privacy of the informants, their affiliation to specific ecoregions has been excluded from the overview. However, every informant in this research is engaged in ICES working groups. To various capacities and degrees, all the involved informants participate in the production of ecosystem overviews, which add a practical and professional approach to the subject and thus constitute a valuable source of information in this context.

Table 3 below provides an overview of the informants who participated in the interviews. In accordance with the measures to ensure the privacy of the people, their position and ecoregion has been excluded from the table. In the column to the left, each interviewee has been assigned an anonymizing letter for further reference in the findings. The center column presents the overview of the informants' current connection to the three groups and level involved in this research. Then a column including information about the informants' disciplinary background and their entry to IEA overviews. The information is included to shed light on the disciplinary variety of the groups, and their inclusion in their respected group. To the right, an overview of the exact duration of the interviews.

Table 3: Interviewee presentation

Interviewee	Group affiliation	Informant background	Duration
A	ICES Secretariat	Existing network in ICES. Disciplinary background: environmental science	1h, 3min
B	IEASG	Got involved in IEA through existing network within ICES.	1h, 43min
C	WG1	Appointed by national institution. Disciplinary background: mathematician	1h, 18min
D	WG1	Got involved through affiliation to national institute and university. Disciplinary background: marine ecologist	1h,18min
E	WG2	Appointed by national institute Disciplinary background: ecology and biology	1h, 17min
F	WG2	Appointed by national institute. Disciplinary background: parasitologist and ecology	1h, 17min
G	WG3	Embedded in the ICES network Disciplinary background: Ecosystem modelling	1h, 12min

4.5 Ethical considerations and confidentiality

The interviews did not involve any sensitive or difficult issues, and none of the interviewees expressed skepticism or discomfort during the interviews. Through the consent form (see appendix 2), the informants had the right to withdraw if they wished, either before, during, or after the interviews. They were also reminded of this verbally before the interviews. Other relevant ethical considerations include trust and confidentiality (Tjora, 2021). To preserve the privacy of the participants the data was anonymized.

The collected data was collected as part of the project and was stored on NTNU-internal storage devices according to NTNU guidelines and the SIKT approval for the project Meta-organizations' Role within the Field of Ocean Governance. In order to ensure that no unauthorized persons are able to access personal data, several measures are in place. Names were replaced with a code. The list of names, contact details and respective codes was stored separately from the rest of the collected data, the data will be stored on a research server, which is locked away. Measures to anonymize the participants are in

place as their names has been removed. However, if anyone has knowledge about the organization and positions it could be possible to infer the identity of the informant.

4.6 Data quality

The following section will provide reflections on the research's reliability and validity and whether it meets the requirements for good standards in qualitative research.

Reliability refers to the consistency and dependability of the research findings. It includes factors such as the accuracy of the variables measured. It involves ensuring that the data collected, and the interpretations made from it are consistent, trustworthy, and credible and can be replicated (van Thiel, 2022). In relation to accuracy, the measurement tool represents an important factor in the research's ability to achieve reliability. In the case of qualitative research methods such as interviews, the measurement tool is the interviewer, which causes certain challenges to reliability, especially considering that the interview, transcription, and coding are the main tools of measurement.

I conduct the interviews with preplanned questions, which are then processed through transcription, coding, and interpretation. (van Thiel, 2022) As a result, the measurement tool risks becoming influenced by subjective factors which would affect the research reliability. The challenge lies primarily in my background; I have limited insights into the scientific community and knowledge practices. Therefore, my interpretation may be influenced by contextual naivety and an inability to interpret accurately due to a preexisting interpretation of the terminology and concepts shaped by my academic background within organizational theory. To mitigate this challenge, I attempted to get well-acquainted with the topic in question through existing literature and also by having several informal conversations with scientists within the field of ocean governance. Moreover, I formulated open-ended interview questions, allowing the interviewee to openly share their perspectives and opinions. For the processing of data, all data went through a standardized process of transcription, followed by coding and analysis.

The second factor to consider when addressing reliability is the replication of the research and findings. This involves the ability to repeat the study using similar methods and procedures to confirm the robustness of the findings, increasing its credibility. The challenge in this case, and often in social sciences in general, is the changing nature of the research object.(van Thiel, 2022) Considering that this is a changing context, it is reasonable to argue that there would be a variation depending on the time of the replication and who is relevant to the interview. Nevertheless, to mitigate this challenge, transparency and detailed presentation of methodologies and approaches have been emphasized to improve the ability of replication.

The research's *validity* refers to the extent to which the research accurately captures and represents the phenomenon in question. It is also separated into two types of validity, internal and external. Internal validity refers to whether findings accurately reflect the causal relationships or patterns observed within the data, in other words, is the research measuring what it set out to measure? Does the causal relationship or patterns observed between the dependent and independent variable exist, or have crucial variables been left out? (van Thiel, 2022). Recognizing the complexity of social systems and the phenomena, it is difficult to successfully argue that the research has been able to capture all variables and potential external factors which potentially could influence the causal

relationship. Nevertheless, it has been attempted to achieve a whole picture. By including the accessible variables, consciously assessing current theories and literature on the topic, and including analysis of documents to strengthen the data, this research has, to the best of its ability, tried to strengthen the internal validity. Yet, it could still be improved by, for instance, increased triangulation of methods and a higher number of interviews to minimize the impact of bias or preconceptions on the interpretation of the data.

External validity, on the other hand, refers to the generalizability and applicability of the research findings outside the specific context in which the study was conducted. Can the research be extended to other populations, contexts, or situations? According to Yin (2018), the goal is not to extrapolate probabilities; to determine or estimate values outside an area where the function is known, but rather to expand or generalize theories (p. 21). Tjora (2017) points to conceptual generalization to generalize qualitative data so that relevance can be ensured beyond the data analyzed in the specific research. The criterion of generalization is challenging to achieve in this context, as it is based on a single case where case-specific variables may significantly impact the outcomes of the results. (Tjora, 2021) Therefore, the goal is not necessarily to generalize based on this research, but it may potentially lead to some interesting indications for future research. Enhancing external validity in qualitative research requires careful consideration of the research design, sampling methods, and data collection procedures to ensure that the findings are representative and applicable to broader populations or situations.

4.7 Data structure and analysis

This section will elaborate and explain the data structure utilized in the research, as well as provide a detailed account of how the data was analyzed. Based on the analytical approach applied to the thesis, an illustration of the data structure has been constructed, which will offer an initial overview of the applied data and analysis. Before presenting the data structure, it is necessary to elaborate about the applied Gioia-inspired method and why it was chosen. (Gioia et al., 2013) Following the illustration, there will be a deeper explanation of the applied method and subsequently an elaboration on how the data was processed, coded, and analyzed using CAQDAS (Computer-Assisted Qualitative Data Analysis Software) (Yin, 2018; Tjora, 2017), specifically NVivo.

The Gioia method is grounded in what its creators (Gioia et al., 2013) consider the potential of qualitative research: how inductive research can be conducted with "qualitative rigor"(Gioia et al., 2013) while simultaneously stimulating conceptual and theoretical creativity.(Magnani and Gioia, 2023) The method also presupposes that research is often influenced or constrained by existing knowledge or preconceived theoretical approaches. This contributes to the refinement and development of existing knowledge, which is highly appropriate, but it can also limit new and potential theoretical originality (Gioia et al., 2013). In this context, it becomes an especially interesting approach, considering that practice theory in general is characterized by a dispersed plurality (Nicolini, 2013), opening the door for originality and new combinations of theoretical perspectives within practice theory. From a knowledge practice perspective, Borie et al. (2021) emphasize that knowledge practices and their applicability must be adapted to further case studies, which paves the way for additional contributions to research on knowledge practices in scientific organizations. This is also supported by a

notion that the method has been applied to studies of practice before.(Jayarathna et al., 2022)

Additionally, it is noted that the Gioia method is particularly well-suited and almost requires a relatively general research question (Gioia et al., 2013), making the method relevant in this context and influencing the formulation of the research question. Beyond the research question, the method, like other robust qualitative research, employs multiple data sources, but the core of data collection lies in semi-structured interviews.(Gioia et al., 2013) This makes it well-suited for research where the primary source of data is semi-structured interviews, supplemented by document analysis or observation. In this particular case, semi-structured interviews and a light document analysis constitute the data basis for the research. The argumentation behind the approach highlighted by Gioia is that the combination of the mentioned factors generates data that is both retrospective and capable of capturing current experiences of the phenomenon (2013).

Moreover, another fundamental principle emphasized by Gioia, which is particularly relevant in this context, is that interviewees must be recognized as "knowledgeable agents" (2013). This means assuming that the informants being interviewed are aware of what they practice and can therefore explain the background of the practices, why they were enacted, and how they are carried out. However, it is not necessarily certain that they share the same theoretical terminology as the interviewers. For this reason, it is crucial that the questions posed to uncover the informants' experiences and perceptions facilitate the informants' own formulations and understanding. If theoretical terminology and concepts guide the data collection too much, there is a risk of missing critical factors from the informants' own terminology that contribute to explaining the phenomenon being studied (Gioia et al. 2013).

The combination of the Gioia-inspired method with practice theory offers a holistic approach to understanding the knowledge practices of ICES. By coupling the theoretical lens of knowledge practices and practice theory with a Gioia-inspired method, the approach arguably provides the research with a robust framework for exploring the enactment, reproduction, and transformation of practices within the organizational context of ICES. Through integrating these approaches, this thesis hopes to achieve a better understanding of the complex dynamics underlying knowledge practices of ICES and, thereby, their knowledge production. Yet, the methodological approach of this research lacks the ability to identify practices beyond what can be discovered by interviews and reviewing documents. This is of course a weakness of the research. However, it does open the floor for further research where the scope and limitations might allow further exploration through deeper explorative methods, including observation over time.

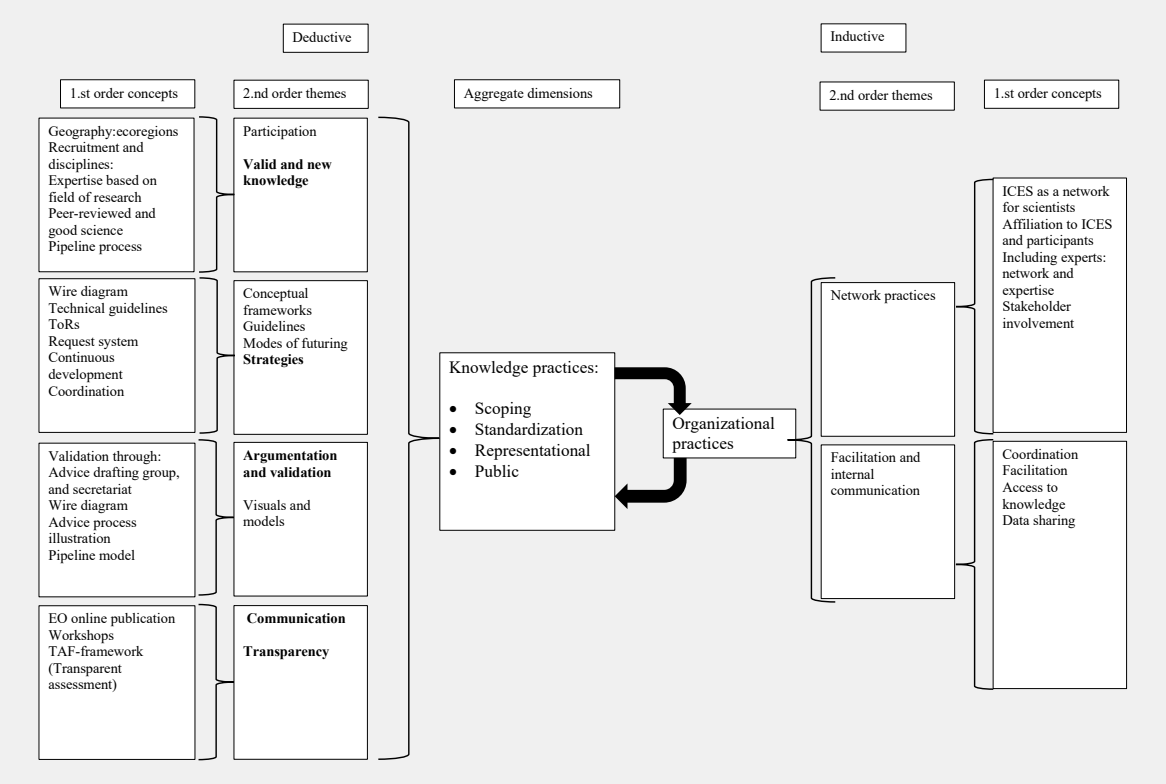

Figure 1: Data structure

Read from the left, you will find the deductive approach. This entails that the process was based on the theoretical framework with four forms of knowledge practices. With the theoretical characteristics of the various practices in the background, the findings were first coded and grouped according to their affiliation with the different theoretical knowledge practices. The empirical data was coded to the first-order concepts by relying on empirical descriptions provided by the informants. Meaning that the codes seen in the column to the left are as close to the terms used by the interviewees as possible. Secondly, the codes were bundled into four distinct concepts to organize the data according to the subcategories of knowledge practices that the theoretical framework presents. The four second-order themes derive from the theoretical framework. (See table 1) However, to appropriately clarify and bridge the framework's terms to the empirical context, some adjustments were made to the terms in the second-order themes. (The adjusted practices are in bold in figure 1).

Scoping practices, as mentioned in the theoretical chapter, involve participation and assumptions about valid knowledge. This theme includes parameters that define the research boundaries concerning geographical scope, who should be included, and how inclusion occurs, as well as which disciplines are involved in the process. In addition to these two, assumptions about valid knowledge have been renamed to valid knowledge and new knowledge. New knowledge is included because it is particularly emphasized by informants as a central theme in the production process of ecosystem overviews.

Under standardization practices, the terms remain the same, with the exception of strategies for coordination and harmonization, which is shortened to strategies to encompasses the same factors and other relevant strategies. Regarding representational practices, consensus/dissensus and argumentation are combined into the code argumentation and validation. This change simplifies the review of the associated

practices. Visuals and models remain unchanged, as they will continue to be a relevant aspect to keep separate. For public practices, communication remains the same. In terms of data sharing, the term is replaced with a more inclusive code that captures a range of essential practices related to transparency and data sharing according to empirical descriptions.

The third and final step of the process was to organize the findings using aggregate coding so that the subcategories of practices could be bridged to the aggregate dimensions from the theoretical framework referring to the four knowledge practices.

To the right of figure 1 one will find the inductive approach. The rationale behind this approach to data structuring is based on the recognition that other organizational practices could potentially play a central role in the knowledge practices of the organization. The research started with a deductive approach based on the four theoretical forms of knowledge practices presented in the applied framework. The challenge with the framework would prove to be that it did not sufficiently address the interference of other practices and dynamics that occur during knowledge production in ICES. The framework was effective when identifying knowledge practices but excluded certain practices that help answer the research question.

Therefore, it became relevant to include an inductive approach to shape an additional factor: organizational practices. Organizational practices emerged in line with the Gioia-inspired method. (2013) First, the data was coded and organized into first-order concepts according to the empirical description provided by the informants. For instance, it includes descriptions of practices of facilitation by ICES and network practices influencing the production process. Secondly, findings such as these led to the generation of codes that aggregate to second-order themes. This meant creating linkage between the first-order concepts to more specific categories of other practices. The themes were then defined as network practices and facilitation and internal communication practices. Internal was added to the theme to distinguish it from communication practices in the knowledge practices subcategory of public practices.

The third step was the aggregation of the two second-order themes into an aggregated dimension: organizational practices. It became necessary to create a distinct concept to sufficiently distinguish these practices from the knowledge practices. Yet, the concept would remain within the practice theoretical realm. Applying a Gioia-inspired method would allow the creation of a new dimension that can prove to be a helpful contribution to knowledge practice theory.(Gioia et al., 2013) Moreover, it allows the incorporation of other theoretical approaches, which may provide helpful insights into answering the research question.

In combination, the intersection between knowledge practices and organizational practices is found in the center of figure 1. The analytical method applied to this thesis consists of exploring the production of ecosystem overviews through the data about knowledge practices and other organizational practices that may help explain how these ecosystem overviews are produced by ICES.

Regarding the processing of data before and during the analysis. The recorded semi-structured interviews were first transcribed using Microsoft Word Dictaphone. Afterward, the transcripts were manually proofread and transcribed while listening to the recording. As mentioned in the introduction to this subsection, this research used NVivo in the

coding and analysis. The use of CAQDAS has been a subject of debate within the research community. Some argue that such software might risk distancing the research from the context in which the original data was generated. On the other hand, these programs offer the advantage of enabling non-destructive coding (Tjora, 2017, p. 227), assuming that the documents are not altered during the coding process. In this case, the transcribed interviews were uploaded to NVivo, where they were reviewed and subsequently coded in line with the uncovering of findings.

5 Results

The following chapter will present the empirical findings identified through the semi-structured interviews and the relevant documents the informants referred to during the interviews.

The first section will cover the deductive approach of knowledge practices, presenting the findings that originated from the analysis of the four knowledge practices. It will be presented accordingly to the order of the theoretical framework and subcategories. Following this order, the second section will present the empirical findings of the organizational practices from the inductive approach.

5.1 Scoping practices

This section will provide empirical findings aligned with the scoping practices introduced by Borie et al. 's framework (2021). Participation practices consist of the parameters for how expertise is included, what disciplines are incorporated, and what geographical boundaries are applied to the shaping of the knowledge production of the overviews. Secondly, scoping practices entail the parameters for the inclusion of what is considered valid knowledge.

5.1.1 Participation

During the interviews, the initial focus was on the participants' disciplinary backgrounds and how they initially became involved in the work with overviews. As shown in the presentation of informants, (See figure 3) their disciplinary backgrounds are diverse but predominantly rooted in the natural sciences. This was a common trait among all participants. However, there were differences regarding how they initially became involved in the work; some participants were involved through a nomination from their home institution, such as a national research institution. Furthermore, it was highlighted that some informants experienced a form of encouragement from their employers to participate, due to the need for representation in ICES. Interviewee F in WG2 said it was "a push from my employer that we should get engaged in the ICES groups. So I volunteered to be engaged because I already had a lot of experience." While interviewee D in WG1 points to:

> It was basically through my institute back home. Now we are a university so I started to be active in ICES and then of course they needed some people to cover some of these, let's say, key working groups. And looking at my background and so on, they asked me if I was interested. That's how the teams developed.

Initially, it was mentioned that there are two ways to be included in the working groups: the first is through nomination, as the findings above indicate, and the second is through invitation from the group's chairs as explained by both WG1 and WG2. Moreover, it points to the fact that the participation in the group is temporary through cycles.

> It's two different ways of joining it. One, some people are nominated by the nation they come from, the country nominate people to ICES working groups and the chairs, and also invite people that have relevant knowledge to contribute. The working group. And we have a lot of both. I don't know, if it's 50/50, but there's a lot of chair invited people.

> The groups work in like a three-year cycles. And the chairs are nominated for three years, so at the beginning of every cycle three-year cycle, the chairs can nominate new people that are then active for three years. The ones that are nominated nationally are permanently in the group. The chair invited are renewed every three years with the chairs, so there is the group from the beginning of this three year period and a lot of them are nominated again again, so they remain in the group.

In the interview with IEASG, it was mentioned by informant B that there is a third form of recruitment, which happens through self-initiation. Researchers can contact ICES themselves and request to participate in working groups, but this form of inclusion is relatively unknown. "You can just ask to join a group, which I don't think enough people know about, which we're trying to get better at promoting."

When people are already involved in ICES groups, their knowledge of the organization and the network, allows them to reach out more easily to other groups they might find interesting. So as the interviewee D describes below, when a person already has been included in a working group, the mobility to other groups is made more accessible.

> I think the majority of groups; if someone's doing research in an area and they decide they want part of ICES and they see this group exists, they can just e-mail the chairs and say I'd like to be part of this. It's super flexible, unless there's a conflict of interest.

In the interview with WG3, it was also pointed out that the groups do not actively reach out to the research community in search of new participants, nor is the opportunity for participation widely promoted.

> We don't often seek new members, so I haven't really gone out of my way to find new people, but we're quite a popular group. But when these new group starts, you often find that a lot of the members of new groups are people that have come from kind of parallel groups.

Strongly linked to the recruitment findings is the disciplinary factor. Below are findings that address the disciplinary factor in the production of overviews. Initially, the multidisciplinary scope is set in a historical context, where it is highlighted that the informant has experienced a change in the organization's inclusion of various disciplines. According to this informant's experiences, there has been a gradual shift that has opened up for a broader inclusion of disciplines, despite friction along the way, ICES has gradually become more collaborative across different disciplines.

> It's becoming a lot more collaborative and we're seeing a lot more instances of kind of interdisciplinary researchers bridging the different groups working between for instance the ecosystem groups and the human dimension steering group. I think there have been barriers, but I think they are breaking down.

Interviewee C refers to points to a distinction between how multidisciplinary inclusion affects the execution and efficiency of workshops. This quote describes that the need for multidisciplinary depends on the purpose of the work. When discussing new concepts or purely as thought experiments, it was interesting to have a wide range of disciplines included in the groups. However, the informant noted that it affected the efficiency in other contexts such as in the situations where something concrete needed to be produced for the overviews.

> For the workshops, I would say that the more diverse the group was, the more difficult it became. But the more interesting it became, so for those exercises it was very valuable. That it was a large variety of different people. I'm not sure if that would be very efficient when we did our annual meetings but for the exercise, absolutely.

In addition to the scoping practices covered above, geographical parameters are also included to define the scope of the research. In this context, findings are presented that

shed light on how geography is used as a parameter for overviews. The technical guidelines (ICES, 2023a) were referred to in the interview with the steering group. It offers important information such as the justifications for how the geographical element affects scoping practices. For example, it is highlighted that overviews are specifically designed for established ecoregions and should therefore be limited to the given boundaries. "Ecosystem overviews are specific to ICES ecoregions and written for each region as a whole; any important differences within a region should be reflected in a few brief subregion bullets."

The map you see below in figure 2 describes the geographical scoping in accordance with the predefined ecoregions of ICES. The differentiation between the ecoregions is based on a range of characteristics and factors and was developed by ACOM in consultation with stakeholders. As a result, the division has taken into consideration factors such as natural scientific factors like biogeographical and oceanographic aspects, but it also includes societal factors such as political, social, and economic characteristics.

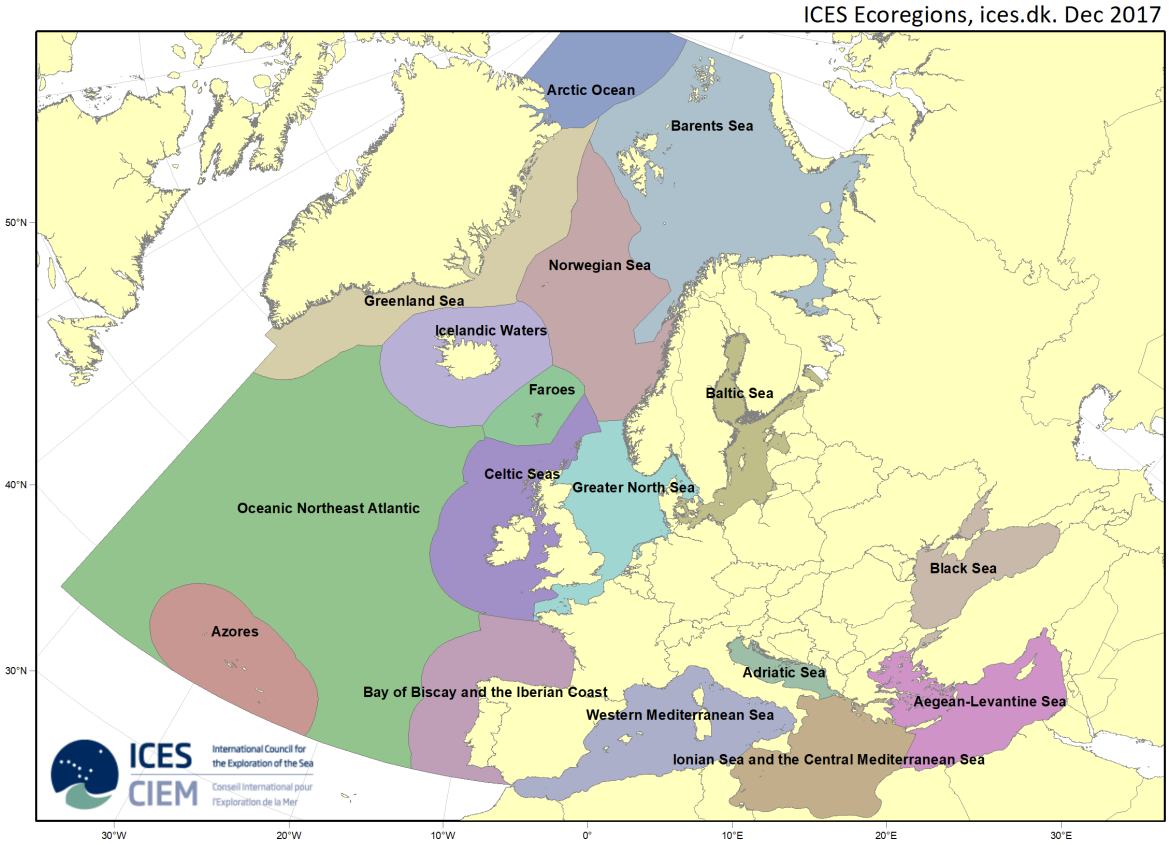

Figure 2: ICES Ecoregions (ICES, 2023b)

5.1.2 Valid and new knowledge

So far, the findings presented have covered practical parameters that contribute to shaping the practices related to the inclusion of people, disciplines, and geography. Thus, the basis for what contributes to the production of overviews. However, a central question remains: what knowledge should these researchers and disciplines utilize to perform valid and robust research within the geographical areas? This leads to the presentation of findings related to valid and new knowledge and, thus, what knowledge should be included in the scoping. This parameter involves how knowledge is selected, delineated and how new knowledge is admitted or rejected from the research scope.

Interviewee G' statement is worth including as it clarifies where the included knowledge should come from. It should not only be the best available science reflected through the overviews, but it should also emphasize that it represents the best science produced within ICES. "The overviews; they have to reflect the best available science that is produced within ICES."

First and foremost, through the technical guidelines, a set of formal practices can be established to govern the inclusion of what can be considered valid knowledge. The following quote therefore focus on the prevailing principles for the inclusion of existing knowledge. (ICES, 2023a)

> The ecosystem overviews are based on the best available information and are developed through a set of workshops and/or by ICES integrated ecosystem assessment (IEA) groups, with contributions from other relevant expert groups (EGs) using automated data products and spatial data layers from accepted legitimate sources. […]Data and knowledge sources must be fully cited. Unpublished or unvalidated sources should not be used.

During the interviews, all responses aligned with these two principles mentioned above. In addition to these principles, interviewee B pointed out that there are also other sources of knowledge incorporated into overviews. The first mentioned involves knowledge sourced from other organizations, which have tools that can contribute to the efficiency of the overviews production.

> I think one of them was another international organization and one of the biggest modelling tools at Ecopass was also having a meeting and then there was another southern European meeting going on and so we wanted to wait until they were done so we could build on their outputs rather than trying to reinvent the wheel.

For example, stakeholder involvement was highlighted as a source of knowledge from WG2 outside of overviews. This finding specifically points to the value of external knowledge that is not necessarily scientifically documented, but rather from the perspective of management in practice.

> There was a workshop that ran for a few years, where they were having stakeholder conversations and they ran models including the fisher's perspective, fisher knowledge and how they use this approach and the kind of reference point from that work is in the management aspect in the Irish Sea. In the publication with the model including the Fisher knowledge was doing much better than the one without.

5.2 Standardization

The following section will present the standardization practices, the conceptual framework, guidelines, modes of futuring, and strategies. In combination, these practices incorporate the overarching practices that enhance or support a collective orientation towards a shared objective.

5.2.1 Conceptual framework

The conceptual framework is referred to as the wire-diagram. It consists of human activities, pressures, and ecosystem components. This framework shows the relationships between the three factors and constitutes the overarching problem framing intended to support the production of overviews with the aim of contributing to achieving the vision of EBM. It is highlighted in the ICES technical guidelines (ICES, 2023a) Interviewee B describes the need for the diagram "Without the conceptual model and operational definition, group discussions tended to fall back and focus on "what is EBM?" Instead of on how we can progress the evidence base for EBM and its practical implementation into advice?"

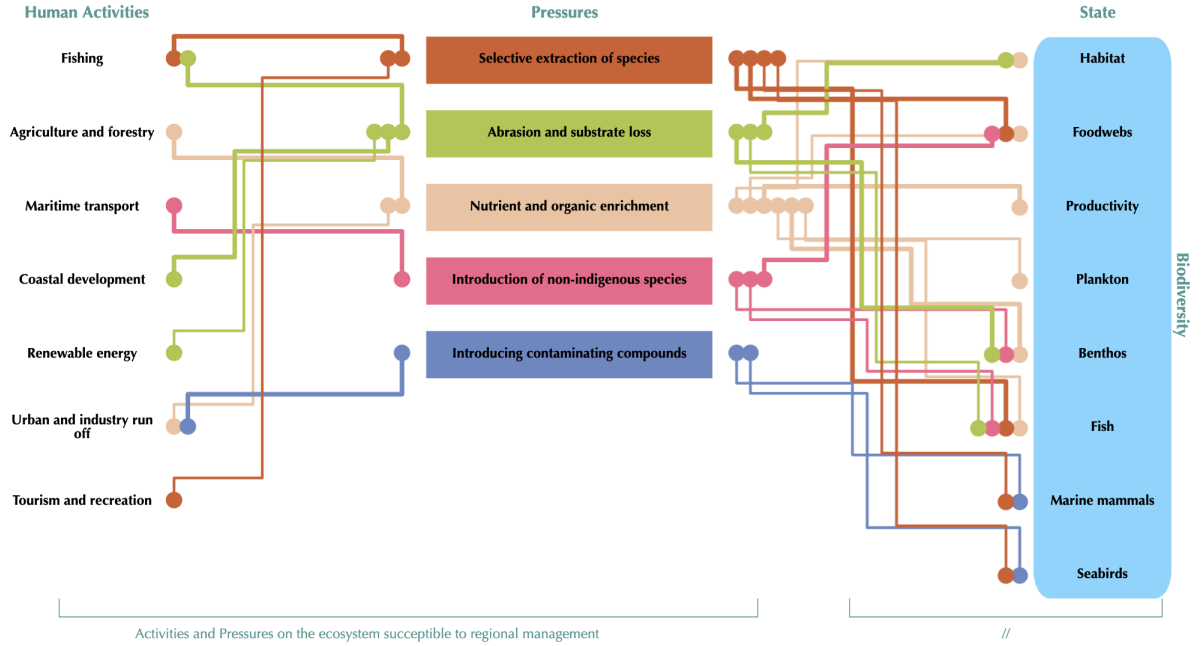

Figure 3: Wire-diagram, source: (ICES, 2023a)

The development of the conceptual framework has taken place over time through a series of workshops. It started with the recognition that there was a need for an improved method to ensure a streamlined process. Interviewee B had a central role in the development and implementation of the diagram and could therefore elaborate on how it was utilized.

> We had agreed that we would roll it out across the groups. and so began the task of developing the methodology, adapting it to ICES, scaling it a bit so that it could be more easily applied by all the IA groups.

During the interview, it was also highlighted that the use of risk assessment was a crucial element, not only for the initial development of the diagram but also for subsequent work on its development.

> Process has changed now because we have this standardized risk assessment, so they have a set list of the sectors that they should be considering. They have a set list of the pressures that they should be considering and I'm not fond of this because there's only five or six ecosystem components. But that's what they have. They have a set system for how they go about assessing this, so it's not down to them to decide what they consider they can add to it, but they should consider everything that's in that list.

The use of the diagram is primarily based on setting a unified direction for the work. Additionally, it is flexible enough to maintain a degree of autonomy and freedom for the individual working group, as interviewee E elaborates on. "ICES is getting more and more structured with how the ecosystem overview should be done and now you have to document more. But in the beginning it was more free range." The interview with WG2 also brought up this flexibility and adaptation to individual circumstances through one of the three overarching elements in the diagram: human activity, pressures and state. When asked to explain how the production process started, every working group consistently referred to the list of given pressures introduced by the diagram.

> The point is that we have a list of pressures, and we had an exercise where we tried to find out which was the most important pressures. Yeah, It was a large exercise setting up different groups of species and different pressures and different whatever outcomes of this.

> When we put it all together, then we ended up with the most important pressures and the idea was to focus on those. So. But I don't think they changed since the last since the first version but, but in principle they could change so that you will update and include new pressures.

5.2.2 Guidelines

A category of standardization practices is the use of guidelines. This section will therefore present the findings related to the use of standardized guidelines during the production of overviews. They illustrate how formal guidelines help to create a clear direction for the production process, as well as provide support and assistance to working groups during the process. Initially, a quote explaining the purpose of the guidelines is presented. This quote is from a frequently referenced document among the informants: the ICES' Ecosystem Overviews Technical Guidelines (2023a).

> The guidelines describe the purpose, content and methodology to produce, revise and update the ICES Ecosystem Overviews (EOs). The information in this document is relevant for the ICES expert groups delivering scientific evidence for EOs but also for interested policy makers, stakeholders and the wider scientific community.

Furthermore, an overview of the various guidelines available for working groups is provided. This finding was retrieved from the guide to ICES advisory framework and principles and identifies several existing guidelines for the production process. (ICES, 2023a)

> The current guidelines include guidelines for ICES groups (including a Code of Conduct which incorporates the Conflict of Interest statement), the meeting etiquette, the Data Policy and best practice guidelines for Data Management, the guidelines for peer review groups and guidelines for advice drafting groups (ADGs). Various technical guidelines also exist that explain the methods used and how advice was established.

In a practical context, several informants pointed to examples of how guidelines are applied in various situations. One of them being ensuring objectivity during discussions, as pointed out by interviewee G. "Have mechanisms in place to deal with challenges that are constructive.[…] So there are formal routes […] you have to start the working group or workshop by going over the code of conduct and ethics devices." Interviewee B mentioned the guidelines in relation to the selection of pressures and the work with the conceptual framework, and how they are developing a standardized methodology. "There wasn't a very strong methodology there. So, one of the things I have been working on with them is we developed a methodology, we introduced that. That's now a standardized advice request."

Another crucial point highlighted by several informants is that ToRs are guidelines over which the participants in groups have influence. In addition to overarching objectives and expectations, ToRs function as a form of agreement between, for instance, the steering committee and the individual WG. This enables negotiation and harmonization between the parties, ensuring that both sides have a clear understanding of what to expect from the cycle.

> Every IA work group we have our terms of reference and we're free to decide what they are except for the ecosystem open term of reference and most work workshop work. Most work IEA working groups will have their term of reference, a delivery system overview.

5.2.3 Modes of futuring

Modes of futuring refers to the incorporation of practices that can contribute to predicting future scenarios or adapt to future. During the interviews, it was reflected around how ICES should move forward with the overviews and emphasized the challenge of how to do so. "The process is still an evolving animal and we're learning from what we've done before; what worked and what hasn't? There are remaining challenges, very little of it is automated, so very little of it is standardized." Moreover, it helps to explain how modes of futuring for the time being remains absent from the overviews. Interviewee F provides a perspective of why the overview is not prescriptive "it's more like providing background information for people to understand the ecosystem context of things" Interviewee D also makes a comparison to a different type of advice in while talking about the inclusion of predictions to the overviews and emphasizes its informative purpose.

> It is not prescriptive in the sense of giving advice like in the case of the single stock assessment for single stock which has a more close you know relation with management option and so on. So it's more to reach out and make people aware of different aspects that they should potentially consider.

Moreover, interviewee B talks about the potential incorporation of predictions in the overviews. However, the challenge is that the process is not there yet. The existing models are developed for specific purposes in other field and is apparently not applicable to the overviews

> There is movement towards that. But the problem with the ecosystem, they're really enthusiastic about doing this. In theory, the learning process for being able to forecast into the future with robustness and confidence is in the those models[...] well, all models are wrong as we know and all of them are built for specific purposes.

5.2.4 Strategies

The framework for ecosystem-informed science and advice (FEISA) is referred to as the overarching standardized strategy for the production of ecosystem overviews. It is illustrated in figure 5, which is retrieved from the FEISA report (Roux and Pedreschi 2024) The strategy entails the incorporation of risk assessment and a system of indicators as the main tools or practices for the development of overviews. The FEISA was brought up by interviewee B.

> Two main tools or approaches, and that's using indicators and carrying out risk assessments. So once we develop anything that we can use as an indicator, then we can carry out risk assessments on them and inform on that basis. A lot of the work we already do within the IA groups aligns with this.

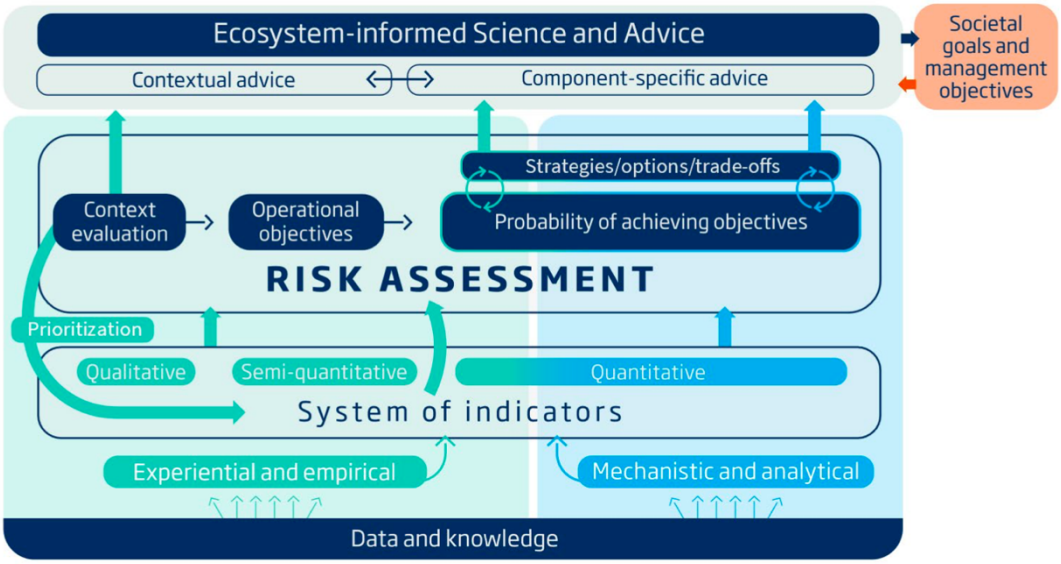

Figure 4: FEISA, source (Roux and Pedreschi, 2024)

The creation of the FEISA approach was a result of recognizing the need for an overarching strategy that would coordinate the pursuit of EBM. As a result, several workshops were initiated in order to formulate a strategy. Interviewee B provided an explanation for how the framework came to be.

> There had been a couple of workshops with members of ACOM and SCICOM, to kind of brainstorm what EBM would look like, cause none of us had any idea right? We have all these ideas, but how do we make something happen? And then everybody has their own nuanced idea of what EBM is, or what an ecosystems approach is. And so, we spend a bit of time on definitions and reviewing what ICES has already said. ICES already has like some principles on ecosystem-based management for instance. So, like anything that we were going to develop needed to be coherent with what ICES had already developed with the science advisory and strategic plans, for instance. We reviewed all those documents too.

In relation to the FEISA strategy and the incorporation of standardized practices. The heterogeneous characteristics of the ecosystem overviews is brought up, interviewee B emphasizes that the coordinating strategies of ICES do and should focus on aligning the different groups towards an overarching objective and facilitating effective delivery rather than strategies aiming towards system-wide standardization. "So the political answer is that I think we should be responsive and adaptive to regional specificities and capacity limitations. But I also think that there is a lot that we can do."

the introduction of new knowledge was a topic that informants discussed extensively, particularly regarding the process of how new knowledge is integrated into the process and overviews. A standardized practice has been established to help accept or reject new knowledge. ICES defines the process as the pipeline process. The pipeline process of introducing new ideas is a visualization developed by the ICES. The purpose behind the visualization is described in the statement provided by the interviewee

> We're trying to get at the earlier stages of this. So the development and the ideas of ecosystem advice. Where can it come from? Who can contribute? How can you do that? And so, ICES has set up like a, what they call a pipeline process. So if you're thinking developing some piece of advice, that you can flag it with ACOM as you're developing it, rather than at the end, going, oh I've made this lovely thing, and they go well actually we can't use that, because of ABCD.

It was also referred to the technical guidelines for the overviews, and an illustration of the pipeline process could be found there. As a result, its incorporated in the findings, with an explanation below. Step 1 refers to the initial scoping and definition. The proposed new science should meet a set of criteria defined by ICES. Moreover, the proposal "should have a specific management objective" and originate internally within the ICES network. Step 2 involves developing the knowledge and involves "the EG development of the new science, including knowledge development and synthesis and assurance of data quality and transparency through data profiling tool(DPT) documentation." Step 3 refers to validation and peer review of the produced science, by external reviewers and ACOM. The final, step 4, refers to the production of new knowledge and the published advice. The step involves "drafting of the advice by an ADG and approval of the advice by ACOM with inclusion of the new science in the ecosystem overviews. It also includes transfer of the methods, data, and outputs to Transparent Assessment Framework (TAF) wherever possible. This stage should strictly follow ICES guidelines of advice" (ICES, 2023a)

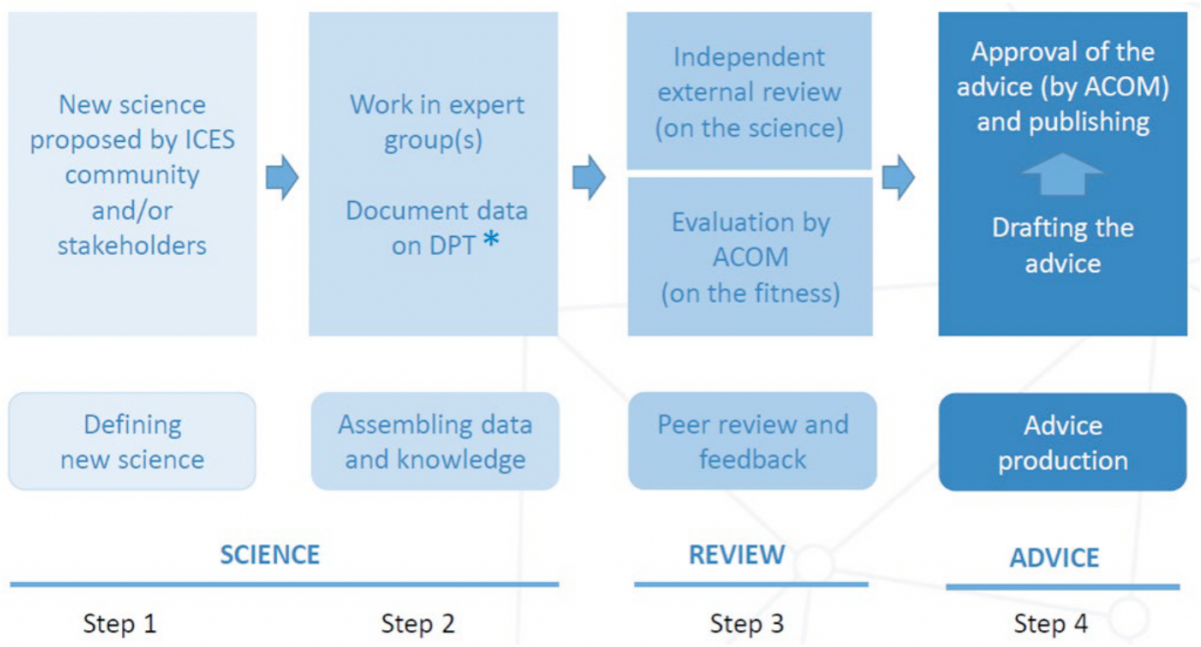

Figure 5:Pipeline process, source: (ICES, 2023a)

5.3 Representational practices

5.3.1 Argumentation and validation

When asked about consensus, there was a shared opinion among the interviewees that the production is guided by what was referred to as good science in the scientific community. When addressing if there are any controversies related to the conceptualization of ecosystems within or outside ICES, interviewee G summarize the shared consensus-driven approach by this statement. "It's all just guided by best available science and justifying why things are best available science. And often we go through review processes to make sure that what we are doing is the best available science."

The interviewees in WG2 addresses the process of submitting and bringing the drafted overview to the ADG for further processing. The process may include adjusting the formalization of the overview, in addition to clarifying the output to best suit the intended receiver.

> You're at the interface, essentially. You're trying to take the report from the science group and translate it in a way that can really inform a decision-maker and society generally. But in order to do that, very often, when you're in an advisory process, the scientists that will represent the working group, usually we have the chair of the working group. The advice drafting group will ask questions about the science.

The interviewees in WG2 describes the process of submitting the final draft to the ICES ADG. The description provided by the interviewee paints a picture of the internal process in the later stages of the production process.

> So the group drafts an advice. The ecosystem overview advice drafts and that goes to the advice drafting group within ICES, but nobody from the group is. It's totally separate group of people. They're like the reviewers, and they go over it all. And they change the text. They had the right to change the text. And they released the final version of the advice, which is then released by ICES. So we, it's not us, the document can be changed quite a lot from us until it's published.

5.3.2 Visuals and models

Two important figures were presented in the FEISA document. These two figures illustrate the shift in how the ICES conceptualizes the world in the context of conventional advice to ecosystem-informed advice. The first illustration depicts conventional science and advice, while the second illustration shows the expanded approach to holistic ecosystem-informed science and advice. Both figures are retrieved from the framework for ecosystem-informed science and advice (FEISA) (Roux and Pedreschi, 2024)

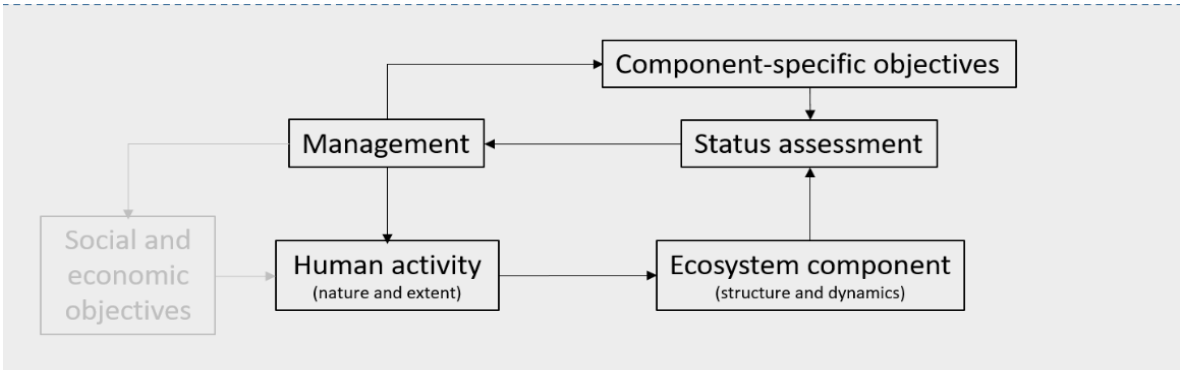

Figure 6: Conventional process (Roux and Pedreschi, 2024)

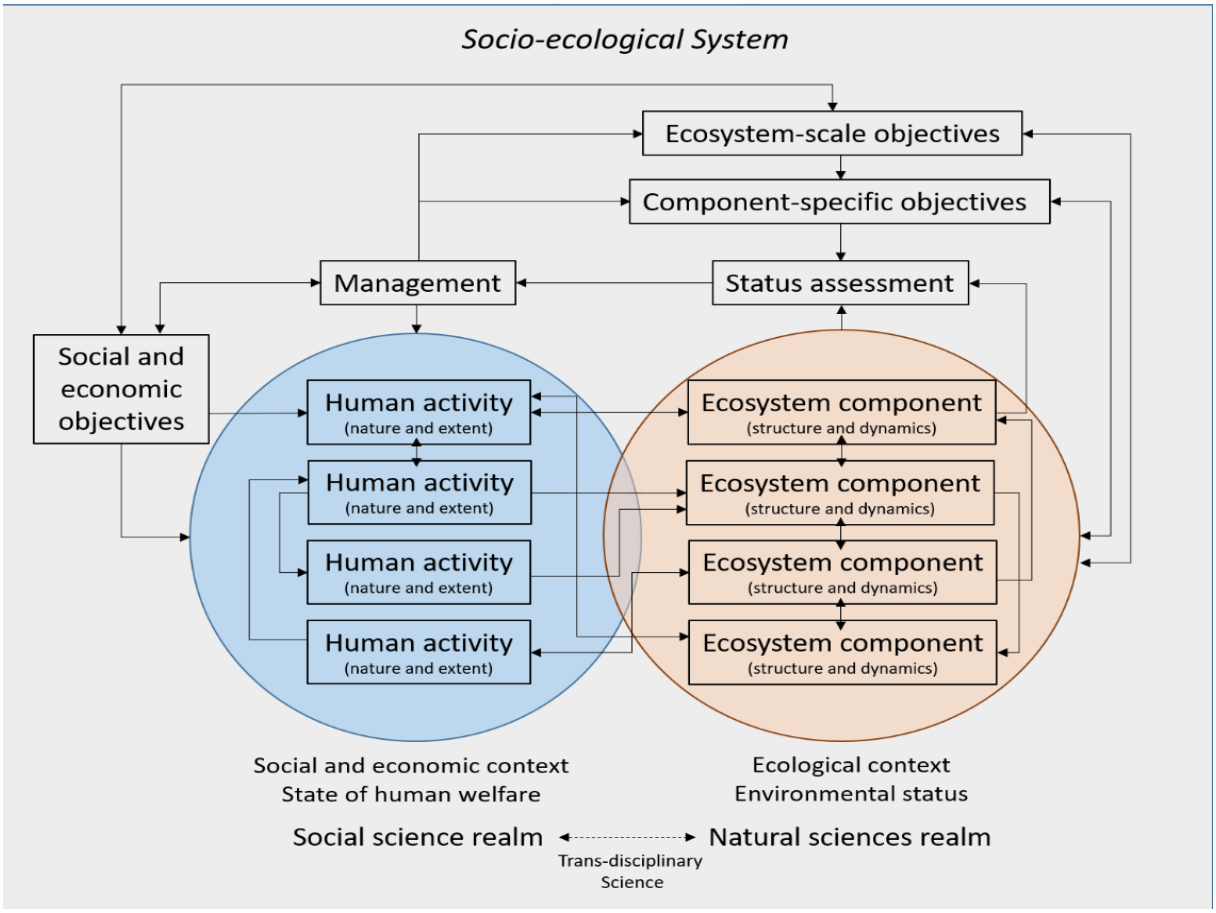

Figure 7: Ecosystem-informed process (Roux and Pedreschi, 2024)

The next findings address the incorporation of visual tools in the overviews. The first one a description of current use of visual illustrations provided by interviewee D.

> The infographic for the ecoregion, that was based on the ecosystem overviews is in the annual ICES report 2022. That's a figure there in PDF. Then there is the wire diagram that is in the in the ecosystem overview, in different colour, online. If you point the cursor to a specific pressure you can see the link is a bit interactive, it is interactive online.

5.4 Public practices

Public practices refer to the practices of interacting with the public sphere. It entails the external communication practices of ICES, as well as the practices related to ensuring transparency.

5.4.1 Communication

Interviewee A describes the communication with the public at the early start of the ecosystem overviews; in particular, A emphasizes the interaction with stakeholders. In detail, how the practice has changed. Where the interaction with stakeholders has been increasing. When interviewees in WG1 refer to them, they are talking about stakeholders. "But at the beginning not that formally, but they participated in some of the workshops, then we were a little bit more formal in asking them and trying to establish new methods"

The interviewee from the steering group describes the interaction between working groups, stakeholders, and clients as non-existent. However, it is referred to formalized arenas for interaction two times annually. Where the interaction stimulates to feedback loops for further development of the overviews.

> The recipients of ICES advice the working groups have no contact with them. At all. I don't have any contact with them. I'm never out. But there is meetings annually, 2 meetings. There's a dialogue there about what do you think are the priorities or what's missing or what do you need to know. And so there is some conversation with those clients about, OK, what is this not delivering on or what are the gaps or or what are the emerging needs and. So there's some dialogue with ICES' and the kinds on those and then that will philter down.

According to multiple interviewees, interaction with stakeholders is limited to the secretariat of ICES, and the individual working groups have no or limited interactions with stakeholders other than through formal workshops. This is a quote from WG2.

> ICES ran different workshop with stakeholders. They were doing some qualitative model with the stakeholder engagement from scratch. And that was facilitated by ICES. So ICES also facilitated if a group is in the need to have a stakeholder workshop.

During the interview with steering group the public practices was discussed in terms of how ICES interact with the public audience. Stakeholder involvement and bringing inclusion of new knowledge through increasing the interactions with external stimuli is argued to be proposed to ICES later this year.

> Consultation across the community. So not just the people involved in your reviews, because it's an open workshop. So whoever wants to can join and give their opinions on what we think. Should be the priorities moving forward. Transparency through to specific topics that they want to see or integration of different disciplines. And so on. So that's one way from the community.

5.4.2 Transparency

Transparency was a reoccurring topic brought up in all interviews, and in different contexts. However, the general consensus was surrounding how important transparency is, and how they deploy practices to ensure the transparency of the process. Yet, the overviews has a different practice than other parts of ICES

The TAF framework the interviewee refers to is the Transparent Assessment Framework of ICES. ICES developed this framework to organize data, methods, and results and ensure transparent and available research data. Currently it does not apply in practice but is an ambition. The concept is to improve the transparency of the EOs over the last few years, and to that end ICES has developed a Data Profiling Tool to track the data and information that goes into the EOs.

> So everything has to be transparent of the advice and reproducible. So all the data are in this TAF framework. So anybody can actually reconstruct the advice and repeat it. And now for the ecosystem overview, when the data are not in this TAF framework the transparency and availability of all the data behind the advice is not there

The technical guidelines formulates a specific guideline for the transparency of the process. Moreover, it explicitly states the formalized practice for which transparency shall be carried out. (ICES, 2023a)

> Good scientific practice, and specifically ICES advisory framework and principles, promotes that we aim to fulfil FAIR (findable, accessible, interoperable, and reusable) principles for ICES outputs. Data used in the ecosystem overviews should be reported via the Data Profiling Tool (DPT) before the start of the Advice Drafting Group to finalize draft Ecosystem Overviews (ADGEO).

Interviewee G elaborates on the use of the data profiling tool and establish that this tool is used for all data being applied in the overviews. “So anything that goes into the overview goes into the data profiling tool, including the source information where it came from, how much you trust it.” Additionally the interviewees in WG2 explained the practice of how the data is processes and made open access. This allows the public access to the information. “So we collect the time series we use and report in a file that's on a ICES SharePoint and we are slowly putting it into Github and making it Open Access.”

5.5 Organizational practices

During the interviews, several findings emerged indicating that other organizational practices influence the production process and thus interfere with the knowledge practices. Specifically, there is a thread that revolves around both network practices as a factor, as well as facilitating practices and internal communication. This section of the empirical findings focuses on the inductive approach and the findings that highlight the influence of other practices. The presentation of findings will first address the second-order themes: network practices, followed by facilitation and internal communication.

5.5.1 Network practices

In the interview with WG1 both interviewees elaborated on the influence of network practices related to the inclusion of expertise in ICES working groups, when they were asked about how scientists such as themselves get involved in ICES working groups. Interviewee D describes a situation where existing networks stretching outside ICES to for instance national institutes create a practice of inclusion. Knowing about interesting working groups that one can contribute to, comes through established networks where individuals are both connected to ICES and for instance a national institute such as in this example.

> It was like also the network of people that I had established outside ICES or some people were actually, let's say, when the biodiversity science working wroup was created. That I knew already some people that they were getting involved so through different networks you kind of, get interested and also you have to be in a sense proactive with your institute in the sense that you also worked in the case for another working group that I'm sharing at present called resilience and marine ecosystem services.

Following up on the same context, interviewee C describes a situation where there is a twofold effect by participation in working groups, which the interviewee perceives as relevant for participants who join the groups through all forms of inclusion; nomination, invitation or requesting to join a group.

> Other people in your network are also involved here, so it means that you can keep up contact with them and also to get increase your network. So there are two sides when you get involved in such groups, it's the scientific thing. And then there is also to; To create and keep your network up doing so.

This finding highlights the significance of networks in the inclusion practices of expertise, specifically how existing networks help shape which expertise is nominated or invited to the working groups. Interviewee E brought it up while elaborating on the practice of including expertise into working groups. "Often the word of mouth and who knows who, when it comes to being nominated and invited."

5.5.2 Facilitation and internal communication

An interesting quote from interviewee G highlights a description of ICES, which describes ICES' ability to ensure a coordinated effort towards overarching objectives. Equally important, it is emphasized that there are facilitating practices that contribute to the development of knowledge.

> One of my favorite quotes I would be saying that thing with Daniel Howard. That ICES does not exist. Is just a group of researchers that comes together to generate science advice. So essentially we are right, it's not this big behemoth that people think it is. ICES just kind of gather it all the package it as overarching and unifying logo.

This is further substantiated in another interview where interviewee F points out that ICES engages in facilitating practices that help maintain the operationalization of knowledge production by the working groups. "They kind of help you with all of the process around setting up meetings, keeping track of reports so we have the SharePoint which sits down on top of and generate report templates and things like that for you" This is also brought up by informant C in WG1 and both interviewees in WG2 when asked about the autonomy of the working group during the production of ecosystem overviews. ICES facilitates for the working groups, by personal support related to technical aspects of the production in addition to technical guidelines. Additionally, interviewee D brings up the facilitation through acquiring data and the data center. "They also have, obviously the data center, so they provide data if you request by the working group, both particular set of ICES data, they can help you to extract the data."

> We also have a person at the secretariat, one person for each working group that is kind of a support for us. Technicalities and how to do this and where is that? They often join the meetings, and they help us out the technicalities, make sure that we're understanding everything correctly, delivering everything we need to deliver.

Another recurring practice that was mentioned is related to internal communication and the importance of internal networks for maintaining communication and information flow within and between workgroups. These findings describe the practices that are carried out to ensure that the workgroups have the necessary information for the knowledge

production they are to perform. The first finding highlighted describes how the collection of data from workgroups outside the IEA is practiced, as interviewee B describes here.

> We would go to other groups, but we started reaching out well in advance and asking them for their contributions. And we also asked for suggestions on how to improve, but not just; can you fill in this little box? And so the conversation started becoming much more with the groups. And it also started making other groups more aware of the overviews because not everybody was that aware of them or that they could contribute to them.

It can, for example, be from specialized workgroups from other fields, as interviewee D points out. "We've also been in contact with the other groups that are working on these other things, like the economic groups they provided, the input and the renewable energy Group, the shipping being just the group of shipping activities."

In an interview with WG1, it is highlighted that the flow of information depends on communication with other specialized groups, but that it is challenging due to organizational practices related to organized communication.

> I mean we are dependent on the other groups to contribute. So I mean the dialogue could be a little bit on and off so, but I guess that's what the challenge is because if you. If you contact them between when they meet, it's like; OK, who's responsible for acting and how much time do you have to spend on the intersessional work.

In this context, interviewee D points out that there are other practices that bypass the established practices standardized by ICES. In the quote below, D refers to informal and formal communications practices for sharing data and information within ICES. The formal one refers to official meetings and workshops facilitated by ICES.

> The informal one, it's usually quicker. Because in the formal one only works once a year during annual meetings. You have to wait for the other group to meet. The meeting in 10 months time etcetera or something, but the informal is a lot quicker because you just e-mail somebody you know and you check on it and you know what is realistic and it's going to be time to do.

The practices related to data flow are also described through networks where the workgroups themselves must be proactive and outgoing to obtain the desired information. Additionally, an interesting point is raised that the lack of systematization has made it highly dependent on individual efforts. Thus, how this activity is practiced is influenced. This is evident from the interview with WG3.

> It's kind of like a spider web network. People go out to different working groups and ask for products to feed in. The issue with that is it's not very systematic or formalized, so these networks breakdown as soon as the person leaves.

Interviewee G continuous to elaborate on the lack of facilitating practices that provide a standardized practice for the data flow. Moreover, emphasize that instead, the maintenance of dataflow relies on practitioners such as the chairs to take on the responsibility to maintain the networks feeding the working groups with the necessary knowledge. "The chair was kind of the powerhouse of creating a network of working groups and reaching out to people to bring together the information."

> The network hasn't been formalized or the pipelines to feed information aren't formalized and that means that the process almost start again with the next revision of these overviews, which is hard. But I guess it's partly because these overviews are reviewed every five years. So that's quite a long time between as well to maintain those networks.

6 Analysis and discussion

This chapter will analyze and discuss the empirical data and place it in the context of the theoretical perspectives applied. Similar to the presentation of the findings, the structure of the analysis will follow the overarching knowledge practices from the theoretical framework, followed by an analysis of organizational practices.

6.1 Knowledge practices

Section 6.1 will analyze and discuss the empirical findings in light of the theoretical framework' four knowledge practices: scoping, standardization, representational, and public practices. (Borie et al. 2021)

6.1.1 Scoping practices

What science observes is influenced by what it seeks to find. (Gioia, 2013) Therefore, ICES' scoping practices are crucial for explaining how ecosystem overviews are produced which aligns with scoping practices inclusion in the framework. (Borie et al., 2021)

Participation

Scoping practices primarily involve concretizing the practices that contribute to setting contextual boundaries and parameters. In Borie's framework, this encompasses participation, including disciplines, geography, and demography. The latter builds on Ford's (2011) work related to the inclusion of, for example, indigenous knowledge in addition to the other parameters. Despite the fact that this is highly valuable information, this research does not have any indications about the current incorporation of, for instance, indigenous knowledge. Instead, it entails how participants of various working groups are included through a set of parameters. The identified parameters include recruitment practices of experts, disciplines, and geography. This is further supported by Clay et al. (2023). The theoretical rationale behind the inclusion of recruitment practices is based on two factors: recruitment practices should be considered as they constitute a significant aspect related to the human element of practices (Giddens 1994). Humans play an active role in practices, and how they are included should, therefore, be part of the analysis. This is further supported by Cummings and Kiesler who address the recruitment of expertise. (2014)

In the context of transdisciplinary research, recruitment practices of expertise determine the range of expertise included in the organization, which in turn influences how effectively the organization fosters collaboration across disciplines. This is particularly relevant in scientific organizations where the inclusion of varied disciplinary perspectives is central to knowledge production (Cummings and Kiesler, 2014).

The findings linked to participation and inclusion of expertise in the groups indicate an important factor; The interviewees identify three entry modes of inclusion that ICES practices to include expertise in a temporary capacity 1) The member is appointed by the national institute or institution in a relevant member country. This implies that the relevant member country is connected to the ecoregion for which an overview is being produced. Within the data set for this research, the findings suggest that most participants were recruited to ICES through this approach. 2) Participants are recruited

through appointment or invitation from the group's chair. This approach may, therefore, have a clearer connection to the networks established in the scientific community. As it relies on the chairs being well-versed in the scientific community and aligning with the decided-upon disciplinary and geographical scope.

3) Lastly, any researcher can contact ICES and a relevant working group on their own initiative for participation. However, within the available data for this research, no findings suggest that this form of recruitment has been present among the informants. Yet, the findings do speak of mobility across the different working groups, and it's emphasized that multiple people participate in several groups at the same time. This would make it reasonable to argue that the possibility of requesting to join additional groups would be accessible and relevant to multiple people.

Does the production of overviews presuppose broader participation in terms of disciplines and expertise in the working group? Even though the content and process of the overview are characterized as transdisciplinary (Clay et al. 2023) and multidisciplinary by ICES. (2019) Empirical findings argue that the production of overviews does not necessarily require a multidisciplinary group. Rather, it requires a group of participants capable of collecting, translating, and simplifying various information into a compressed product. Within the available data for this research, there was a relatively homogenous sample of disciplines from natural sciences, and the interviewees could not point to the inclusion of, for instance, social sciences. Consequently, the process of a highly multidisciplinary group was perceived as a beneficial thought experiment to stimulate innovation, but less effective for the production process. Hence, the practice of initiating larger group events, such as workshops, serves a strategic purpose in line with the overarching strategy for the development of new trajectories for the overviews.

Practices such as the geographical scoping of ecoregions help shape clearly defined areas for the production's scope. This establishes concrete and formalized borders for the overviews. Furthermore, the geographical scoping influences ICES' other inclusion and exclusion practices, as the involved researchers have a direct connection to the relevant ecoregion. Usually through their home institution that initially nominated them to the ICES group. These practices are also formally standardized through ICES guidelines. Participants may also be recruited through networks and invited by group chairs, but inclusion must still be appropriate for the group in terms of geography and discipline. These practices can be argued to contribute to the stability of the group's work by clearly defining which geographic area is to be addressed and from where expertise should be sourced.

Valid and new knowledge

The transdisciplinary scope does, however, apply to the incorporation of knowledge. The group relies on incorporating expert knowledge on an inter-group level. By doing so, overviews compile knowledge from a variety of disciplinary knowledge originating in other specialized working groups within ICES. The inclusion of knowledge is arguably more dynamic as the inclusion of disciplinary expertise is influenced by the implementation of new fields to the conceptual framework. (See figure 4) For example, the introduction of food webs into the conceptual framework leads to the inclusion of new expertise within that field. This suggests that adaptability plays a significant role. It allows the incorporation of new knowledge and expertise, provided it is appropriate for

the development of overviews. In similarity with the argumentation made by Clay et al. (2023)

Yet, the inclusion of knowledge relies on the principle of peer-reviewed material such as described in Borie et al.'s framework. (2021) As mentioned by the interviewees, the existing knowledge within ICES is substantial and validated. The incorporation of knowledge should be in accordance with the best available science in the scientific community. However, it is also argued that they do include data from outside the organization, as long as it is peer-reviewed and transparent.

The working groups tasked with producing ecosystem overviews are characterized by heterogeneity and relative disciplinary diversity within the relevant geographical scope. This, similar to Knorr-Cetinas and Haas' argument,(1982, 1992) entails a set of shared norms, values, and practices that help establish a clear foundation and shared common understanding for the common methodologies for knowledge production.

The participants operate in a temporary capacity, which involves cycles of both 3 and 6 years. Through participation in multiple groups, participants have the opportunity to gain expertise in several fields, which can be transferred to the multidisciplinary context of ecosystem overviews. Conversely, findings indicated that the concrete production of ecosystem overviews requires participants who are well-suited to the overall picture rather than specialized expertise in individual fields. This is interesting compared to Fuller et al.' study, which indicates that the working groups consist of highly specialized participants.(2023)

6.1.2 Standardization practices

Conceptual framework

Standardization practices play a central role by providing a unifying and coordinating direction for the knowledge production. Moreover, the practices are central to understanding the balancing dynamics between change and stability in the production of overviews. These standardized practices involve formalized boundaries and tools to maintain the process's stability (Borie et al., 2021) Through anchoring in the conceptual framework and problem definition such as the Wire diagram (See figure 4), group participants and groups converge around a shared understanding of the problem, and thus an overarching objective to direct their efforts towards. Several informants argued that the production process of ecosystem overviews will likely never be universally standardized, however, the focus is rather on achieving a degree of standardization capable of streamlining and further developing production processes in the long run. The Wire diagram serves as the conceptual framework in which ICES frames the pressing issues they have identified in collaboration with stakeholders.

In consequence, the conceptual framework unites the various involved participants around a common banner and purpose. Nevertheless, there appears to be considerable openness regarding the further development of the diagram and the path forward. By providing the working groups the ability to influence and adapt the priority of pressures to the individual ecoregion, they achieve a degree of adaptability that takes individual characteristics into consideration. In summary, in aligns with the theoretical framework; "the conceptual framework delineate whose knowledge and expertise should be included, or excluded, in the production" (Borie et al.,2021)

Modes of futuring

Regarding modes of futuring, the findings suggest that the attempt and focus on incorporating indicators potentially can assist the overviews' ability to provide future scenarios. However, based on the available data, it is difficult to infer that it will be implemented. From a theoretical stance, mode of futuring includes the application of future scenarios and the methodologies to forecast potential outcomes. (Borie, et al., 2021) However, the findings cannot sufficiently indicate any proof of futuring. Yet, it remains to be discussed why the absence of concrete examples of modes of futuring is interesting in itself.

Particularly, if one were to take into consideration the purpose of the advice. (ICES, 2023) Even though the knowledge is produced with the objective of providing actionable advice to recipients, the advice does not provide any scientific suggestions or recommendations for future actions. Hence, it is difficult to state that the overviews include any form of modes of futuring. Nevertheless, it may be a result of two factors that was identified by the informants: 1) the complexity of the ecosystem overviews and their broad scope makes it increasingly challenging to formulate concrete trajectories or suggestive actions. As an example, the interviewees bring up that the models and tools are there in specialized groups, but they are not adapted to the overview context. The ecosystem assessment consists of variables of greater complexity. A notion which is further substantiated by Costanza. (1999) 2) The scientific norms that rule the scientific community, linked to the first notion, the complexity of the overview's content makes it challenging to incorporate recommendations of a predictive nature that can delineate the causal effects and valid linkage.

This reasoning is based on the notion that the complex nature and interconnectedness of the research might not be able to provide sufficient predictions. It is however, better suited for providing an update of current states. These findings draw a direct connection to the paradoxes Wilson addresses, in particular concerning the balancing act between scientific integrity and expertise while being able to meet the call for actionable information from ICES' clients. (Wilson, 2009) On the other hand, ICES expresses a desire to incorporate a scenario-based approach for ecosystem-informed advice through FEISA. (ICES, 2024) A strategy to develop a standardized methodology incorporating risk assessment and indicators.

Guidelines

The practices related to standardization through the implementation of guidelines serve as tools and guidelines to ensure the process is conducted in a uniform and coordinated manner. (Borie et al., 2021) Which inevitably represents an intersection between knowledge practice and institutionalization. (Nicolini, 2013) As pointed out by informants, they can always refer to both the technical guidelines for processes as well as the individual ToRs for each working group. In this context, it can be argued that the general guidelines contribute to the coordinated process across working groups, while the individual ToRs allow for a greater degree of freedom and adaptation. ToRs practically function as guidelines for the process but take greater account of individual circumstances associated with the various working groups. Moreover, ToRs contribute to mitigating the working groups' capacity and ICES' expectations for the process, thereby aligning on a shared direction. In addition to setting the rules for the group's internal dynamic, including predetermined courses of action, such as resolutions for conflicts.

Strategies

To stimulate the desired adaptable development of the process, various practices directly influence the introduction of new knowledge. For instance, with the introduction of food webs into the overarching wire diagram, the process is standardized through the pipeline process. This process is formalized and standardized to ensure a controllable and organized approach to the inclusion of new knowledge. The pipeline process thus plays a crucial role in handling new perspectives and contributions to ecosystem overviews. However, there is little indication that it itself stimulates new ideas. Instead, it serves as a tool and a material practice that helps organize the development of ecosystem overviews.

In this context, other practices generate new ideas and development opportunities for the production process. Findings suggest that workshops are used as tools to stimulate thought experiments and idea development. These gatherings, therefore, constitute a facilitated arena for multidisciplinary interaction for those associated with the production process. In addition to the use of tools such as workshops, informants emphasize that ICES facilitates and encourages innovation.

To ensure coordinated efforts towards ICES overarching problem formulation expressed through the wire diagram as well as the strategic development goals for the ecosystem overviews. The vision of ICES constitutes a pursuit of actionable advice, upon which stakeholders and clients can base their decisions. In order to do so, ICES enacts practices that standardize the approach of the working groups with the overarching pursuit of EBM. The FEISA framework is a standardized framework with the purpose of incorporating risk assessment and a system of indicator development in a common methodology. As the findings indicate, common methodologies have been practiced, however, without a standardized method. FEISA provided the desired standardized methodology. (Roux and Pedreschi, 2024)

Nevertheless, it is possible to identify a gap in the findings related to the application of the ecosystem overviews. On one hand, there is a description of current uncertainty among working group participants, while on a strategic level of the steering group, there is a forward-looking description of an interactive tool for EBM. Wilson claims uncertainty is a crucial challenge to the ICES IEA process, (2009) which is further supported by this research.

When asked about their views on the applicability and impact of knowledge, the findings range from descriptions of ecosystem overviews as purely informative overviews to desired interactive sources of data intended to strengthen the decision-making basis for recipients. In context with the theoretical framework, these findings can be linked to two ICES standardization practices: the strategy aimed at coordinating production toward common goals and mode of futuring. This is relevant to highlight as it illustrates how the overviews are produced with regard to their purpose and alignment with the overarching vision. Considering that ICES expresses that the overarching vision for ecosystem overviews is to stimulate and achieve EBM, this implies guidance that is actionable for the recipients. The findings draw a comparison to concrete fishery quotas, where specific numbers and quantities are presented, in contrast to ecosystem overviews that provide an informative overview of the relevant ecosystems based on pressures from the Wire diagram.

6.1.3 Representational practices

The process relies on standardized practices to lay the ground rules for the production process. Yet, it remains to be discussed who possesses the power to establish said rules and who can raise their voice in opposition. More concretely, this part focuses on the practices related to argumentation and validation during the production process. It aims to discuss how a consensus-oriented process is practiced through discussions and adherence to prevailing norms in the scientific community.

Argumentation and validation

Primarily, argumentation pertains to the findings that shed light on how the involved researchers reach consensus. From a theoretical perspective, when viewed in conjunction with the empirical material, it can be argued that the process is consensus-oriented and guided by an objective of consensus.(Montana, 2017, Borie et al., 2021) Nevertheless, it is relevant to highlight that the informants mentioned that once the draft is submitted to the advice drafting group, the working groups relinquish some control over what happens to the report. As highlighted, this implies that the report can undergo a range of changes before it is published.

Additionally, the advice drafting group serves as a mechanism for objective and external peer review, as no participants are involved in both the working groups and the advice drafting group, such as the findings argue. However, as pointed out in the previous paragraph, the advice drafting group is, in practice, assigned significant power and responsibility for the quality assurance of the knowledge. In Borie's description addresses the question of whom has the validating voice in the process (Borie et al., 2021)

On an operational level, consensus occurs through a discussion-based practice at the group level. This means that the group's participants discuss, for example, the prioritization of the various pressures identified in the wire-diagram. From this starting point, the group is free to discuss and reach a consensus on how they wish to continue the work and how best to do so. In the transdisciplinary context, where different professional backgrounds meet, it would not be an unlikely hypothesis that disagreements could arise as a result of different premises. However, no internal disagreements worth mentioning are reported. In this context, it was rather referred to that the established rules and guidelines for the process function as mechanisms that maintain a given code of conduct and guidelines for resolving disagreements. This leads the discussion to another aspect of consensus.

Regarding consensus and its role in the knowledge incorporated into the process, it is based on the principle that it is governed by the consensus of the scientific community and what is considered valid science. Considering that the working groups consist of a broad selection of disciplines and various professional norms, it suggests that a universal approach to validation and consensus can be seen as advantageous for achieving a common goal. Consensus prevails as a central method for establishing the quality assurance of the knowledge and data on which the advice is based. Similar to a point derived from Montana's description, it can be said that consensus itself is a goal, but also that the goal of consensus is to achieve a shared understanding and agreement that incorporates the strengths of each discipline, thereby enhancing the credibility and applicability of the produced knowledge (Montana, 2017).

Visuals and models

The use of visual representations appears to be encouraged and deemed as important by both ICES and the theoretical framework. (Borie et al., 2021) Primarily, strategy documents highlight that visual representations should be employed whenever possible. The findings of this research reveal that visual illustrations are utilized to present the problem statement through a conceptual framework. Additionally, visual tools are used to simplify and convey various internal processes, such as the pipeline model and the framework for ecosystem-informed scientific advice. The use of visual representations aids in simplifying and translating content into comprehensible messages, facilitating a shared understanding of the process. Wilson argues that "the ability to clearly explain becomes a criterion for the validity of results." Implying that, what is put forward needs to be understandable. (2009) For example, informants referred to the illustrations to explain the process during interviews, which argues in favor of the practice of relying on visual aids to convey knowledge. By providing a clear way to present data, visual representations can support transparency in research. As it can make it more accessible for others to review and understand the data and methods used, simplify complex data. Which is substantiated by Evagorou's study on the use of visual representation in science (Evagorou et al.,2015)

In regard to the representational practices of the conceptualization of the world, figures 6 and 7 become relevant. The two illustrations show, the transition to ecosystem-informed science and advice has significantly expanded the production process by bridging the social and economic context with the ecological context. This positions it within trans-disciplinary science, a domain connecting social and natural sciences. This shift to a more interconnected system comprising human activities and ecosystem components forms a substantial basis for the research question of this thesis. The conventional approach included singular feedback loops and focused on isolated interactions, such as fish stocks and fishing opportunities. Although social and economic elements were present, they were rarely explicitly stated and considered (Roux and Pedreschi, 2024). In contrast, the ecosystem-informed approach includes multiple interactions and connections among various human activities and ecosystem components. This involves recognizing and addressing the interconnectedness between socio-economic and ecological factors and operationalizing it. The production of the overviews exemplifies the operationalization: overviews encompass multiple pressures, subjects, and a web of goods and services. In summary, overviews provide key signals, ecoregion descriptions, pressures (impacts), climate change effects, socio-economic context, and ecosystem state (current status of system and species). This creates a complex approach through a tapestry of multiple interactions and connections (Roux and Pedreschi, 2024).

6.1.4 Public practices

Communication

Considering that ICES emphasizes interaction with the public sphere to establish feedback loops that contribute to the appropriate development of Eos (ICES, 2024), it is particularly interesting when the findings point out that there is very limited interaction with stakeholders and clients. During interviews, it was brought up that interaction with the public sphere is limited to the secretariat and that working groups have little to no interaction with clients or stakeholders. On the other hand, it is emphasized that increased interaction with the public could benefit the production process. Yet, it is present, and so it does align with the theoretical framework. (Borie et al., 2021)

Moreover, the initial development of the overviews relied on feedback from stakeholders. From a theoretical standpoint, this desired practice is supported by Gibbons et al.'s emphasis on strengthening the applicability of knowledge in the society it is intended to benefit.(1994) The societal context referred to by Gibbons et al, similar to the informants' descriptions, involves gaining a better understanding of how the produced knowledge can be applied (1994). Interviewees describe it as challenging for working groups to know how the information can be used, as they receive questions from the public about how this knowledge should be utilized. Linke et al.'s research (2023) makes similar claims, which substantiate this notion. Moreover, Linke et al.'s study also point to another similarity: an ambiguity related to whether ICES pushes the knowledge on the public or if it is the other way around through pulling mechanisms. (2023) In this case, informants describe a practice where the overviews are made available to the public, but limited effort to draw attention to the knowledge.

Transparency

When it comes to ICES practices related to data sharing, two prominent elements are highlighted, the first of which is directly linked to transparency, and the second is related to ICES' network-based structure. The former, transparency, is based on a core element consistently emphasized by both informants and documents. In order for ICES to maintain its trust among recipients and users of the knowledge it produces, it must maintain a degree of transparency that ensures the data foundation (upon which its advice is based) is accessible to the public. This is supported by Cvitanovic et al. (2009), who argue that ICES' level of trust relies on its consistency in practicing transparency. However, Wilson highlights certain challenges to making complex knowledge accessible to non-scientists, even though the process is transparent, it doesn't necessarily make it understandable to non-scientific recipients. (Wilson, 2009) Moreover, practices related to data sharing encompass the traceability and transparency of research. As asserted in (Cvitanovic et al., 2024), the sharing of data enforces the traceability and transparency of knowledge production. These practices reproduce and reinforce the transparency of production by establishing practices to safeguard the traceability of the production process. This traceability is, for instance, showcased through the practice of reporting. Moreover, the practice is enforced through the incorporation of the technical guidelines (ICES, 2023a)

The second element is data sharing practices and the availability of the knowledge produced by ICES to the public. Which corresponds with the theoretical framework. (Borie et al., 2021) To produce ecosystem overviews the working groups depend on others' work and data to produce them. Open access data and transparent data sharing seem to be important practice according to findings. It reflects a central element of scientific knowledge production and how the scientific sphere is changing, as argued by Cummings and Kiesler. The increasing collaborative dynamic within the scientific community leads to changes in how proprietary knowledge is shared and made accessible to a broader audience.(2014)

6.2 Organizational practices

Organizational practices refer to other relevant practices that have been identified in addition to the knowledge practices originating from the theoretical framework. The following section will analyze and discuss organizational practices related to network practices and facilitation and internal communication practices.

6.2.1 Network practices

Firstly, as Wilson's study argues, ICES as a network and its inherent network practices are what provide ICES and its advice with its authority(2009). Moreover, ICES networking practices become visible in the intersection with scoping practices. As several interviewees argued, scoping practices related to the inclusion of participants often rely on existing networks and affiliations to ICES. As previously mentioned, the recruitment of participants primarily relies on three entry modes, two of which are connected to existing networks in the scientific community. Informants argue that existing networks between people in and outside ICES contribute to making relevant scientists aware of the working groups. Particularly in the case when the chairs invite participants, the chair would be dependent on networks within ICES, stretching outside the organization to know the appropriate and relevant expertise to be included.

In the production of ecosystem overviews, the need for close interaction and utilization of networks remains both an advantage and a challenge. On one hand, networks contribute to increased accessibility of data and existing knowledge. (Hoegl et al., 2003) Despite this, the lack of an adapted communication network practice appears to currently place a significant responsibility on unstable communication practices for the ecosystem overview's working groups. As the findings indicate, individual agency and ability to stimulate the network play a vital role in maintaining the network practices that supply the working groups with knowledge and expertise. Network practices are largely dependent on agency (Giddens, 1984) to achieve durability over time similar to Nicolini's argument (2013)

In relation to the inclusion of knowledge, the participants leverage existing networks internally in ICES between groups to acquire knowledge. Through networks, participants in the working groups can initiate contact across groups and share knowledge. This further aligns with the dynamic described by Cummings and Kiesler (2014) of increased cross-collaboration. This leads to practices where the groups share knowledge across groups based on who they know and who they know is working on a relevant topic. From a theoretical stance, this is addressed by Fuller et al' insights into the connectivity of ICES groups. (2023) They argue that some IEA working groups are more dependent on existing networks than others depending on the interconnectedness of the specific ecoregion.

For instance, it can be noted that practices for requesting data and information across various working groups follow a structure that is not always time-efficient. This is supported by the need for increased synchronization such as Cumming and Kiesler argue for in general,(2014) and which Fuller et al argues for in the ICES context (2023). This leads to the significant role of networks and acquaintances within the organization, often as a result of participation in multiple working groups, in facilitating data flow and input to the overviews. Several empirical findings indicate that the individual networks across the organization's different groups play a critical function in establishing and maintaining networks that supply the working groups with data and information.

6.2.2 Facilitation and internal communication practices

Internal communication practices are described as dependent on practitioners taking responsibility for responding to inter-group requests. However, it must align with other groups' formal meetings, and the responsibility for responding to requests does not have designated responsible parties. This results in the quickest and most efficient method for acquiring new and necessary data being through contact points with participants in other groups. Thereby, bypassing any formal routes stated in ToRs, and gaining faster access to necessary data.

Despite the goal of establishing a stable data flow into the working groups over time, there does not appear to be a stabilized practice at this stage of development. Even though ICES provides the groups with facilitation for workshops and technical assistance during the process, it does not seem to be universally standardized. More importantly, the increasing need for inter-group communication and collaboration makes it challenging to maintain a steady input of information. The lack of facilitation through, for instance, formalized communication practices arguably influence the production process of the overviews.

One can argue that the intersection between knowledge practices and other organizational practices, such as facilitation becomes particularly visible because of two factors: First, the overviews differ from other forms of advice produced by ICES. (Linke et al., 2023) Which entails a change in the conceptual perception of the world and potentially adopting a new set of specific knowledge practices adapted to support a transition to a holistic approach that underpins EBM. In similarity to Nicolini’s argument, it would impose environmental changes impacting the knowledge practice's durability.(2013) Second, the production of ecosystem overviews is characterized by interviewees as evolving, and in need of facilitation. The relatively unstable knowledge practices are thereby influenced by other organizational practices and rely on them for their ability to stabilize and achieve durability over time, in line with Nicolini’s notion of interdependency between practices.(2013)

6.3 Practicing stability and continuous improvement

In this section I discuss how the evolving characteristics of the knowledge production of the ecosystem overviews the practices involved has reciprocal influence, from a empirical and theoretical perspective. ICES itself has established through its labeling of ecosystem overviews as continuously evolving advisory documents, (ICES, 2024) that the production process of overviews should maintain an iterative and adaptive approach. This requires that the combination of knowledge practices and organizational practices must both anchor and establish a stable production process ensuring efficiency and quality. While also promoting continuous improvement and development. To understand how overviews are produced, it is therefore necessary to examine how knowledge practices and other organizational practices contribute to the process's stability and adaptability.

The development of the overviews is in a phase where new practices are emerging and may not necessarily align perfectly with existing knowledge practices in the organization. This means that organizational practices largely influence the development of new production processes. Whether these organizational practices are reproduced over time and become established and incorporated into knowledge practices remains to be seen. However, in similarity to Kuhn’s perspective, new methods and approaches replace older ones.(1962) Which, in this case, refers to the holistic approach of ecosystem-informed science and the application of the wire diagram and implementation of risk and indicator assessment imposing a change in working groups methodologies.

The role of organizational practices can be further discussed in line with the criticism directed at ICES for its lack of formal processes and its ability to implement a holistic approach, as highlighted by Cvitanovic (2024). The findings repeatedly emphasize that the development of overviews is characterized precisely by the term "development." The process is evolving, which means it is not necessarily sufficiently stabilized through knowledge practices, increasing the influence of other organizational practices. Similarly, respondents argue that the process should not necessarily be standardized. This is justified by the increased complexity, which suggests that uniform practices across all groups may lead to greater challenges than benefits. The individual differences among the ecoregions require a certain level of autonomy and independence from one another, as it helps enhance quality and highlight the individual characteristics of the different ecoregions.

However, there seems to be a balancing act between employing standardizing practices that set the premise and frames for the production process and practices that allow the adaptability needed in a developmental process. Based on the findings, the general argument is that ICES establishes and maintains organizational practices that ensure stability while simultaneously encouraging and stimulating the dynamic development of the overviews. The deployed practices to produce the ecosystem overviews, both knowledge practices and other organizational practices are highly influenced by the five steps Levin et al. outlines as crucial for the implementation of EBM (2009). Especially considering the scoping practices of multiple disciplines. Moreover, the standardization of practices such as incorporating risk assessment and indicators as common practices. (ICES, 2024)

Given that the overviews differ from what is characterized as conventional ICES advice as argued by figure 6 and 7 (Roux and Pedreschi 2024) and further supported by Linke et al. (2023) It implies that the existing practices predating the ecosystem overviews might not be adequately adapted to the changes the ecosystem overviews entail. Furthermore,

it can be argued that the innovative and development-oriented strategy for the overviews favors a process in which the organization is still in the development phase of new practices related to the specific overviews.

A relevant perspective to consider when comparing the two views in figure 6 and 7 derives from Gibbons et al' description of knowledge production models and his classification of two modes of knowledge production. Essentially, Gibbons et al. points out that Mode 1 includes a disciplinary approach and excludes the practical applicability of the produced knowledge. Mode 2, on the other hand, emphasizes the practical applicability of knowledge, social context, and interdisciplinarity. (Gibbons et al., 1994) Mode 2 entails, among other things, the inclusion of varied expertise in addressing complex societal challenges that extend beyond single disciplines. It recognizes the interconnectedness required by the challenges to solutions and practices guided by a clear consensus and direction.

Another characteristic highlighted by Gibbons et al is that multidisciplinary knowledge production adopts characteristics and practices from the various disciplines included in the process. This means that production processes such as ecosystem overviews become arenas where different practices from different fields can either be reproduced or omitted. This dynamic contributes to the development of unique practices in terms of conceptual approaches, communication and interaction, and processes. This dynamic is especially emphasized by findings that indicate the development of ecosystem overviews sets new directions for practices related to information flow within the organization. In line with Gibbons et al' description, this necessitates closer interaction within the network of involved researchers (1994).

Based on ICES' participation practices in combination with network practices, it can be argued that there is little rigidity and high mobility within the working groups. This mobility can be argued to be beneficial for maintaining and establishing internal networks, as participants can maintain contact points across ICES' various branches and thereby create transdisciplinary networks within ICES. On the other hand, temporary participation also presents challenges for maintaining these networks and consistency. As already highlighted, certain individuals bear significant responsibility for the maintenance of these networks, making the production dependent on individuals, rather than stable practices. A notion that can be further argued by the role of agency as a crucial practice theoretical element (Giddens, 1984) It can, therefore, be debated whether this responsibility pertains to disciplinary expertise or whether the coordinating role plays a larger part.

In this context, a connection can be made to Gibbons et al' argument that knowledge production occurs as a form of reproduction of practices that characterize disciplinary scientific approaches, as seen in Mode 1 (1994). In this regard, it can be argued that the practices reproduced in the production of ecosystem overviews are largely carried over from less multidisciplinary approaches within ICES' knowledge production. This would mean that the production of the ecosystem overviews relies on bundling of several practices which would then be reproduced or not within this spatial context. As already established, the transdisciplinary approach characterizing the production of ecosystem overviews differentiates it from traditional practices within ICES. (Linke et al., 2023) This description is supported by findings that indicate that the knowledge practices to produce the overviews are inherited from other production processes. This would contribute to

explaining why the production process is still developing its own set of adapted knowledge practices that does not seem to be stabilized.

However, this should be seen in conjunction with the previously mentioned factor: temporary participation. Participants in the working groups engage in cyclical participation, which means they may eventually leave the group. Simultaneously, the stabilization of practices takes time and is ultimately challenging to pinpoint as it does not happen overnight. In other words, unless a practice's stability is formally established and maintained through standardization practices such as guidelines and ToRs, it is uncertain whether the practices can achieve durability(Nicolini, 2013) before participants are replaced. This can be further explained through an example from the findings. In the case of internal communication and network practices for data sharing; despite the existence of formal routes in ToRs for communication practices, many groups utilize networks to streamline the process. This results in a practice that overturns the standardized one. Which in turn is dependent on certain individuals, as highlighted by the informants. This implies a change by humans in the use of tools and material objects that influence the practice, as argued by Nicolini.(2013)

As a result, the durability of network practices can arguably be more unstable, as it relies on the agency and participant's ability to maintain the practice until it has stabilized during their participation. Yet, Østerlund and Carlile,(2005) argue that a practitioner rarely can control the practices. This reliance on certain participants' abilities to sustain the networks further suggests that human actors play a significant factor, aligning with Latour's argument about the interplay between human and non-human actors (2005).

7 Conclusion

7.1 Final conclusions

This study has explored how ICES practices the knowledge production of ecosystem overviews, with the purpose of contributing to the understanding of how holistic scientific advice is produced by scientific organizations. Specifically, it contributes to the understanding of how ICES, as a science-policy interface, produces knowledge in support of ecosystem-based management of marine ecosystems.

Subsequently, this research responds to the call in Borie et al.'s article to continue investigating how knowledge practices can contribute to understanding the production of knowledge in scientific organizations. (2021) Although, they emphasize that the knowledge practices applied in subsequent case studies should be adapted and expanded in line with the specific organization being studied. (Borie et al., 2021) This research attempts to test the theoretical framework's applicability to the case of ICES without a significant contextual adaption beforehand. It allowed me to examine whether the originally applied knowledge practices could also explain the knowledge production of ecosystem overviews in ICES. They do, but this preconception likely causes me to overlook other crucial explanatory variables. To mitigate this challenge, other practice-theoretical perspectives are applied to address additional practices that fall outside the theoretical framework, such as Nicolini (2013) and Giddens(1984).

There may still be a lack of sufficient empirical basis to establish causal conclusions and provide a detailed answer to the research question. This research can, however, based on the data collected through interviews and documents indicate certain tendencies within the specific case. Moreover, one can argue that to achieve a better understanding of how ICES practices the knowledge production of ecosystem overviews, the theoretical framework developed by Borie et al. (2021) should be contextually adapted to a greater extent for increased accuracy.

The results show that ICES practices the four forms of knowledge practices: scoping, standardization, representational, and public practices during the production of ecosystem overviews, as well as other organizational practices such as network and facilitation and internal communication practices. The production of the overviews requires and aspires to a balance between stability and continuous improvement. This relationship affects how practices stabilize and the different practices' interdependency.

The results indicate that scoping practices are characterized by their adaptability to the product's development. This includes both the expertise and disciplines, as they are influenced by the overarching strategy for the overviews. Through standardization practices, ICES creates a unified worldview, strategy, and approach that coordinates the participants' efforts. Among the strategies and the conceptual framework, significant emphasis is placed on establishing methodologies that maintain a stable process while encouraging continuous improvement. Standardization practices are interesting, as they

are intended to contribute to change and development by providing stable practices.(Borie et al, 2021)

Additionally, the course of the production process is influenced by factors such as consensus within the scientific community. Representational practices refer to how ICES' production of overviews is guided by and towards consensus, following the norms and standards for quality prevailing in the scientific community. In addition to consensus, this also involves how the translation of complex knowledge is presented using visual tools; ICES has established guidelines for using visuals and models where applicable to ensure effective knowledge dissemination. (Borie et al., 2021)

Considering that the purpose of the overviews is to offer scientific advice to non-scientists, their practices for communication and interaction with the public are crucial. Through public practices such as communication and transparency, ICES interacts with the public sphere. In these interactions, ICES receives formalized feedback that helps clarify expectations and provides input for further improvement. ICES also emphasizes transparency, meaning processes are documented, reported, and made public to ensure transparency and traceability, in consequence supporting ICES' credibility. (Borie et al., 2021)

The knowledge practices, which are interconnected, are also linked to a broader system of practices supporting the production of ecosystem overviews. The findings highlight that network practices and facilitating practices influence production. These organizational practices contribute to the explanatory power of the research by illustrating how network practices affect the inclusion of expertise in the process at both inter-group levels and from external sources. They also influence how knowledge is shared and acquired; in the absence of tools to maintain information flow, the responsibility for information gathering rests on practitioners' ability to utilize networks.

In summary, it can be argued that the knowledge production of ecosystem overviews is practiced through a constellation of various practices that support stability and continuous improvement in the production process. This constellation consists of practices identified through the theoretical framework (Borie et al., 2021) and other external practices characterized by varying degrees of durability and stabilization (Nicolini, 2013). In the interaction between these different practices, a production process is formed where certain knowledge practices, such as participation and inclusion of knowledge, in conjunction with the conceptual framework (see figure 3) and FEISA (see figure 4), provide stability and structure through shared understanding and methodologies. While other standardization practices, such as the pipeline process strategy (See figure 5), offer tools to stimulate continuous improvement, accompanied by practices such as network to further support the production of ecosystem overviews.

7.2 Further research and potential courses

This process has created multiple question which this thesis was unable to address within the scope and limitations of the project. Therefore, this chapter is dedicated to addressing some of the most apparent topics for further research, accompanied by an encouragement to further research knowledge production in scientific organizations.

Firstly, this project was limited to the production process of ecosystem overviews excluding what happens after the advice is published. The question of their applicability remains an important factor to consider. This thesis has provided an attempt to deconstruct the practices involved while the ecosystem overviews are being produced by the hands of ICES. However, for the overviews to serve their intended purpose, they would also have to be able to provide decision-makers with actionable advice. Unfortunately, the applicability in practice and the experience of the recipients of the overviews is still unclear. To successfully assess the applicability of the overviews, I would argue that further research and case studies should be conducted through an approach focused on how clients and stakeholders of ICES apply the information from the overviews to their decision-making processes.

Moreover, during the preparations to this research, the theoretical approach of actor network theory(ANT), presented itself as a relevant theoretical perspective. In relation to deconstructing the knowledge practices within ICES, it follows a set of characteristics that would be helpful. By applying concepts such as translation, stabilization, and actor-network, it would allow researchers to pursue the actors involved rather than the objectives.(Nicolini, 2013) Which hopefully would contribute to the understanding of the interconnectedness and fluency of practices. By applying theories such as ANT the research would have tools to help explain the process of constant reconfiguration of society or a social system such as ICES and the production of ecosystem overviews.

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Appendixes

Appendix 1: Interview guide

Background and membership in ICES

Q1: Can you tell me about yourself, such as your professional background, your affiliations, and your engagement in ICES?

Practices

Q2: Based on your experience in your latest projects. Could you walk me through the steps of how the knowledge is created and processed within ICES?
Q3: How are decisions reached? To what extent do these processes impact the effectiveness of actionable knowledge, from your point of view?

Q4: How would you describe the working group's level of autonomy and ICES practices to facilitate the group's work?

Q5: In your own words, how would you describe the integration of theoretical knowledge and practical skills in your past projects with ICES?

Q6: Additionally, how is the product, such as the overview, relate to other documents you produce?

Q7: From 2012 until now, how have the overviews developed over time? in the sense of standardization, particular audience, stakeholder involvement,

If time and if in need to dig deeper into the practices of the science-policy interface**.** If not brought up by interviewees, the following questions are meant to direct the interview towards science-policy interface.

Q8: From your point of view, knowing that the work at some point will contribute to formulating advice: How does the integration of scientific findings into policies impact the production of actionable knowledge/advice?

Q9: How does your engagement with stakeholders impact the production of actionable knowledge?

Q10: How does ICES facilitate internal knowledge sharing among its members and teams? Are there specific mechanisms in place to ensure effective communication and collaboration?

Appendix 2: Information letter and consent form

Are you interested in taking part in the research project

"Meta-organizations' Role within the Field of Ocean Governance"?

Purpose of the project
You are invited to participate in a research project where the main purpose is to analyse organizations making the ocean an object of concern. More specifically, this project focuses on the role of so-called meta-organizations (organizations with organizations as members) in what the academic literature calls "ocean governance".
The project's research question is twofold:
(1) What is the role of meta-organizations within the field of ocean governance?
(2) How are meta-organizations and the pursuit of greater sustainability related to each other within this field?
The data will be used for academic articles, for teaching purposes, and for giving feedback to the involved organizations.

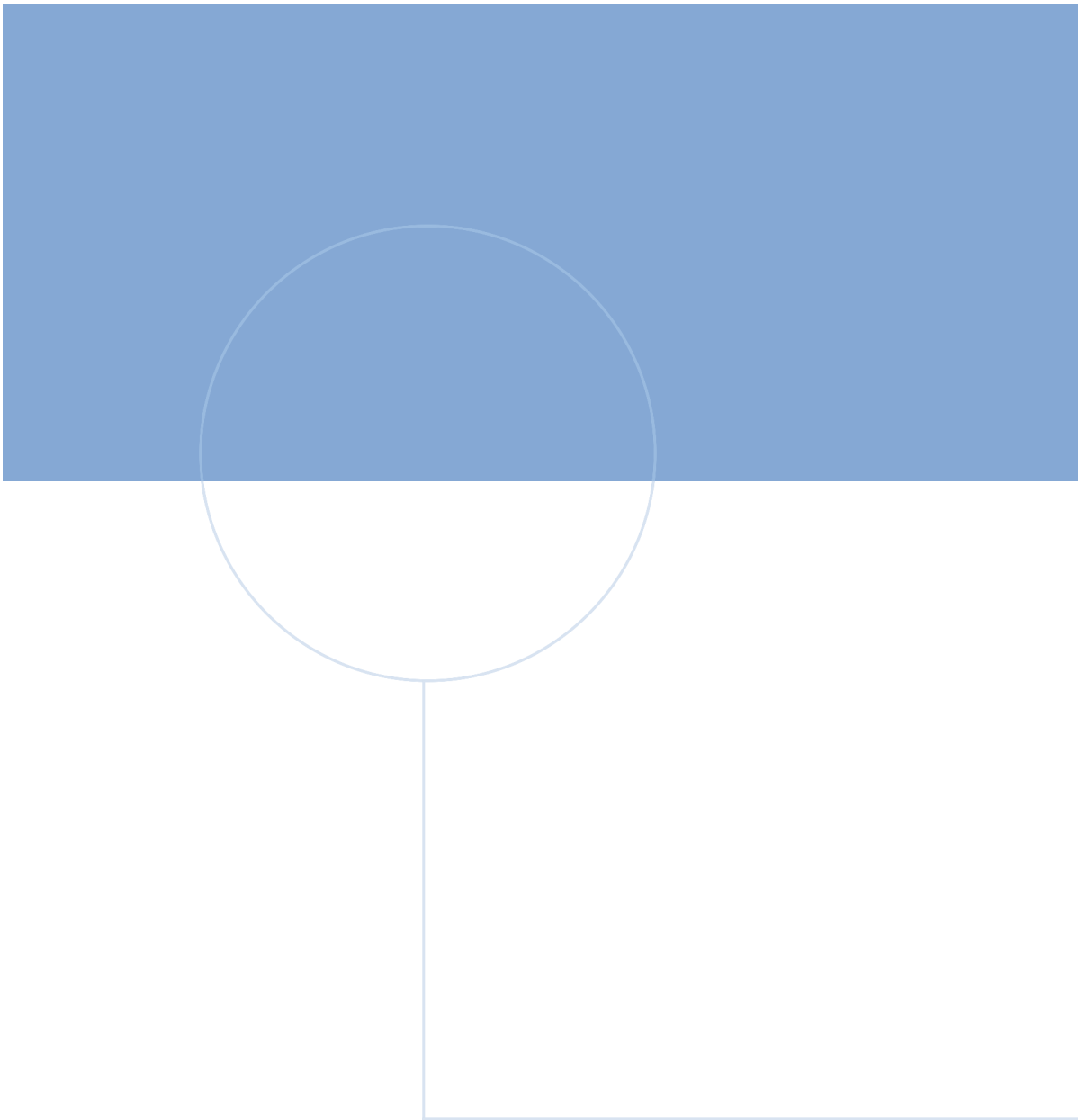
Which institution is responsible for the research project?
NTNU (Norwegian University of Science and Technology) is responsible for the project (data controller).

Why are you being asked to participate?
You have been asked to participate in this research project as an interviewee because you have some kind of knowledge about organizations involved in ocean governance. We are both interested in how these organizations perceive of themselves and how they are perceived of by members of other organizations.

What does participation involve for you?
The interviews will be recorded electronically and afterwards transcribed. Thus, if you choose to take part in the project, this will involve taking part in an interview of approx. 60 minutes. The interviews contain questions about the organization you are a member of (or: you are familiar with), its relations to other organizations and corresponding processes and perceptions.

Participation is voluntary
Participation in the project is voluntary. If you choose to participate, you can withdraw your consent at any time without giving a reason. All information about you will then be made anonymous. There will be no negative consequences for you if you choose not to participate or later decide to withdraw.

Your personal privacy – how we will store and use your personal data
We will only use your personal data for the purpose(s) specified here and we will process your personal data in accordance with data protection legislation (the GDPR).
Access to the data is restricted exclusively to the research team consisting of Michael Grothe-Hammer (NTNU, Førsteamanuensis), Jennifer Leigh Bailey (NTNU, Professor), Kurt Rachlitz (NTNU, Stipendiat), and other internal as well as external co-workers and collaborators. External co-workers and collaborators comprise co-authors supporting the research team in producing research outputs (e.g., articles and reports), and persons providing assistance in data processing like transcription and



NTNU

Norwegian University of
Science and Technology