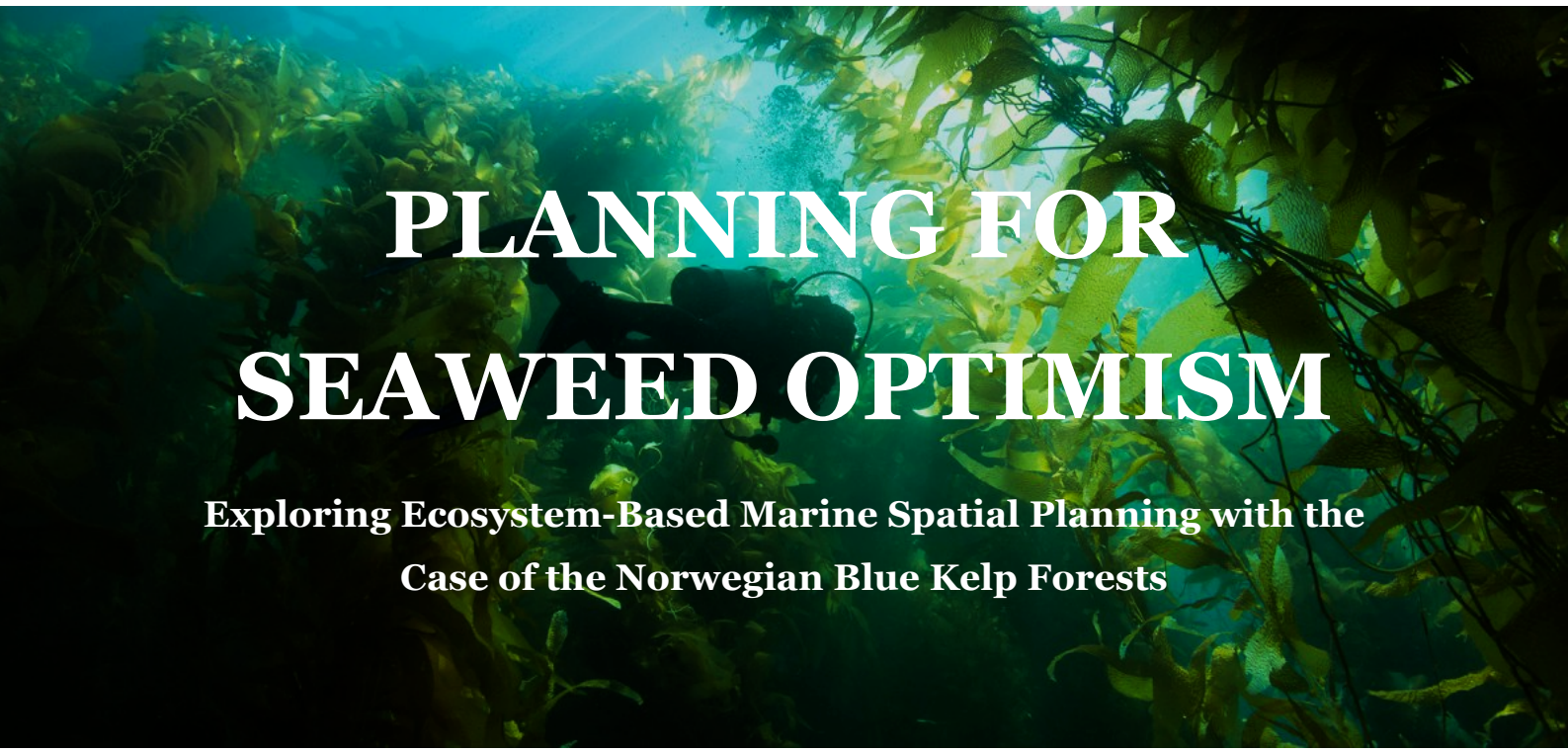

PLANNING FOR SEAWEED OPTIMISM

Exploring Ecosystem-Based Marine Spatial Planning with the Case of the Norwegian Blue Kelp Forests

Jan-Christoph Bädeker

May 23rd 2021

Master's Thesis

Water and Coastal Management /
Environmental and Infrastructure Planning
(DDM / Double-Degree Master's Programme)

Rijksuniversiteit Groningen
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ABSTRACT

Overarching goal of this thesis is to find out whether more traditional Marine Spatial Planning (MSP) or a more ecosystem-based approach (EBA) focus is more adept at achieving sustainable end goals for marine governance. For this purpose, a case study around the Norwegian Blue Kelp Forests (NBKF) was researched. Kelp is a diverse and multi-faceted ecosystem that is linked to different phenomena like hindering climate change or acting as a carbon sink within the carbon capture and storage realm. Its many uses from seafood for human consumption to marine habitats and breeding grounds for local species provide a seemingly broad range of potential benefits for planning. Data was collected through a literature review, conference participation and semi-structured expert interviews. Interviews revealed that many researchers are dealing with EBAs, yet mostly remain in an informative role towards planning. In the bottom-up nature of Norwegian governance, potential uses for kelp forests are identified. Utilizing these efforts for planning is seen as an important step to integrate more ecosystems across the three dimensions of natural resource management (NRM): social, ecological and economic. Whilst there was no apparent link from preliminary research between the use of kelp forests and MSP, the research established a high-potential albeit indirect connection through the EBAs. Kelp forests are deemed "no-regret measures" and their many benefits make them viable tools for the planner within the new framework of more ecosystem-focused MSP going forward.

Key words: *Marine Spatial Planning, Ecosystem-Based Approaches, Ecosystem Services, Ecosystem Accounting, Ecosystem-Based Management, Sustainable Marine Governance, Natural Resource Management*

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The timeframe for this thesis was full of surprises, some pleasant and some not so much. Finishing a degree during a pandemic was challenging. Spontaneously parting ways with many fellow students without the chance for proper goodbyes was an experience unknown to me prior to these times.

Especially throughout data collection, there were setbacks, uplifts and challenges. Therefore, I owe a profound amount of gratitude to my supervisor Mr. Mark Robin Neef. Together, we always made the best of every situation the pandemic threw our way. Thank you for accompanying my thesis work with your great ideas, solutions, communicative skills, patience and understanding as well as the ongoing guidance – I thoroughly enjoyed working with you.

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I also owe a big thank you to my proofreaders Patricia and JD, your thorough dive into my thesis has resulted in a better readability of a topic that has become second nature for me personally. Lastly, some words of gratitude go towards my fellow students, many of whom I now consider close friends as well as everyone in my close social proximity. Thus, a big thank you to Franzi, my family as well as everyone from the Faculty of Spatial Sciences in Groningen and the WCM crew from Oldenburg.

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LIST OF ABBREVIATIONS

CCS	*Carbon Capture and Storage*
CO_2	*Carbon Dioxide*
EA	*Ecosystem Accounting*
EBA(s)	*Ecosystem-Based Approach(es)*
EBM	*Ecosystem-Based Management*
EEA	*European Economic Area*
EFTA	*European Free Trade Association*
ES	*Ecosystem Services*
EU	*European Union*
ICZM	*Integrated Coastal Zone Management*
IMR	*Institute for Marine Research*
IOC	*Intergovernmental Oceanographic Commission*
MPA(s)	*Marine Protected Area(s)*
MSP	*Marine Spatial Planning*
NBFN	*Norwegian Blue Forest Network*
NBKF	*Norwegian Blue Kelp Forests*
RES	*(Interview) Respondent*
RQ	*Research Question*
SDG(s)	*Sustainable Development Goal(s)*
TEEB	*The Economics of Ecosystems & Biodiversity*
UNESCO	*United Nations Educational, Scientific and Cultural Organization*

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1. INTRODUCTION

"We need more knowledge to be able to mitigate the problems and make use of the opportunities but we also need better policies and we need more effective action and we can't have that in sequence, we need all that at the same time because the situation is very urgent for global oceans."

[Vidar Helgesen, Norwegian Special Advisor for the Sea @ Blue Forest Week 2020]

1.1 Societal and Scientific Relevance

The quote above expresses the need and also the urgency for effective policies and governance in the marine space. As said, when maneuvering between complex problems and sustainable opportunities, sometimes the answer may be straightforward and other times it may be hard to find. This thesis is aimed at exploring new approaches to bring Blue Kelp Forests and Marine Spatial Planning (MSP) together through the use of ecosystem-based planning approaches.

Looking back, it is widely evident that the human population has caused a lot of harm to nature and the environment over the last century. Among these are interconnected issues, deforestation, climate change, pollution and generally the way humans overexploit ecosystems – especially in aquatic environments (National Geographic, 2021). Picking up on the quote above, the importance and key role that our oceans play for sustained living on our planet are manyfold. The oceans are one of the main sources of protein for mankind and contribute to our climate stability (Anderson and Rivkin, 2009). They are part of many global cycles from physical, biological and chemical points of view. Awareness about the importance of ocean and marine health has been growing steadily for the last decade (Visbeck, 2018). Yet, there is apparently no common consensus on how to sustainably govern this vast space taking up about 71% of the Earth's surface, neither from ecologically nor economically or socially sound viewpoints.

Ideally, and in contribution to the quote above, there would be a sustainable, fair and uniform way plan for these matters. Yet, we are facing the consequences of overexploiting marine and maritime resources and our contributions to climate change. Just one example of the more reactionary way we go about these issues is part of the coastal and offshore fisheries sector. After long periods of over-fishing the oceans, the massive rise in the use of aquaculture does not necessitate a better global food security or more resilience (Troell et al., 2014). Thus, nature is so inherently complex, that simple solutions to large problems are typically not sufficient.

One planning approach to consider for marine governance is MSP. MSP is a widely acknowledged tool for marine governance. Its scope spans from the coastal areas all the way to offshore development. Yet, MSP as a concept does not directly translate to practice. "Marine spatial planning [...] has been lauded as a remedy to unsuitable marine management. There is, however, growing MSP research illustrating that it is failing to foster paradigm shifts towards sustainable governance" (Flannery et al., 2019). Another prospective issue is its tendency to deviate towards sectoral objectives (Schupp et al., 2019) instead of providing a holistic tool set for sustainable ocean use. Therefore, the ecological aspects may need considerably more input and potential use cases to accomplish this feat.

"The next decade is the decade of ocean science. We can't – we don't have the luxury now of saying okay, let's spend a decade learning more and then we'll shape policies. We need to do all this at the same time. And the only way to go about it is to have processes that are as inclusive as possible of different sectors and different layers of government but also the civil societies, coastal communities and businesses."

[Vidar Helgesen, Norwegian Special Advisor for the Sea @ Blue Forest Week 2020]

A move towards a more ecosystem-based approach (EBA) for planning seems like a potential and promising solution. Fueled by the uprising awareness of Ecosystem Services (ES), several approaches including Ecosystem-Based Management (EBM) or the more economically centered Ecosystem Accounting (EA) continue to be trending. Integrating more ES and serving a variety of purposes, these approaches are characterized by a wide range of key aspects that can be attributed to the marine and maritime space. The concept of Natural Resource Management (NRM) also delivers an overview of the major tensions. It divides these tensions into three debates: socio-economic, socio-ecological and economic-ecological. ES are in the main focus of these debates. Within the scientific community these ideas, especially those regarding ES are currently on the uprise. A change of focus towards a more ecosystem-centric planning approach could lead to substantial changes in the way the oceans and coastlines are utilized, managed and governed. It is important to already incorporate ecosystems, natural habitats and subsequent wildlife into the planning aspect and decision-making process.

As characterized above, there is also a sense of urgency involved. MSP undergoes regular revisions, and a more inclusive approach of ecosystems is on the current European Union (EU) agenda (Fernandes et al., 2018).

1.2 Exploring the Case Study – Blue Kelp Forests

Norway's coastline is vast and expansive. Including smaller islands and peninsulas, its length has been recalculated to be around 100,000km (Hurtigruten, 2020). Norway's coast is characterized by rocky shores and its fjord landscape is thus harboring immense amount of seaweed. Water temperatures, seafloor structure and water quality deliver the perfect framework for kelp to flourish (Kelp Farming, 2020).

Large conglomerates of kelp are considered kelp *forests*. This is due to their close resemblance to actual forest trees when viewed from underwater. Due to the recent interest in these ecosystems, stemming from their brethren the seagrass meadows and the mangroves, their characteristic to take up CO_2 and store it has given it the label of a *blue* forest, the color often associated with carbon. Blue forests are "Marine and coastal ecosystems that are particularly valuable through their provision of multiple ecosystem services, of which carbon sequestration and storage is one" (Langaas, 2017, p.5). This is also akin to the terrestrial counterpart, where this label has occurred first (Pendleton et al., 2012).

Kelp is a point of interest of ecologists, economists and the public alike. It fulfills ecological services with both direct and indirect benefits. Its economic value is significant, as also seen by the uprise in kelp cultivation industry next to the ongoing wild harvest. Among its many uses, it is used for human consumption, as animal feed and as important delivery of alginate – an ingredient of the pharmaceutical, medical and food industry (Szekalska, 2016).

Despite its positive characteristics and services, kelp is not typically considered in planning. Marine Spatial Planning does allow for the use of Marine Protected Areas (MPAs), yet deliberate *use* of kelp is not to be found. The potential of integrating kelp in zoning, governing and use-scenario discourses of coastal zones could arguably lead to a very promising combination. It could tackle many issues and obstacles found in current MSP and be at the center of a more ecosystem-centric approach.

"Blue Forests have a key role to play. Whichever angle you take you can end up with Blue Forests and if you start with Blue Forests you are bound to reach into a lot of interesting ocean wealth opportunities but also critically important ocean health issues."

[Vidar Helgesen, Norwegian Special Advisor for the Sea @ Blue Forest Week 2020]

1.3 Goal and Scope of the Thesis

Overarching goal of this thesis is to find out whether more traditional MSP or a more ecosystem-based focus is more adept at achieving sustainable end goals. For this purpose, a case study around the Norwegian Blue Kelp Forests (NBKF) is used.

Among answering the research questions, the following sub-goals shall be targeted as well. First and foremost, new ideas and approaches towards compatible, more ecosystem-centric approaches to MSP shall be explored and discussed. Second, the role of Blue Kelp Forests within this web of ecosystem-based approaches and the planning realm shall be identified and discussed through the help of experts associated with the matter.

Geographically, the scope has been limited to the Norwegian coastline and its local kelp forest population, the NBKF. Temporally, the research conducted for this thesis spans the timeframe of around 18 months, ending with the handing-in of the thesis in May 2021. Furthermore, and to add another temporal dimension, the focus for the literature research is on publications dated from within the last decade. Yet, if necessary, earlier literature is also assessed and used throughout the research process.

To further enhance the delineated scope, there is an emphasis on communication and wording. The terminology around the ecosystem-based approaches and MSP has many different and fuzzy explanations and definitions. This is also the case for container terms like *sustainability*, especially in the context of "sustainable end goals". Sustainability has evolved into a vessel for many allegedly positive and green impacts. Its extreme ambiguity is strongly dependent on phrasing and can therefore attribute positive and negative aspects. Nevertheless, and despite its fuzzy context, it is important to include it. It unites and motivates movements and brings many different people and viewpoint to the table, resulting in an actual multi-disciplinary discourse. This discourse is what is needed to find new ways to sustainably govern, and plan coastal areas and the oceans. A process which needs to be socially, economically and ecologically sound.

1.4 Presentation of the Research Question

For the purpose of this thesis, the following primary research question is formulated:

Is Marine Spatial Planning able to achieve sustainable end goals better through its current approach or through ecosystem-based approaches?

Alongside the primary research question, the following five secondary research questions are formulated to enhance the depth of this thesis research:

(1) What are the characteristics of the current traditional MSP approach?

(2) What are the characteristics of EBAs in the marine context?

(3) What are characteristics and demands of sustainable end goals?

(4) What are the tensions between the traditional MSP approach and the EBAs?

(5) What are the tensions of NRM as an interface between (traditional) MSP and EBAs?

1.5 Framework and Outline of the Thesis

Following the introductory Chapter 1, Chapter 2 describes MSP and the EBA consisting of ES, EA and EBM. Emerging discourses are used to connect the theories using the NRM viewpoint. Chapter 3 explains the research design based on Kuckartz (2018) as well as details about the case of the NBKF. Furthermore, the qualitative data analysis and content analysis are outlined. In Chapter 4, the results of the analysis are presented. Chapter 5 discusses the findings in different discourses that emerged alongside the collected data. Chapter 6 concludes the thesis, answers the research questions and gives pointers towards a critical reflection as well as an outlook for further research.

A comprehensive overview of the thesis structure can be seen in the figure below.

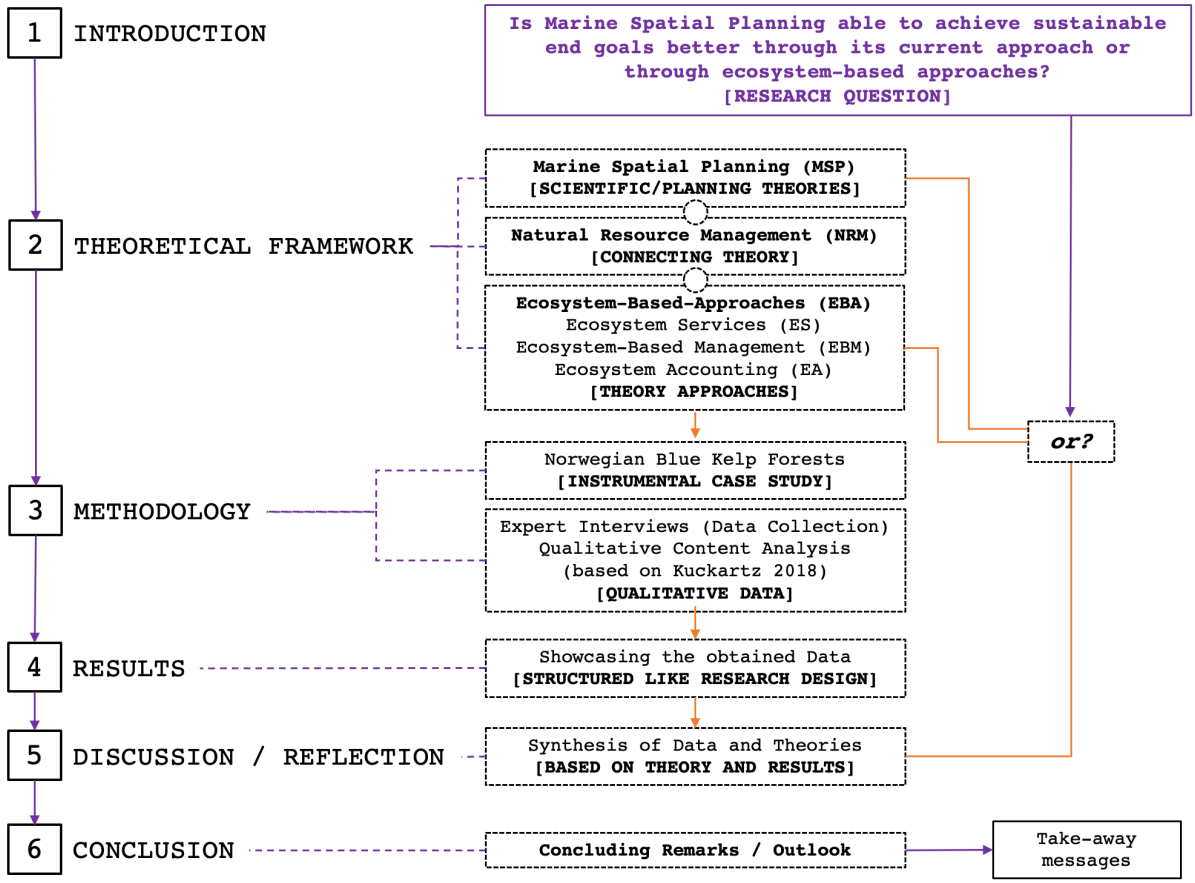

Figure 1: Outline of the thesis.

[Author's own depiction]

2. THEORETICAL FRAMEWORK

Section one of this chapter describes Marine Spatial Planning. The second section describes the collective of theories around EBA, namely ES, EA and EBM. Thirdly, a section on NRM as a connecting theory is introduced.

2.1 Marine Spatial Planning

As a start, both terminologies *Marine* Spatial Planning as well as *Maritime* Spatial Planning co-exist. For the purpose of this research, they are thought to be of the same ideology that will just be referred to as Marine Spatial Planning or MSP going forward.

2.1.1 Defining Marine Spatial Planning

Acknowledging the plurality of the concept of MSP and the discussion about the definitions and approaches in literature (Ehler et al., 2019; Day, 2002; Douvere and Ehler, 2009; Flannery et al., 2019; Schubert, 2018; Jay et al., 2016; Douvere, 2008; Gopnik et al., 2012; Ehler and Douvere 2008; Domínguez-Tejo et al., 2016) our concept can generally be defined along the lines of the UNESCO and IOC definition provided by Douvere and Ehler(2009): "[MSP] is a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives that have been specified through a political process" (p.18). First off, the public process is debatable, since this is mostly limited to informative characteristics on opinions and ideas whereas the decision-making and further discussions are often done on higher level (European MSP Platform, 2016). The spatial and temporal distribution of human activities in marine areas is an aspect that is found in further definitions and that is inherited from terrestrial planning. Spatially, the focus is on the coastal and marine environment with definitions changing from case to case. Temporally, planning is typically executed in medium- to long-term timeframes which equates to measurements in up to 12 years or longer in some contexts (VARAM, 2020). Marine areas are designated either indefinitely to the allocated use-case or this may have a certain set timeline. The fulfillment of ecological, economic and social objectives plays an important role in the ecosystem context. It is also the main vision behind the concept of NRM to be discussed in chapter 2. Ehler & Douvere (2009) also denote these points in their definition of MSP, where they relate these interests towards the resources of the marine realm. The *Integrated Maritime Policy* of the EU adds a further aspect to MSP by denoting the tendency towards more inclusive decision-making processes (European Parliament, 2020). This inclusivity stems from the emerging multi-sectoral approach.

The meaning of what MSP stands for is strongly dependent on context, constitutions, implementation and worldviews. Contextually, MSP refers to all things that are considered marine, this includes the coastal zone as well as nearshore and offshore development. Constitutionally, different governance and planning agencies are employed within MSP that differ from user to user. From an implementation standpoint, MSP is often used as a tool for many use-scenarios ranging from MPAs to offshore development to blue growth activities. As for worldviews, depending on the use-scenario and the governing body, MSP can be seen as a way to implement and further sustainable governance while at the same time favoring massive offshore developments (Afrokomi-Afroula et al., 2015).

In the context of this research, MSP has received two key points of critiques. Firstly, "[m]arine spatial planning (MSP) has been lauded as a remedy to unsuitable marine management. There is, however, growing MSP research illustrating that it is failing to foster paradigm shifts towards sustainable governance" (Flannery et al., 2019) This quote underlines that MSP does not realize what it intended to do. It was originally meant to be a suitable alternative to marine management, but does not result in better outcomes, i.e. achieving a unified solution to the complex issues of the marine space. Secondly, Jay (2017) put the issues of this matter into perspective. "[T]here are established principles and recommended processes for MSP. However, it is being carried out in a variety of ways, reflecting different legal and administrative frameworks as well as local characteristics of the marine environment and maritime activities" (p.6) They conclude that "[a]ttention is now turning to the evaluation of MSP, to assess whether or not it is achieving [the] desired outputs" (ibid.). The fact that MSP is in need to be evaluated supports the issue addressed in the first critique. Further, the wide range of uses of MSP makes a uniform output in terms of governance and management unclear. Therefore, a delineated and more accessible variant of MSP will arguably be a key end goal for the future. This has been an issue due to the change towards the multi-sectoral, yet ineffective approach that strays away from the ecosystems. These issues lead to further tensions in the way that ecosystems have been tried to incorporate to date. Marine ecosystems are very complex, as is also evident from the challenges of attempting to model them (Fulton et al., 2003). Thus, a focus on more research and an acceptance of the complexity factor that the inclusion of ecosystems brings to MSP is needed.

2.1.2 Exploring a Future Framework for MSP

Depending on the communicated understanding of MSP, three suggestions for a future framework for MSP emerge. These are thought enhance the tools and solutions that MSP delivers while tackling the issues mentioned above. Firstly, said suggestions include improvements about its adaptability and long-term and future-oriented characteristics (Douvere, 2008; Gopnik et al., 2012; Schubert, 2018). Due to its current sector-orientation,

the adaptability is limited. Secondly, the need for a more ecosystem-centric focus is brought up. Foley et al. (2010) argue for precise *guiding ecological principles* to retain this focus. This may be a solution "which is a process that informs the spatial distribution of activities in the ocean so that the existing and emerging uses can be maintained, use conflicts reduced, and ecosystem health and services protected and sustained for future generations" (p.955). This can be done through more inclusions of ES that emerge from marine ecosystems. With ES in the center, junctions towards a more economic-based view like EA and more governance- and management-focused concepts like EBM show potential.

Thirdly, Jay (2017) delivers a suggestion that includes key issues to improve the effectiveness of MSP. Among these points are "addressing key priorities" and "maintaining flexibility" (p.6). This is a further hint towards the origin of MSP with more ecosystems in focus. Thus, regarding the more ecosystem-based implementation, there is a need to create space for biodiversity and nature preservation, where human and their associated activities do not overly stress the marine environment (Ehler, 2008). This emphasizes once more that an inclusion of ecosystems is not solely sufficient for a long-term and future-proof purpose. The focus should be on retaining healthy ecosystems and sustainably using the services they provide. Domínguez-Tejo et al. (2016) have concluded that when this is qualitatively pursued, including more ecosystem-based routes into MSP will have a broad spectrum of acceptance and understanding. Yet, good communication plays an important role in future frameworks, as their "comparative study reveals major differences in how coastal managers understand and integrate [EBA] with [MSP]" (p.115).

2.2 Ecosystem-Based Planning Approaches

ES, EA and EBM are singled out as the approaches of choice for this thesis. ES are the (dis-) services that nature provides humans with. EA is an approach that applies economic variables to ES. EBM is focused on governance and management of ES.

2.2.1 Ecosystem Services

Categorizing and quantifying services and benefits that nature provides is an ongoing debate. ES are a way of solving this issue. ES are not specifically confined to the marine space. Rather, they have been introduced from the terrestrial terminology. The term stems from the fact that ecosystems fulfill important tasks and cycles or *services*, which are beneficial to humans (WHO, 2005).

This research acknowledges the different emphases that various authors (Lester et al., 2013; Leslie and McLeod, 2007; Geange et al., 2019) present in their work. Going forward, the baselines of ES are considered to be the services and dis-services that nature and the ecosystems provide for other systems and benefactors, including mankind. Within the "Millennium Ecosystem Assessment", four widely acknowledged categories for ES were developed. These are differentiated between *provisioning*, *regulating*, *supporting*, and *cultural* categories (Lester et al., 2013). Provisioning services are often associated with nutritional or other resources that directly stem from the service like (sea) food, peat or timber. Regulating services have an immediate effect on issues like climate and water quality and prevent problems including flooding. Regulating services are not directly seen, yet they impact a broad range of underlying issues. Supporting services refer to contextual support of other services, for instance global nutrient cycling in the oceans of pollination of crops in the terrestrial space. Cultural services include recreational or spiritual values, that connect an individual's heritage. This differentiation includes the often-overlooked cultural aspect, an important and distinctive element of holistic ES (FAO, 2021).

Leslie and McLeod (2007) phrased the term of *key* ecosystem services, that differentiate themselves through playing pivotal roles in human lives. These are mentioned in conjunction with the Sustainable Development Goals (SDGs) as issued by the UN in 2016 (UN SDG, 2021). Among these goals and within the marine context, one specific mention is climate regulation speaking to both SDGs #13 (Climate Action) and #14 (Life below water).

Recent research has coupled ES with a *matrix approach*. Matrix approaches explore and communicate the links between a specific ecosystem and the services they provide. Geange et al. (2019) state that a "matrix approach helps to communicate the non-market value of supporting and regulating ecosystem services and can be used by resource managers to identify and track the potential for benefits derived from benthic marine habitats" (p.150). This concept is thus bridging to both EA as well as NRM in Chapter 2.3, as it speaks directly to the resource manager as an entity. Thus, it becomes apparent that ES are an important part to help categorize, quantify and integrate these services into ecosystem-based approaches.

2.2.2 Ecosystem Accounting

EA has its focus in the economic side of ecosystems. Its goal is to find a balance between the interactions of the human and non-human environment. To achieve this, it tries to add a *monetary value* perspective to ecosystems and the ES they provide. This is a difficult task, as ecosystem services are not simple measured or numerated. This research acknowledges the differing emphases and definitions of EA by a variety of authors (Chen et al., 2020; Franzese et al., 2019; Häyhä and Franzese, 2014; Lomas and Giampietro, 2017). The main ideology

behind EA is thus referred to adding an economic viewpoint to ES in the attempt to quantify the services provided by the ecosystems.

Research towards EA was catalyzed by the European Commission with the goal to reach a more in-depth understanding of economics behind ecosystems and biodiversity. The study highlights the growing *cost* of biodiversity loss and ecosystem degradation. Yet it also allows and forwards the inclusion of nature's value into national accounts and policy-making (de Groot et al., 2010). This furthers the idea that not only monetary benefits are included in EA, yet costs that may arise from neglect and loss of ecosystems are also included.

Policy-making and governance is another focus within EA. Furthermore, Chen et al. (2020) argue that EA is found as potentially valuable and stress the novelty factor of this ecosystem-based approach. They further iterate that EA "enhance[s] transparency in governance, elucidate material dependencies and link stocks and flows of natural resources with a broad spectrum of ecosystem services and values" (p.1). While an added transparency within the governance aspect is likely welcome, it mostly speaks towards the perception to the general public. The aspect of transparency sets EA apart from traditional MSP. The emphasis on the material dependencies as well as the stocks and flows are turning points in perceiving values provided by ES. These characteristics also speak to multiple viewpoints about NRM in Chapter 2.3. Despite their positive stance towards this novel approach, Chen et al. (2020) give more context about its limitations. They argue that "[t]he linkages between EA, policy articulation and implementation should be considered in their complexity" and add that "pure transparency does not exist, that neutrality of accounting tools is a fiction, and that the potential of EA is shaped by the governance context" (ibid.). This yet again denotes a governance context to be a substantial variable in shaping sustainable end goals. It connects to the marine governance framework provided by MSP.

A further perspective on EA is delivered by Franzese et al. (2019). In the editorial about environmental modeling, they iterate that "[e]nvironmental accounting systems allow [to] explore the interplay between natural ecosystems and human activities" (p.36). In a further publication by Häyhä and Franzese (2014) they stress the need to assess "(1) sustained economic and environmental costs, (2) received benefits, and (3) generated impacts" (p.124) related to the exploitation of natural resources. This argumentation is in line with realizing a direct context between the benefits received from the ecosystem and the short- and long-term costs that are coupled to the benefits. It is specially emphasized in the context of (over-) exploitation and *sustained* environmental impacts.

Despite a strong and growing economic interest in ecosystems, there are still limitations. Lomas and Giampietro (2017) thus refer to a different viewpoint within EA in their take about ecological modeling approaches while also adding to the debate above. They iterate on the fact that economic growth is basically determined by two factors, namely "its dependence on the availability of natural resources [...] and the damage that socio-economic activities [imply] on nature" (p.10). Socio-economic activities can range from the business to the recreational side. By implying this tradeoff analysis, they too juxtapose available resources versus the amount of stress the ecosystem can handle. Nevertheless, they also link EA to be beneficial in the sense of NRM. By stating to deem an accounting approach useful to study the "feasibility of socio-economic systems in relation to external constraints posed by ecological compatibility" (ibid.). This also implies a careful use of changes made to the ecosystems by humans. The ecological compatibility and accompanying constraints are most often debated in contexts where humans add factors to local ecosystems – fish farming for instance.

2.2.3 Ecosystem-Based Management

EBM has its focus on managing and governing ecosystem-related topics like the use of ES. This research acknowledges the variety of emphases and definitions of EBM by a number of authors (Levin et al., 2009; Leslie and McLeod, 2007; Rocchi et al., 2017; Arkema et al., 2006; Domínguez-Tejo and Metternicht, 2018). The main ideology behind EBM is thus referred to managing and governing ES in the attempt to sustainably govern the services provided by the ecosystems.

EBM is akin to a growing popularity, yet it is nevertheless subject to different approaches and definitions depending on the context. Yet, it has improved and "over the last several decades EBM has evolved from a vague principle to a central paradigm" (Levin et al., 2009, p.23). Two aspects of EBM differentiate it from the other concepts mentioned in this research. One aspect is the inclusion of humans as a factor while discussing the variables within ecosystems. Levin et al. (2009) iterate this in their research. They state that "[i]mportantly, EBM considers humans as an integral part of the ecosystem, since humans derive a portfolio of services from the ecosystem and also act as a driver influencing ecosystem processes" (p.23). Other research has denoted this aspect to be a strong principle of EBM. The "increasing recognition of the linkages among marine ecosystems and the human communities that depend on these systems" (Leslie and McLeod, 2007, p.541) is an important pillar of this management type. It is important to devote resources towards recognizing and addressing interactions between "stakeholder groups and communities interested in the health and stewardship of coastal and marine areas" (p.540). Within this idea, it becomes clear that EBM is not solely focused on traditional stakeholder groups but rather includes a more *public* factor with the generally interested population. Another aspect or feature that sets EBM apart is that "it distinguishes

itself from typical resource management approaches in the sense that it defines management strategies for complete systems, not merely individual components of one chosen ecosystem" (Levin et al., 2009, p.23). Examining ecosystems on multiple levels is a step to both improve the support and well-being of the ecosystem health while simultaneously and carefully advancing the level of economic use. It is therefore necessary to have knowledge about all interconnected actors of the socio-ecological system. Rocchi et al. (2016) elaborate by stating that the "interplay [within this system] determines the dynamic behavior of the single actors as well as that of the system as a whole" (p.1). They iterate this further by delivering the simplified image of looking at both the *fish* and the *fishers* involved. Ultimately and with this image in mind, EBM is still geared towards the marine space within this research. The systems level does speak directly to the complex nature of this space. Yet, many of these complex linkages – some more hidden than others – e.g., some of the key ES "tend to be overlooked" (Leslie & McLeod, 2007, p.541). This shows that aiming for holistic management in the marine space is a complex feat itself.

Concluding, even though it has become quite popular, EBM is still not without misconceptions. This becomes especially apparent when considering the involved entities. Arkema et al. (2006) have touched upon this fact in their research. They have observed that "[s]cientists characterize EBM differently than agencies planning to manage coastal and marine ecosystems" (p.531). This is an important fact to reconcile when aiming for complete and holistic solutions to these issues. Picking up the mention of the planners above, Domínguez-Tejo and Metternicht (2018) also mention this in their paper about the potential impact on MSP. They conclude the "need to develop objectives across all three dimensions of natural resources management: environmental, social and economic" (p.122). This will be discussed in more detail in the following sub-chapter.

2.3 Natural Resource Management

NRM plays an important role to bring planning, ecosystem-based approaches and other entities together. In its most basic form NRM aims to combine three viewpoints: economic, ecological and social aspects. They constitute the pillars this approach is known for. Typically juxtaposed in a balancing triangle, the connecting lines deliver three topics of tensions, as can be seen in figure 2 below. Thus, balancing social-ecological, social-economic and ecological-economic issues is the main takeaway from this concept.

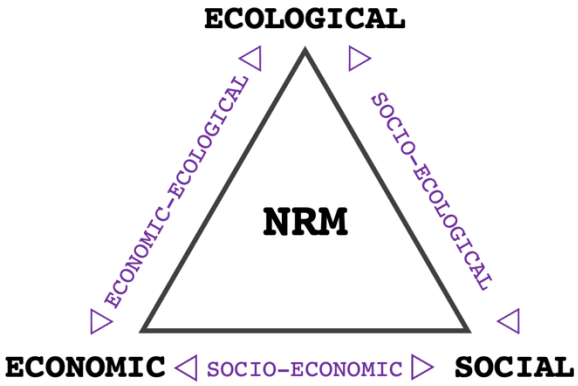

Figure 2: Classic NRM model and tensions.
[Author's own depiction]

Similar to the EBA, NRM is also subject to different definitions and viewpoints. This research acknowledges this range of interpretation by the authors mentioned in this chapter within the ecosystem context, where tensions emerge. Recent research from Essington et al., (2018) underlines this potential beneficial relationship by pointing out that "[e]cosystem approaches to natural resource management are seen as a way to provide better outcomes for ecosystems and for people, yet the nature and strength of interactions among ecosystem components is usually unknown" (p.1658). Some of these more recent discussions also directly tie into the contexts of the balancing acts mentioned above. Tallis and Polasky (2009) discuss this in their paper and state that "[c]urrent approaches to conservation and natural-resource management often focus on single objectives, resulting in many unintended consequences. These outcomes often affect society through unaccounted-for ecosystem services" (p.265). When comparing this statement to observations from Chapter 2.1 about MSP, there are seemingly different directions active here. MSP has evolved towards a broader multi-sectoral stage whereas NRM has a narrower scope. Leenhardt et al. (2015) also discuss this issue in their paper about the connection of social and ecological aspects, stating that "[c]lassical single variable/hypothesis studies rooted in one or two [of these] disciplines are still most common, leading to incremental growth in knowledge about the natural or social system, but rarely both" (p.49).

NRM is not limited to the marine space. Similar to other ecosystem concepts, nomenclatures or processes, it is typically transferred from the terrestrial to the marine space. Thus, many communicated aspects or linkages to global topic like climate change are still founded on the terrestrial side. In addition to the inconsistent governance perspectives as discussed in Chapter 2.1 this results in a very slow adaptation to the marine space. Hartje et al. (2003) discuss this topic in their working paper, stating that "[s]ome sectors like forestry gained increased attention and produced substantial progress due to their relevance for combating global climate change, while other sectors with promising approaches such as [Integrated Coastal Zone Management] ICZM [...] only show slow advances due the complexity of institutional and

management issues" (p.35). This is an important attribute to keep in mind when discussing the efficiency of the framework provided by MSP.

Within the EBAs researched in the previous chapter, the role that humans play in conjunction with governing ecosystems in the marine space is an important yet complex issue to tackle. "The recognition of human dimension is a key aspect of successful planning and implementation in natural resource management" (Leenhardt et al., 2015, p.49). They recognize this importance alongside the combinations of especially ecological-social but also economic-social viewpoints and stress for more in-depth research. They continue to iterate that "[t]he lack of social data relating to human-nature interactions in this particular context is now seen as an omission, which can often erode the efficacy of any resource management or conservation action" (ibid.). The connection between humans and the ecosystem and especially with regards to the chosen case study will therefore be of utmost interest.

Concluding this perspective on NRM, this concept can deliver a viable connection between ecosystems and EBAs towards the framework provided by MSP. Especially in the strategical governance context, Weiskopf et al. (2020) discuss these implications, stating that "[a]lthough not all impacts are negative, even positive changes can require costly societal adjustments" (p.1) They continue that "[n]atural resource managers need proactive, flexible adaptation strategies that consider historical and future outlooks to minimize costs over the long term" (ibid.). Furthermore, Leenhardt et al. (2015) continue this topic, even broadening the scope of typical NRM. They iterate that in order to "[t]o achieve this vision [of transdisciplinary approaches], we need to embrace diverse research methodologies that incorporate ecology, sociology, anthropology, political science, economics and other discipline that are anchored in empirical data" (p.49). For the purpose of this research, these methodologies are of minor importance, yet they still play a role for qualitative research moving forward.

2.4 Interim Conclusion & Conceptual Model

This sub-chapter discusses a quick interim conclusion up to this point. The most important takeaways regard the framework that MSP provides as well as the concepts that EBAs entail and the tensions within NRM.For MSP, the most important aspects going forward are about multi-sectoral marine governance concepts with a spatial and temporal component to achieve a balance between economic, ecological and social objectives.

The chosen EBA for this research culminate in the following principles. From the ES side, their differentiation into the services they provide (provisioning, regulating, supporting, and cultural) deliver a basis for their integration. Regarding EA the focus in on the valuation of ecosystem services. For EBM there is a focus on holistic management and governance to try to incorporate more ES.

As a point of interface, NRM has delivered a set of principles that help in the selection of the core principles. Next to the traditional views of ecological, economic and social along with the connections they provide, the view is broadened. This includes a special emphasis on the role of humans and ecosystems, as well as the inclusion of other disciplines like political science moving forward. Ecologically, as can be derived from the approaches, there should be a focus around the ecosystems and the (dis-) services they provide. Economically, values that can be attested to ecosystems may act as a catalyst in promoting the services they provide. Socially, multiple viewpoints should be taken into account with a focus on acceptance for a broad variety of actors and entities involved. Table 1 summarizes the characteristics of the EBAs.

Ecosystem Services (ES)	
ES#1	*Communicating the non-market value of supporting and regulating services and identifying the potential for benefits derived from marine habitats.*
ES#2	*Inclusion of human benefits and values like recreation activities or spiritual bonds to the marine space.*
ES#3	*Acknowledgement of indirect benefits received through regulatory efforts, e.g., climate stabilization.*
ES#4	*Use of trade-off analyses to reduce competition for space in the maritime realm.*
Ecosystem Accounting (EA)	
EA#1	*Reaching feasibility of socio-economic systems in relation to the external constraints posed by ecological compatibility.*
EA#2	*Exploration of the interplay between natural ecosystems and human activities, and assessment of sustained environmental costs vs. received benefits related to the exploitation of natural resources.*
EA#3	*Enhancement of transparency in governance, showcasing material dependencies and linking a broad spectrum of ecosystem services and values.*
EA#4	*Wanting to reach a more in-depth understanding of economics behind ecosystems and biodiversity.*

Ecosystem-Based Management (EBM)	
EBM#1	*Recognition of interactions between stakeholder groups and communities that show interest about the health of coastal ecosystems.*
EBM#2	*Definition of management strategies on systems level rather than on individual components.*
EBM#3	*Acknowledgement of humans as a factor and increasing recognition of the human-ecosystem interface.*
EBM#4	*Goal to unite all dimensions of natural resource management: economic, ecological and social.*

Table 1: EBA characteristics.

The following table 2 compares the characteristics of the different EBAs, MSP, and NRM. Characteristics that are compared with their origin (e.g., ES#1 to ES) are marked neutral (o). Furthermore, characteristics that neither comply nor defy the arguments of their comparative approaches are also marked neutral (o). Characteristics that are mutually inclusive, i.e., encountered in another are marked with a plus sign (+). This means that they are part of the same argument and mentioned in this context. Mutually exclusive characteristics are marked with a minus sign (-). This means that they are specifically contradictory and thus argue in different directions. Characteristics with neither inclusive nor exclusive and thus neutral context are marked with a circle (o). This means they are neither mentioned, nor inferable. In the NRM column, the corresponding NRM tension of the characteristic is stated.

	MSP	NRM	ES	EA	EBM
ES#1 (non-market value communication)	o	social-ecological	o	o	o
ES#2 (human benefits and values)	o	social-economic	o	o	–
ES#3 (acknowledging indirect benefits)	o	social-ecological	o	o	o
ES#4 (tradeoff-analyses)	+	economic-ecological	o	o	o
EA#1 (feasibility of socio-economic systems)	o	social-economic	o	o	–
EA#2 (interplay ecosystems vs. humans)	o	economic-ecological	o	o	o
EA#3 (enhancing transparency)	+	economic-ecological	–	o	–
EA#4 (in-depth understanding of economics)	o	social-economic	–	o	o
EBM#1 (interaction stakeholder groups)	+	social-ecological	+	o	o
EBM#2 (systems level strategies)	o	socio-economic	o	o	o
EBM#3 (humans as a factor)	o	socio-ecological	o	o	o
EBM#4 (goal to unite NRM)	+	o	+	+	o

Table 2: Context of the EBA characteristics and theories.

Based on table 2 above, the connections need to be briefly discussed. Generally, characteristics that are either exclusive (-) or neutral (o) clearly differentiate themselves content- and context-wise. Thus, they do not implicate any issues for further description. Yet, the identified seven inclusive (+) connections need clarification in order to differentiate them further. Firstly, the connection between ES#4 and MSP. Within the corresponding tension of economic-ecological backgrounds, the issue of competition in the maritime space is both tackled by this characteristic as well as MSP itself. For this case, the focus of MSP is on the spatial component, whereas the specific use of trade-off analyses is attested to ES#4. Secondly, the connection between EA#3 and MSP. Within the corresponding tension of economic-ecological backgrounds, the issue of transparency in governance is brought up. Whereas MSP is more akin to deliver more transparent governance per se, the explicit linkage to dependencies and the ecosystem services and values are attested to EA#3. Thirdly, EBM#1 and MSP. The issue with the stakeholder groups also speaks to the original idea of MSP being a public process as discussed prior. Yet in this case, the characteristic focuses on the recognition of such entities

that show interest as opposed to the MSP issue about people taking part in general. Fourthly, fifthly and sixthly EBM#4 with MSP, ES and EA. Since EBM#4 aims to unite the different dimensions of NRM by itself, this uniting effort is seen as the main argument of this characteristic. The connections to the other issues are in accordance with their individual foci.

To conclude this chapter, the conceptual model is presented in figure 3 below. Included in the conceptual model are MSP and EBA. NRM bridges the gap between the former concepts.

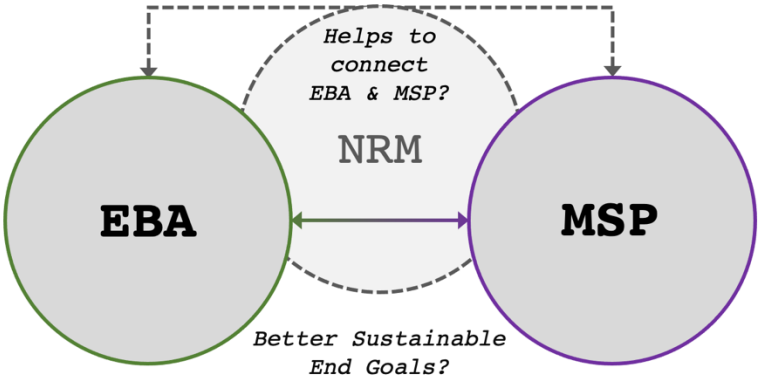

Figure 3: Conceptual Model.
[Author's own depiction]

3. METHODOLOGY

A detailed view into the design and conducting of the interviews as the main type of data collection reflects the efforts taken to obtain viable and representative data. Overarching and at the end of the chapter, views towards ethical considerations and codes of conduct for qualitative research are presented.

3.1 Research Approach

The research approach to this thesis is based on the qualitative approach by Kuckartz (2018). This approach continuously focuses on the RQ. This starts from the work done in researching through the literature review as well as obtaining further data and knowledge from other venues. After this first step, this approach also helps shape and design the guideline for the semi-structured interviews. It also aids in the coding portion, the analysis and the processing and presentation of the results. Therefore, it is visualizing the operationalization taking place for the research. This basic scheme can be viewed in the adapted figure 4 based on Kuckartz (2018) seen below.

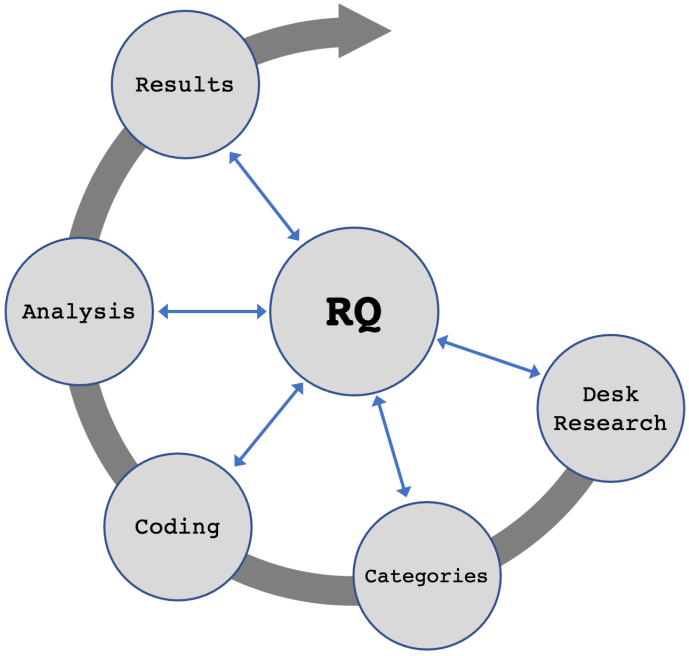

Figure 4: Research design based on Kuckartz (2018). [Author's own depiction]

Epistemologically, the research is of the deductive-inductive type. The deductive portion stems from the literature review on the theories and case and is included in the design of the semi-structured interview guideline. Yet, the inductive portion is also of great interest. The approach allows for further observations to be made that emerge from data collection.

3.1.1 Literature Review

A key construct for the theories and also case demarcation stems from an extensive literature review. Thus, the literature review for this thesis is focused on the main pillars of theory and the corresponding case context. Roughly, these efforts can be divided into the main theory items (1) MSP, (2) EBA, (3) NRM and the case item (4) NBKF which will be explored in detail in Chapter 3.2.3. Wherever applicable, there was a focus on more recent publications the last two decades. Yet and where relevant, earlier publications were also studied and referenced accordingly. The literature review made it possible to extract many important core characteristics of EBA which then delivered a further basis for the qualitative research portion of this thesis.

3.1.2 Conference Participation

Highlights of this research also included the participation of a conference on the topic. Organized by the Norwegian Blue Forest week, the *Blue Forest Week* took place in November 2020. Here, researchers and industry specialists presented their current work and focused on many issues surrounding the Blue Kelp Forests. Among them were the status of the kelp forests, monitoring activities, economic challenges as well as ecosystem services and their use in planning. Albeit the first four out of five days being conducted in Norwegian only, the contexts and high number of English presentation slides still yielded viable information for this research. Main topics also included a take on kelp farming as an emerging industry as well as the management of kelp forests.

The final day of the conference was held in English for the more international audience. Topics included the role of kelp in Blue Carbon issues as well as community and economic benefits that can be derived from Blue Forests. The ensuing panel discussion titled "*How protecting and restoring Blue Forests can be 'nature-based solutions' to climate change, biodiversity conservation and health*" delivered interesting viewpoints in conjunction with the research conducted for this thesis. Participating in this conference contributed to a broader understanding of the case, research design and theoretical framework. The quotes from Vidar Helgesen (Norwegian Special Advisor for the Sea) found throughout this thesis were taken from this panel discussion as well.

3.1.3 Qualitative Research

Due to the topic's nature of being a more *niche* case within the framework of MSP, sourcing reliable data is challenging. Therefore, the choice was made to further complete the data from the literature review and the conference with semi-structured interviews. Qualitative research is a way to go into more *depth* around a chosen topic (Lareau and Rao, 2016). The

semi-structured interviews follow a certain guideline but simultaneously give more flexibility to deepen the conversation when adjacent topics arise or move in a different direction than anticipated. This is where some important further topics and connections can be explored and extracted from the interviews, leading to a more diverse discussion at the end of the thesis.

3.2 Case Study

Research conducted for this thesis is built upon a case study. Since this research brings together several different viewpoints such as MSP, EBA and bridging that gap via NRM, a case study is a fitting unit of research. Especially within this exploratory research character, it aids in connecting these many theories to practice, as it can be used both for "generating and testing of hypotheses but [it] is not limited to these research activities alone" (Flyvbjerg, 2006, p.229). The goal of applying a case to this research is to further the understanding and validate results.

3.2.1 Case Study Design

Within case study research, different types of cases lead to different emphases on the outcome. The main type of case study for this research was chosen to be an instrumental case study. Instrumental cases rely on the fact that its purpose is that of a tool. Here, the case itself is of secondary interest and its role is supportive (Stake, 2005). Utilizing the case as a tool to catalyze the understanding of the connected theories is an important step in this explorative research.

The supportive character of an instrumental case aided three issues throughout research. First and foremost, "[t]he primary purpose is to generate an in-depth understanding of a specific topic" (Simons, 2009 p.10). Second, delineating towards a specific case narrows down the expert population significantly, potentially enhancing the data collection. Third, it delivers the possibility to go into more detail in the connection between theory and practice by applying the lessons learned in this specific context (McIntyre et al., 2015).

3.2.2 Case Selection and Demarcation

Based on aspects that were discussed in Chapter 2, the scope of finding a fitting case included several viewpoints. NRM in the traditional sense demands aspects from economic, ecological and social points of views. Furthermore, the case has to be able to offer ES and be compatible with EA and EBM. Incorporating the aspect of MSP necessitates the case to be of a coastal or marine framework.

From the economic side, the case should include factors that allowed for strong economic benefits and a concurring high value. With the EU driving the MSP agenda, other connections are deemed as beneficial. For instance, the idea of pushing towards more cross-sectoral value chain innovation is an additional aspect on the agenda of the EU in this marine context. This also culminated in a policy brief by Interreg Europe (2017). They define value chain innovation efforts to be the "transformation of 'traditional' value chains into new ones - emerging industries - through cross-border and cross-sectoral collaboration" (p.1). These *emerging industries* also include sectors with a connection to the marine space. This includes biopharmaceuticals, blue growth industries, environmental industries and advanced packaging industries (ibid.). Overarching sectors also include terrestrial issues like precision farming, which can also be related to the coastal area and marine space through industries like aquaculture and mariculture.

Ecological factors should be a further focus of the case. Finding a case which suits this role and also acts as a beneficiary towards ecosystem stability with a ration of more services than dis-services is an important factor in the selection process. Furthermore, the case shall feature resilience to the many adverse factors and effects experienced in the marine space. These factors include currents, temperature, (bio)-chemistry, pollution and bioaccumulation (Florida Tech, 2018). Finally, it would be beneficial towards the general understanding and perception, that the case may be something graspable.

The social viewpoint has a wide variance of aspects. While the economic and ecological factors typically have their predefined goals, the social viewpoints include stakeholders, researchers and professionals from both other disciplines as well as the general population with its norms, rules and acceptance levels. This makes the social viewpoint and its inherent connections, the *socio-economic* and *socio-ecological* disciplines important topics, which will be reflected upon in the discussions chapter. In conjunction with finding a suitable fit for MSP, the case's acceptance also plays a role, since "[f]or all actors in the decision-making process, the question of acceptability [for MSP] is at stake" (Wüstenhagen et al., 2007, p.2686).

Ultimately, the case was chosen to be a part of a coastal kelp ecosystem, then leading to the exact case of the *Norwegian Blue Kelp Forests*. These are part of the *Blue Forest Ecosystems*, which are comprised of mangroves, seagrass meadows and kelp forests (UNEP, 2017). The term *blue* hereby refers to the current understanding in research, that these types of ecosystems can store and sequester carbon. There are terrestrial counterparts aptly named 'Blue Forests' from where this expression has originated. The reason these kelp landscapes are

also named *forests* can be seen below in figure 5. Depending on the viewpoint from below the sea surface, the resemblance to terrestrial forests is remarkable.

Figure 5: Similarities of Kelp forests (left) and terrestrial rainforests (right).
*[Author's own depiction based on **Image1** and **Image2**]*

Concluding, choosing the NBKF as a case is a good fit from several standpoints. Firstly, it addresses research gaps denoted by Smale et al. (2013). Secondly, it is part of many research projects and its characteristic to potentially store large quantities of carbon has been a strong economic driver exploiting this capability. Kelp research includes but is not limited to marine biology, geology, resource management, climate change studies, marine affairs and policy integration, socio-economics, socio-ecology and planning. Thirdly, due to kelp forests populating a large area of global coastal zones, lessons learned from this research may be applicable to a wide range of other geographical areas. An overview of the global kelp forest population with a focus on the *laminaria* variant in Norway can be seen in figure 6 below.

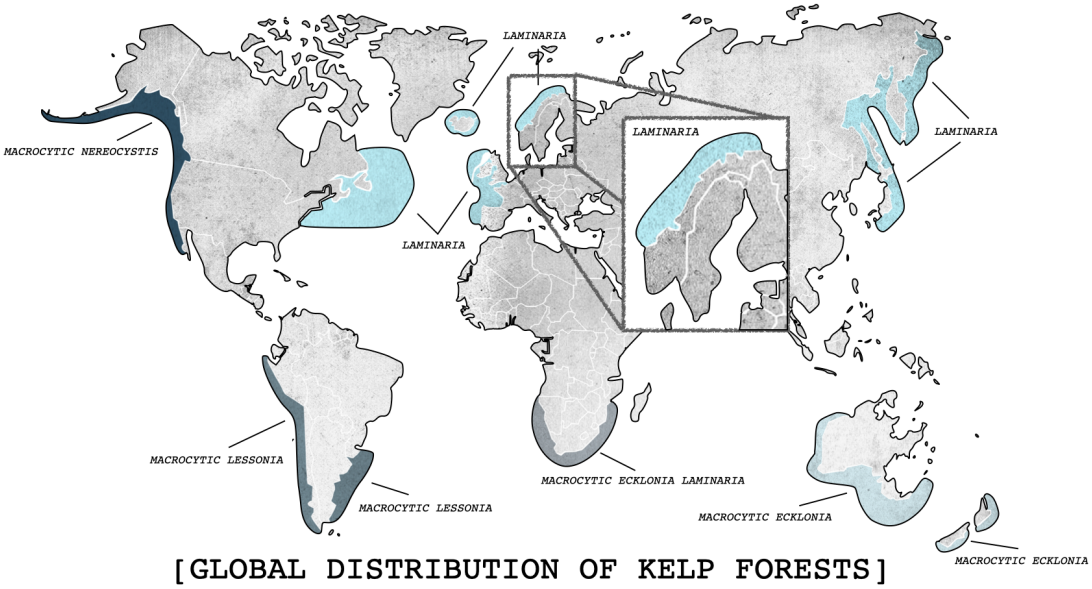

Figure 6: Global distribution of kelp forests.
*[Author's own depiction based on **Image3**]*

A further delineation of how this case is specified can be found in the following chapter. This chapter will not only detail on unique attributes of the NBKF per se, but also add further information as well as characteristics and implications of kelp forests in general.

3.2.3 Norwegian Blue Kelp Forests

Delineation of the case in the geographical sense was done for several reasons. Firstly, the NBKF are completely bounded to the Norwegian coast at the time of writing this thesis. They are diminishing in the southern part in the Skagerrak region and slowly expanding in the north, yet they do not span across national borders and can therefore be seen as one unit from a governance perspective. Secondly, the Norwegian kelp forest population is arguably among the best researched world-wide (Stévant et al., 2017). Monitoring of size and health of the kelp ecosystem in Norway has been conducted for decades. This has led all major players in Norwegian marine research to participate, collaborate and conduct research projects on international level. One collaboration of these institutes is their combined effort in the *Norwegian Blue Forest Network* (NBFN). Within this network, GRID Arendal, a center for environmental information management and assessment; NIVA, the Norwegian institute for water research; and the HI, the Havforskningsinstituttet are included. These institutes are part of several kelp-related research projects with a global reach and interest. Notable research projects from the recent past include but are not limited to the projects *Nordic Blue Carbon*, *BlueConnect*, *OptimaKelp*, *KELPEX* and *Green Gravel*. The carbon aspect is directly derivable from projects with the *blue* designation in their name. Nordic Blue Carbon focuses on the distribution of kelp biomass and its implications for carbon sequestration and cycling, as well as management measures and communication about blue forests sector (Nordic Blue Carbon, 2021). BlueConnect focuses on researching and evaluating the ecosystem services that can be derived from kelp forests as well as researching climate-driven changes to the kelp ecosystem. They further more focus on "valuable training opportunities and research collaborations between South Africa and Norway that center around knowledge-based management of kelp forest resources under changing ocean conditions" (BlueConnect, 2021). A further research project is OPTIMAKELP. "OPTIMAKELP's objective is to generate knowledge that can support ecosystem-based management of recovering kelp forests by analyzing kelp distribution, value of ecosystem services, and adaptive management options under climatic and socio-economic change" (OPTIMAKELP, 2021). It has become apparent that kelp forests are starting to return to the arctic waters in the northern parts of Norway. This fact and the role that kelp play in those ecosystems is researched by the KELPEX project. "The overall goal of KELPEX is to quantify kelp production and export and assess its role in shaping the structure and functioning of communities adjacent to kelp forests, both shallow and deep, in arctic Norway" (KELPEX, 2021). A newer addition to these medium to long-term projects is the Green Gravel project. It "is a novel technique for restoring kelp forests. It involves seeding

small rocks with kelp propagules, rearing them in the lab and then out-planting them into the field" (Green Gravel, 2021). They continue to explain that "Green gravel is a restoration tool that overcomes some of the major hurdles in kelp restoration and provides a promising new defence to combat declining kelp forests" (ibid.).

Kelp forests are very multi-faceted ecosystems that provides many services towards society, marine health, neighboring ecosystems and global cycles. Their many attributes can be seen in a variety of research articles, papers, op-eds, magazines, journals and news pieces. As an overview, 11 kelp characteristics have been identified. (1) CCS source; (2) biological stability provider; (3) detoxing provider; (4) habitat provider; (5) economic value source; (6) global seafood industry source; (7) renewable energy source; (8) coastal erosion inhibitor; (9) ocean acidification inhibitor; (10) climate change inhibitor and (11) ES provider. A comprehensive explanation of these characteristics can be seen in Appendix C.

The case is spatially bounded to the Norwegian coast. This implies geographically, that the case spans along the Norwegian coastline from the south up to the arctic waters. From the perspective of the water bodies involved, the case spans from the Skagerrak through the North Sea, the Norwegian Sea up to the Barents Sea. Further bounding of the case is done from the temporal perspective. Hence, this bounds the case and its research from December 2019 to May 2021 with the handing-in of this thesis. Qualitative data collection started November 3rd, 2020 and concluded on February 4th, 2021.

3.2.4 Norwegian Implementation of MSP

An important aspect in this context is that Norway is not part of the EU and thus not in direct contact with MSP that is mostly promoted there. In contrast to its neighboring states of Denmark, Sweden and Finland, the connection to the EU is primarily dealt with through the EEA and the EFTA. Norway is also part of the Schengen Area. This results in differing implications for marine governance in Norway. Norway uses the MSP efforts as provided in the EU context as a baseline for its own governance, as also to remain compatible with cross-border collaborations (Douvere and Ehler, 2010). Norway's position with regards to MSP does not make a difference content-wise. Thus, it will be addressed when necessary.

3.3 Methods of Data Collection

Semi-structured interviews were the means to collect qualitative data. There was a careful selection of interview partners that originated both from the literature study as well as search

repositories of research institutions and projects.The semi-structured guideline for the interviews evolved from the literature review and theories in accordance with the research design and operationalization based on Kuckartz (2018), as seen in Chapter 3.1.

3.3.1 Selection of Interview Partners

Interviewees from the expert pool of research institutes and projects featured in Chapter 3.2.3 were singled out primarily. The NBFN is a cooperative with efforts combined from three large Norwegian research institutes. These include GRID Arendal, a center for environmental information management and assessment; NIVA, the Norwegian institute for water research; and the HI, the Havforskningsinstituttet also known as the IMR, the Norwegian Institute for Marine Research.

The snowballing technique was used to acquire new interviewees by asking about other people associated with the matter. This yielded two outcomes. Firstly, very fitting further interview partners were acquired. Secondly and arguably more important, this often resulted in recurring names, some names almost always being mentioned in the case context. This was done despite coming from different angles and also from "competing" institutes. Ultimately, this fact leads me to argue, that having interviewed over 50% of the constantly recurring names from the already carefully chosen list of experts, that my expert population for the purpose of this study is saturated. In total, six interviews have been conducted for the purpose of data collection. A randomized assigned number, function of the interviewee as well as the duration of the conducted interview can be seen in the following table 3.

#	Training / Degree / Emphasis	Institute	Date	Duration
RES#1	Marine Ecologist / M.Sc. / Ocean Governance	GRID Arendal	2020-11-03	38min
RES#2	Marine Ecologist / PhD / Kelp Ecology	HI / IMR	2020-11-06	37min
RES#3	Oceanographer / PhD / Marine Ecology	HI / IMR	2020-12-01	34min
RES#4	Marine Biologist / PhD / Arctic Ecology	NIVA	2021-01-07	46min
RES#5	Geography / PhD / Research Management	NIVA	2021-01-25	56min
RES#6	Marine Botanist / PhD / Marine Ecology	HI / IMR	2021-02-04	53min

Table 3: Detailed list of interview partners.

3.3.2 Operationalization and Interview Guideline Design

The semi-structured interview guideline follows the operationalized research design, which can be seen below. Further important implications for the interview guideline design stem

from the information gathered about the case. Thus, the researched characteristics kelp that emerged throughout the literature review (Appendix 3) also contribute to the operationalized research design. The operationalization is summarized in table 4 below.

Category	Concept	Sub-Concept	Description	Origin
Ecosystem-Based Approaches	Ecosystem Services	Non-market value communication	Communicating the non-market value (e.g., meaning) of supporting and regulating services of ecosystems as well as identification of derived benefits.	Theory deductive
		Human benefits and values	Inclusion of human benefits and values like recreation activities or spiritual bonds to the marine space.	Theory deductive
		Acknowledgement of indirect benefits	Acknowledging indirect benefits that are received through regulatory efforts, such as climate stabilization.	Theory deductive
		Trade-off analyses	Reducing the competition for space in the maritime realm and formulating this in a tradeoff-analysis.	Theory deductive
	Ecosystem Accounting	Feasibility of socio-economic systems	Reaching a feasible balance between socio-economic systems and ecological compatibility.	Theory deductive
		Interplay between natural ecosystems and human activities	Exploring the interplay between natural ecosystems and human activities assessing environmental costs vs. received benefits related to the over-use of natural resources.	Theory deductive
		Enhancing Transparency in governance	Enhancing the transparency in governance, showcasing dependencies and linking them to a broad spectrum of services and values.	Theory deductive
		Increase understanding of underlying economics	Reaching a more in-depth understanding of the underlying economics behind ecosystems and biodiversity.	Theory deductive
	Ecosystem-Based Management	Recognizing stakeholders that show interest	Recognizing interactions between stakeholder groups and communities that show interest about the health of coastal ecosystems.	Theory deductive
		Systems-level action	Focusing more on the definition of management strategies on higher hierarchy levels, e.g., systems level.	Theory deductive
		Acknowledging humans as a factor	Acknowledging humans as a factor and increasing awareness of the human-ecosystem interface.	Theory deductive
		Uniting all dimensions of natural resource management	Uniting all dimensions of natural resource management: economic, ecological and social aspects.	Theory deductive

Category	Concept	Sub-Concept	Description	Origin
Marine Spatial Planning	Framework	n/a	This is the framework that MSP provides. It encompasses processes and scenarios encountered within MSP.	Theory deductive
	Policy	n/a	The policy section is aimed at dedicated efforts towards policymaking and implementation.	Theory deductive
	Governance	n/a	Governance in this sense is seen as the output of MSP for governing bodies and its implications for the designated coastal areas.	Theory deductive
Natural Resource Management	Socio-Economic	n/a	This tension is about the connection between stakeholders ranging from the general population to experts and policymakers towards the economic viewpoints.	Theory inductive
	Socio-Ecological	n/a	This tension is about the connection between stakeholders ranging from the general population to experts and policymakers towards the ecological viewpoints.	Theory inductive
	Economic-Ecological	n/a	This tension is about the connection between the economic viewpoints and the ecological viewpoints.	Theory inductive

Table 4: Operationalization table.

The combination of the EBA and MSP make up the majority of input for the semi-structured interview guideline. Along with pointers from the case of the NBKF, the questionnaire is framed by introduction and reflection about case-specifics at the beginning and end of the interview. NRM aspects are secondary at this stage. Yet, they are included in the EBM#4 aspect itself.

3.3.3 Conducting the Semi-Structured Interviews

The interviews follow the designed semi-structured guideline as mentioned in the previous sub-chapter and available in Appendix A. The first half of the interview structure consists of different blocks of EBA characteristics. These sections are freely interchangeable.

To start off the interview, there is a brief welcome and - depending on whether the interviewee agreed to the consent per email before - the prepared informed consent is read aloud with the request to confirm said consent. The wording of this informed consent can be seen in Appendix B. Afterwards, a quick catch-up to the main themes of the interview is given as a primer to the conversation, along with a quick introduction of myself as a person. This is done to establish a trustful connection towards the interviewee. To ease into the interview setting, the interviewees should briefly introduce themselves within the context of the case. Snippets of their introduction shall be denoted and used again throughout the interview to conjure a feeling of being heard by the interviewer. What follows is the first block of characteristics directed at the case.

The first set of EBA characteristics covers the connections between humans and the kelp forest ecosystem. This set aims to address the characteristics <Human benefits and values> (ES#2), <Interplay between natural ecosystems and human activities> (EA#2), <Recognizing stakeholders that show interest> (EBM#1) and <Acknowledging humans as a factor> (EBM#3).
The second set of EBA characteristics is geared towards factors like communication, understanding and transparency. This category focuses on the previously determined characteristics <Non-market value communication> (ES#1), <Enhancing Transparency in governance> (EA#3) and <Increase understanding of underlying economics> (EA#4).
The third set is aimed at the understanding of benefits, drawbacks or tradeoffs in connection with the Blue Kelp Forests. Here, the focus is on the characteristics of <Acknowledgements of indirect benefits> (ES#3), <Trade-off analyses> (ES#4) and <Uniting all dimensions of natural resource management> (EBM#4).
The fourth and final set is based on the interviewees' take on feasibility and action surrounding Blue Kelp Forests. Characteristics include <Systems-level action> (EBM#2) and the <Feasibility of socio-economic systems> (EA#1).

The second goal of the interview is pursued after the presentation of the blocks of characteristics. Questions in this section typically include whether the interviewees have come across these terminologies before in their professional or academic environment. By naming the approaches by their original names, additional dimensions of answers are expected. This may lead to other connections that did not emerge before. Thus, this section of the interview makes full use of the flexibility that a semi-structure provides.

3.4 Qualitative Content Analysis

Structuring the data analysis of the semi-structured interviews in accord to Kuckartz (2018), the focus inherently lies on and around the RQ. Categorizing and analyzing the data was done through coding. "Coding is a way of indexing or categorizing the text in order to establish a framework of thematic ideas about it" (Gibbs, 2007, p.38). Interview data was coded using the software MAXQDA2020. Within coding, room was intentionally left for the inductive parts that emerged throughout the data material.

The developed codes are then used to analyze and interpret the data. Thus, the coded raw data is divided into three categories. These categories include (1) relevant data to answer the RQ; (2) relevant data to explain the context to the reader; and (3) irrelevant data. Whilst the latter data is discarded, the two former categories are further interpreted with an emphasis on

answering the RQ as per the research approach and conceptual model. The deductive component of the analysis is based on the operationalization table in chapter 3.2.2 and is thus leading towards answering the RQ through the main and sub-codes. This is also the way the results will be structured. The inductive component delivered information about the research context important for the reader. Emerging patterns and connections to the used theories as well as the literature research are interpreted, highlighted and denoted for further use in this research.

To aid in visualizing the coding efforts taken, a visualized coding tree can be seen below in figure 7. As per the research design based on Kuckartz (2018), the RQ is at the center of various steps in the research process. In this case, it is the origin of the main and sub-codes. The sub-codes include the mentioned characteristics of the groupings from the EBA as depicted in chapter 3.3.3.

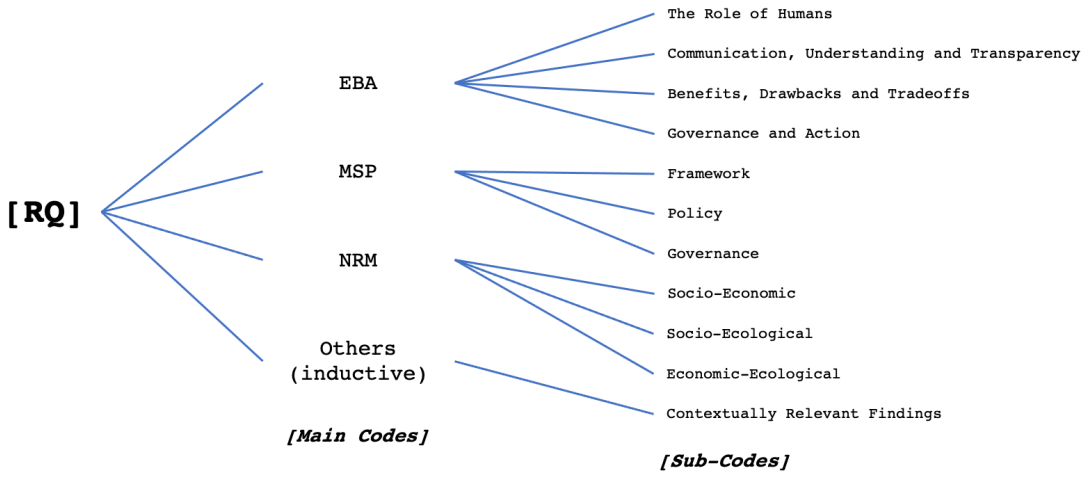

Figure 7 Coding Tree.
[Author's own depiction]

3.5 Challenges and Limitations of the Methodological Approach

The methodology designed for this thesis encountered potential challenges. Discussing these issues early in the research process is a means of minimizing the negative effects that may arise.

Qualitative data collection was conducted by interviewing a small group of six experts. Despite this, the diverse range of backgrounds both from the professional and academic side is substantial - there is always a chance of having biased opinions. Yet and more importantly, this

bias may also lead to unexpected results. In any case, the experts were singled out beforehand and their reputation and knowledge background were checked from the publicly accessible vitae. This results in a level of trust towards the interviewees and the data expected.

Despite being singled out for their unfiltered expert opinion, there is nevertheless a fear of response bias. Response bias itself can take on several forms. Among these forms are (1) the length and type of task provided, (2) social desirability bias by answering questions the society would want them to be answered or (3) order of questions and wording choices (Lavrakas, 2008). Unobstructive wording as well as clear and precise questions are means to counter response bias. Nonetheless, "[b]ecause of the widespread range of factors that can lead to response bias, all data collection methods are potentially at risk of being affected by response bias" (p.753).

A further connected issue is based on the debate about the perception of the social acceptance vs. the public acceptance. Wolsink (2018) argues that "[s]ocial acceptance research was initially characterized by its predominant attention on public acceptance, i.e., the aggregated degree of acceptance by individual citizens" (p.288). This is important to keep in mind when choosing the correct wording for the different interview situations.

3.6 Ethical Considerations

Considerations about the ethical component of qualitative data retrieval are unavoidable. For this reason and already at early stages of research and interview planning, these ideologies were incorporated. One basis is the Dutch code of conduct for research integrity. The code consists of several main principles, including (1) honesty, (2) scrupulousness, (3) transparency, (4) independence and (5) responsibility (NWO, 2018). These pillars and their implications have been taken into account during the entire research process. With a special emphasis on the qualitative data collection, the ethical considerations also included obtaining informed consent. Anonymizing the findings from the participants was also a crucial step to ensure their integrity. The formulated consent can be seen in Appendix B. It was sent in written form or was read out aloud during the introduction of the interviews.

As a final remark on ethics, there was also close cooperation and communication with my thesis supervisor. This furthermore ensured the creation and follow-through of a devised research plan and resulted in a continuous standard about ethically and methodically sound research practice.

4. RESULTS

The results cover the EBA portion first. Afterwards, MSP is addressed, followed by the NRM tensions, when they appeared. Lastly, there is room for the inductive findings.

4.1 Ecosystem-Based Approaches

The EBAs cover the four groupings as per Chapter 3.3.3. These include (1) the role of humans; (2) communication, understanding and transparency; (3) benefits, drawbacks and tradeoffs; and (4) feasibility and action.

4.1.1 The Role of Humans

As per the grouping in blocks according to Chapter 3.3.3, the block "The Role of Humans" was found in 6 ways, differing in their relation between EBA and MSP per individual. These ways include (1) the industrial vs. the personal interaction; (2) what the ecosystem can do for humans and vice versa; (3) the disturbance of the ecosystem balance through human impacts; (4) historical and cultural heritage; (5) direct and indirect dependability of humans on kelp; and (6) general support of stakeholders if it is free of other spatial or economic conflict. Table 5 below delivers an overview of the included characteristics as well as the flagged words in the results column per interviewee

THE ROLE OF HUMANS		CONTEXT OF RESULTS	
ES#2	"Human benefits and values"	RES#1	Ecosystem conservation vs. service provision / industrial vs. personal interactions / employment
EA#2	"Interplay ecosystems vs. humans"	RES#2	Ecosystem Services / Resource / indirect support of fishing industry
EBM#1	"Interaction stakeholder groups"	RES#3	Human stressors and impacts / disrupting the balance
EBM#3	"Humans as a factor"	RES#4	High interaction / historical and cultural value / direct and indirect dependability on kelp
		RES#5	Kelp cultivation industry / creating employment / supported if free of conflict
		RES#6	Norwegian people very nature-based / historic value and identity / recreationally and commercially important

Table 5: Result overview "The Role of Humans".

The views were quite diverse on the topic, yet also included aspects of unison when asked about this set of characteristics. "[O]ne is the conservation part and that is based on the understanding of ecosystem services they provide, I think. And the other one is the growing interest in industrial extraction. […] Turned to - you know - as raw material for export. Those are really the main interactions that I see. Another meaningful interaction is just leaving it alone basically" (RES#1). Additional information was given in the form of stakeholders. "[T]he actual operators, it would be the actual businesses, it would be the municipalities as well. And some of these areas are really remote and if you were underdeveloped by Norwegian standards - this is income, this is a source of employment and tax" (RES#1).

Other views were given stressing the services they provide for humans. "[T]he way I always think of that is through ecosystem services […] in terms of maybe the most important connections for Norway, […] it's a direct resource" (RES#2). This is a typical example of primary benefits obtained. Yet, also the secondary benefits are mentioned. "There's also sort of more tenuous connections but they're still important in these ecosystems and that is how the kelp are supporting coastal fish. […] They are quite important for those commercial species and that sort of links back into the people who are relying on the ecosystem being healthy" (RES#2).

Furthermore, the interaction between humans and kelp forests has also been turned around in one instance. Kelp disappearing due to ecological factors are often human-derived issues. "[H]uman *stressors* - if you call them that - impact kelp forests in many ways. Both through eutrophication, changes in nutrients etc. causing them, basically the balance in the kelp forests to change and maybe favor these turf algae that overgrow the kelp" (RES#3). Turf algae are one of the most prominent hostile species that oppose kelp in Norwegian waters (Christie et al., 2019).

Another viewpoint comes from the more emotional side. "[I]t's more a feeling, I don't work very much with the people-relation to it but it is a big subject. […] The interaction with kelp forests and blue forests and both human culture and human society, recreation and economy" (RES#4). Furthermore, implications were given towards the cultural and historical use of kelp and the meaning for the coastal inhabitants. "[T]raditionally, there is a long history back, also. Where kelps were used to feed the animals, farming animals and it's been used in culture for a lot of things. I think what comes close to me is that kelp forest is a natural and important habitat nursing ground for fish stocks. So indirectly, it means a whole lot for the Norwegian population where both the recreational fishing is popular and commercial coastal fishing and without them necessarily knowing it very much, they're certainly depending on the function of the kelp forests" (RES#4). This stresses not only the importance of kelp dating back to earlier

times but also implicates its role in the fish stock and therefore more indirect connection to humans.
Next to the naturally occurring kelp forests, seaweed cultivation and kelp harvesting are up-and-coming industries, also in the less densely populated areas along the coastline. This meaningful interaction with humans provides grounds for concern next to the economic potential. The reactions vary in dependence of the type of seaweed harvest. "[Seaweed cultivation is] a bit like salmon aquaculture. It's a potential for actually creating work along the coast and that there is no pollution is involved [...] that's the kind activity that is welcomed by most actors as long as there is not a strong conflict with other coastal uses" (RES#5). In contrast to that, the harvesting especially of the wild kelp is more akin to concerns. "[K]elp harvesting is more contested. And locally there has been a lot of negative emotions. I know that [the] lobster fishing community - they have been very negative in some places" (RES#5).

A final viewpoint results from the Norwegian mindset and their heritage. "[Norwegians are] very nature-based and because there's so much coastline, they are essentially a coastal people more or less. They are very closely connected to the coast" (RES#6). This intricate connection was also mentioned in a different context by RES#4. "[I]n Norway I think it is right from the cultural value - I mean historically, they've eaten kelp, they've harvested kelp to feed to their sheep, going way back [...] kelp has always been part of the picture [...] a little bit like cod - it's a massive central species in the Norwegian sort of *identity*" (RES#6). The importance of kelp is also intensely valued by the population, be it from the direct benefits or from the broader interconnected and secondary benefits derived from the ecosystem. "[T]here is a lot of appreciation for instance for recreational fishing that the kelp forests are where the cod [are]. Recreationally, kelp forests are important and also of course commercially. The coastal cod depend on the kelp [...] it's front and center [...] to a lot of the activities that Norwegians do" (RES#6).

4.1.2 Communication, Understanding and Transparency

As per the grouping in blocks according to Chapter 3.3.3, the block "Communication, Understanding and Transparency" was found in 5 ways. These ways include (1) the role of BKF not being well known to the public; (2) political and governmental interest in carbon sequestration; (3) more present understanding about coastal ecosystems; (4) rising and present awareness among the general public; and (5) governmental agendas on several levels that include the benefits of BKF. Table 6 below delivers an overview of the included characteristics as well as the flagged words in the results column per interviewee.

COMMUNICATION, UNDERSTANDING AND TRANSPARENCY		CONTEXT OF RESULTS	
ES#1	Non-market value communication	RES#1	Carbon sequestration politically important / role not well known to public
		RES#2	Relationship towards coastal ecosystems more present / opportunities for sustainable resources
EA#3	Enhancing transparency	RES#3	Governance structure levels / trickling down awareness / fishermen researching disappearing fish stocks
EA#4	In-depth understanding of economics	RES#4	Rising awareness / kelp forests on high Norwegian agendas
		RES#5	Not well known to broad public / public is more in contact with non-commercial species
		RES#6	Awareness on all levels, even indirect / willingness-to-pay is high among general public

Table 6: Result overview "Communication, Understanding and Transparency".

Viewpoints were diverse about the knowledge and awareness of the case in this regard. "I don't think it's very well known in the general public at least not its role, in the role that it plays. I think most people on the shore they see that something is washing up. And I don't think that the role of it, I mean the broader role is generally known to the political audience as well" (RES#1). Yet, the already mentioned context with the carbon sequestration angle inadvertently leads to a gain in momentum towards learning more about this topic. "[T]he thing that is a bit of a scientific question, that has been raised politically is carbon sequestration [...] how much it sequesters and then transports into deep sea and leaves it. That is, I think, still a matter of scientific debate but it being picked up on" (RES#1). This complied with the viewpoints of a further interviewee. "[T]his is an issue that is not something that the general public would be aware of. I mean within the community that are concerned with the exploitation and conservation of kelp forests, so that is not, it's not let's say a broader community that are sensitized to this" (RES#5). Furthermore, it is important to differentiate between the type of seaweeds the population typically encounters. Mostly it is the type that is washed up on the beaches and not the kelp forest ecosystem per se. "[I]n Norway we have the term *tang* or *tare*. Tare is the kind of kelp or seaweed that grows [...] below 5 meters under sea level. Tare is what is on the shoreline. [...] So, what most people are having a connection to is the tare things. Not actually the commercial interesting kelp species" (RES#5).

It has been established that Norwegians are essentially a coastal people. This also directly translates from their relationship into the way the topic is approached and its role understood. "[T]he relationship with the coastal ecosystems and the ocean is just so much stronger and so

much more present all the time. So, you find that like blue opportunities, blue solutions, how can we use the ocean resources sustainably and how can we look for opportunities in the coastal zone is always like a forefronted question in Norway and I think part of it is because they're ahead of the game" (RES#2).

Another viewpoint is yet made by RES#3, when factoring in the political and governance structure levels. Here, awareness may differ through other dependencies. "On the local level, I think maybe. We have this structure: *Kommune* [1]and then county council and county governor. I think at least the county governor and the county council level, there is some awareness. It's trickling down I would say" (RES#3). This is also further exemplified through the picture of people being aware of their surroundings and the issues that arise within, which then trigger the need to understand the dynamics behind local issues. "And a lot of fishermen as well have been really [catching up] with this story with the disappearance of the kelp forests, because a lot of the fisheries of Skagerrak have basically disappeared in terms of coastal cod populations" (RES#3).

Within the global context, the interest in more detailed information about ocean ecosystems also plays into the communication aspects in Norway. "I would absolutely say that [awareness is rising]. The whole awareness and the society for the ocean and coast and significance of that is rising. And in Norway, certainly kelp forest is on the agenda" (RES#4). As mentioned in the response of RES#3, this is now also a subject taken up on higher hierarchy levels. "[T]he prime minister of Norway came out last year with five steps or solutions to climate change. And kelp forest is mentioned as an important part of this political document" (RES#4).

Finally, there is a viewpoint that puts kelp forests into the view of a broad span of stakeholders. "I think it is in hand at all levels, […] across the general public as well. […] You know there is a lot of interest in these kinds of things, even at a public level" (RES#6). Even if not everyone is directly connected to the topic, "it's in the back of people's minds all the time" (RES#6). Also, a recent study showed strong awareness and favorism towards kelp forests through a willingness-to-pay study for restoration efforts. "[T]here was very high community support for restoration initiatives and so I think that it's very much present" (RES#6).

4.1.3 Benefits, Drawbacks and Tradeoffs

As per the grouping in blocks according to Chapter 3.3.3, the block "Benefits, Drawbacks and Tradeoffs" was found in 4 ways, namely (1) having no downsides or being a non-regret

[1] "A Kommune is one of the smallest geographical and administrative jurisdictions in Norway" (FamilySearch, 2015)

measure; (2) no concern about harvest as long as it is sustainable; (3) kelp having a very substantial value with many benefits; and (4) broad recognized benefits dependent on the point of view of the individual entity. Table 7 below delivers an overview of the included characteristics as well as the flagged words in the results column per interviewee.

BENEFITS, DRAWBACKS AND TRADEOFFS		CONTEXT OF RESULTS	
ES#3	Acknowledging indirect benefits	RES#1	Recognized benefits / dependent on viewpoint
ES#4	Tradeoff analyses	RES#2	Alternative to the spatial use / in Norway sea urchins are not viable to harvest
EBM#4	Goal to unite NRM	RES#3	Kelp as a no-regret-measure / BKF should be among first options to conservation
		RES#4	No downsides to kelp / investing in climate solutions
		RES#5	No negatives to the harvest as long as sustainably done and fairly compensated
		RES#6	BKF have substantial value / economically only benefits a few / preserving ecosystems benefits all

Table 7: Result overview "Benefits, Drawbacks and Tradeoffs".

Starting with its implications for the local and neighboring ecosystems, kelp is regarded as a key factor to safeguard biodiversity. But this being a positive aspect for the most part, it too is dependent of the lens it is viewed through. "[The role of kelp] for biodiversity is recognized, at least for the ministry of environment [...] if you see to the ministry of fisheries and... well, they don't want to look at that" (RES#1).

Regarding potential downsides or tradeoffs, the question about what is optimal for the given space is raised. "[Y]ou have to compare to what would be there instead ... in Norway [there] is a sea urchin barren [...] they overgraze all of the kelp and you [...] have these flat bare rocks and that does not provide very much [...] you can't fish [the urchins], they are low quality" (RES#2). Globally, there is a market for sea urchins which are then seen as a more positive outcome. "There's some examples in the world where you [...] would want urchin barrens and that maybe becomes viable so that's a tradeoff [...] but it's definitely not a tradeoff in Norway" (RES#2). This sums up some of the discussions about the decline of kelp through the overgrazing, where efforts are being realized to stop the sea urchins. In other parts of the world, sea urchins are harvested for food, yet the Norwegian variant does not suffice qualitatively. Making it short for the Norwegian context, "[y]ou don't want an urchin barren, you want the kelp" (RES#2).

Through the basic 'lack' of drawbacks, kelp forests are referred to so-called no-regret-measures. This means that there is basically no downside to keeping up kelp forest health or designating areas for kelp forests. "You won't regret it in any way. It's good for many things and should just be done regardless" (RES#3). This has also reached higher hierarchy institutions involved in sustainable ocean economy. The ecosystems surrounding kelp forest are deemed to be a good starting point, also when trying to incorporate the Blue Carbon angle. "Kelp forests together with these Blue Carbon ecosystems are one of the most sort of *low-hanging fruit* that should be one of the first options that you do in order to … conserve nature types. You should start with those, because they have multiple benefits" (RES#3). Other interviewees agree with this assessment on this topic. "I can't think of any downsides at all really for the kelp forest. Of course, if you come to economy and you want to invest money in climate solutions, then you want to consider what the cost is of restoring a piece of kelp forest" (RES#4). There is also strong agreement on the balance of services to dis-services. "[T]aking care of kelp forests is what we call no-regret solutions" (RES#4).

Regarding communication efforts and general views towards it, the topic of harvest is picked up again. "[W]ithin the Norwegian Blue Forest Network I think, I haven't heard any that are negative to kelp being harvested, as long as it's done sustainable and as long as those who lose from it gain something" (RES#5). This is furthered by mentions about value derivation and resulting benefits. "[T]he values are substantial and that some of the other values that we derive from activities that are potentially detrimental to kelp forests and other ecosystems are short-term gains at a relatively low monetary value. That also, lastly, only benefits only a few people. Whereas, you know, preserving the health of kelp forests benefits everyone" (RES#6).

4.1.4 Feasibility and Action

The Block "Feasibility and Action" was found in 4 ways, namely (1) Norway's role in kelp harvest, monitoring and output; (2) high potential and focus on policy level to include BKF; (3) the carbon sequestration and trading aspect; and (4) the search for alternatives to the declining oil stock in Norwegian waters. Table 8 below delivers an overview of the included characteristics as well as the flagged words in the results column per interviewee.

FEASIBILITY AND ACTION		CONTEXT OF RESULTS	
EA#1	Socio-economic feasibility	RES#1	Role is recognized / output is important
EBM#2	Systems-level action	RES#2	Norway leading wild kelp harvest / high potential / good monitoring efforts / high alginate yields
		RES#3	High focus / project national and Nordic policy level
		RES#4	Kelp farming rising topic / interest om carbon aspect has picked up
		RES#5	One company dominating the market / new means of renewables to counter declining oil stock
		RES#6	Concerns about integration of BKF in carbon trading /

Table 8: Result overview "Feasibility and Action".

For some of the interviewees and surely many experts in the field, the economic outcome is one of the most important factors. This holds true despite the other positive influences, that kelp has ecologically. "[T]he role in terms of biodiversity in this habitat is recognized. It and well, you know, what comes out of it so to speak" (RES#1).

Norway is sitting on a lot of untapped economic potential with their vast amounts of kelp. Nevertheless, the industry is taking off slowly, also with regards to a long-term sustainable way of harvesting. Yet, Norway is leading in some areas, also due to its monitoring and research efforts of the ecosystem. "[T]he next would be - in terms of wild harvest [...] Chile and of course some parts of Asia but in terms of industrial harvest of kelp, Norway is definitely *world-class* in that. And that's partly to do with the species they have, where you can get a lot of alginate out of it" (RES#2).

Regarding governance aspects and policies, the researchers interviewed report to different levels of Norwegian governance bodies. These have become more aware of the services of kelp forests not only in the direct sense but also through the indirect benefits. Indirect benefits have been identified before to also be connected to the fish stock, like the coastal cod fisheries. When the cod stocks declined, the search to find reasoning behind this started and ultimately ended up in the decline of kelp forests as breeding grounds. This has been part of many discussions and research. "[T]here is a lot of focus on this now. And [...] with [this specific project] that we've had, the target group was very much more the national policy level and the Nordic policy level, so it was Norwegian, Swedish, Danish [...] the level of awareness varies across those countries" (RES#3).

It is more or less subsided, that kelp will play an important role in Norway's future resource extraction market. Next to the dredging of wild kelp forests, more and more farming is taking place as well. "It's worth mentioning that kelp cultivation, farming of kelp is certainly a rising topic in Norway. Right now the actual harvest is pretty low, about 200 tons a year [...] But the awareness and the interest of industry and investors is picking up really rapidly these years. [...] the belief is that there is a large potential to build a kelp cultivation industry along the Norwegian coast" (RES#4). This also translates to governance, when it is coupled with the Blue Carbon angle for future implementations of this topic. "It's more visions for the times to come. But what is on governance level now is an awareness of that oceans and kelp forests also store carbon. And there is of course a big international interest in carbon stocks and carbon credits" (RES#4). This is also in line with the other blue forest ecosystems, where this connection has been made longer ago. "On the international level, seagrass and mangroves is answering those systems in recent years. But kelp forests are so far not. But that has picked up as a recent interest in Norwegian management" (RES#4). This view is also shared by RES#6. "[I]n that context actually kelp forests are quite a new addition, because there are still some concerns about including kelp forests and kelp forest biomass in the carbon trading framework, because it's very hard to attribute the production and the side of production to the side of sequestration" (RES#6).

The interest in natural resources, especially in Norway has piqued rapidly, also due to the declining stock in oil. To future-proof the basis of the Norwegian pension, other means of resources had to be found and incorporated on the governance level. "In Norway we had to replace the oil extraction, gas production with renewable sources." (RES#5). Yet, the kelp extraction market is dominated by a single company from overseas. "[O]ne thing that strikes me is that the kelp harvesting is completely dominated by one actor [...] it's a bit strange that we in 2021 still give away the kelp for free to the world's second or third biggest petrochemical industry" (RES#5).

4.2 Marine Spatial Planning

As a precursor, it has to be denoted, that none of the interviewees are marine spatial planners per se, yet from their vitae it is evident that they contribute in some way to planning or are involved with projects that include the planning aspect.

4.2.1 Framework

Mentions included areas where MSP was part of projects the interviewees were involved in. "[W]e would do this more in terms of where to put the MPA [...] So, you can fish inside a kelp forests, you can get a lobster or a crab out of it without actually going to impact [it]" (RES#2). MSP has often come up in the context of Blue Growth, a strategy initiated by the EU (Eikeset et al., 2018) and underlining the origin of MSP further. "[I]t's come up [...] not recently but a couple of years ago more in relation to Blue Growth" (RES#3). In a typical fashion, these projects turn to researchers to give a first impression on how the area in focus could be developed within the Blue Growth context. These are "projects where we basically try to tell them what resources they have available within these, their coastal waters and then come with some suggestions for sustainable blue growth activities" (RES#3).

Additionally, thoughts towards the case-related framework for MSP are given. "[Y]ou probably learned that Norway is not implementing neither the Marine Spatial Planning directive, nor the Marine Strategy framework directive" (RES#5). This is a consequence of Norway not being part of the EU. "Which is essentially I would say a very high-level Norwegian policy not the let the EU have any ability to steer our, or direct or govern our Norwegian Marine resources. *Sadly* speaking I would say [...] We have that out in the *open* sea far away from the coast. But they are not so specific when getting closer to the coast with the municipalities 'jurisdiction of the coastal marine waters" (RES#5). Yet and despite these limitations and concurring freedom, Norway's governance of marine space still wants to retain compatibility with the EU framework. "[M]y impression is that Norway tries very hard to be in line with a lot of the EU initiatives in many ways and is also able to participate in a lot of initiatives" (RES#6).

4.2.2 Policy

Policies and implications are mentioned through an interviewee with experience in the matter, downright trying to avoid MSP where possible. "I don't work with it; I try to stay out of the Spatial Planning issue actively in fact. And I'm often asked for instance for kelp cultivation: Isn't the space limitation a critical issue? And my most common reply is that space for kelp cultivation is really a political decision and not a natural scientist decision" (RES#4). The role of the scientific researcher goes more towards a consulting role, which then needs to be translated into a governance and policy form. "[I]t's a political question, it's not an environmental question" (RES#4). Again, there is agreement from a third viewpoint to the points raised. "It is not of direct consequence to the questions we ask as researchers so most of that is something that is more in the background and we see our information taken on by others, probably people like yourself at some stage to take into consideration [...] But we do not do research with a particular focus for instance to inform spatial planning. Others do that

but what we do [...] is more at a slightly more fundamental level" (RES#6). It is thus the role of the researcher to inform the next hierarchical level towards policy and implementation, yet a direct link or contact with planners appear rare.

4.2.3 Governance

The interviewees gave different answers based on their knowledge and experience with MSP. "Marine Spatial Planning in my view is probably the most effective tool for good marine governance in the end" (RES#1). Yet, the complexity of planning for the marine sector is also mentioned, in the sense which the current multi-sectoral focus brings to the table. "[I]t means that you have to bring in a whole range of sectors anywhere from [...] the environment, you have the fisheries, you have the maritime transportation, you have oil and gas, you have wind, whoever governs that" (RES#1). Furthermore, the number of involved actors makes it hard to come to a solid conclusion. "And then you have a whole bunch of actors from each around the table who may not talk to each other, it's just a massive effort. So, that is the challenge both [...] scientifically and in terms of governance. And of course, then you have the academic actors, civil society actors, private actors, public actors, so it's just quite daunting" (RES#1).

4.3 Natural Resource Management

The aspect of NRM was sought out to be one of the connecting aspects of theory, as explained in Chapter 2.3. NRM was thought to be of semi-inductive character as to not take away from the main focus of EBA and MSP.

4.3.1 Socio-Economic

This connection between the population and many involved stakeholders and the economic side to kelp forests led to some thoughts that built up und the awareness and perception. "[E]ach time something can be thought of as a direct resource it just increases value and importance in people's minds. It's an easier connection to make if you say the kelp is supporting the fish and the fish is something you need" (RES#2). Translating these points to a political framework is also filled with tension, especially when factoring in the current drivers like carbon credits."[I]t's really difficult to use in a political, international political context, the trade with the carbon. Because you're not 100% sure where that carbon ends up" (RES#6).

4.3.2 Socio-Ecological

Overall, kelp forests deliver many services through their place in the coastal ecosystems. In accordance with the priorly mentioned thoughts about stakeholder groups and their

viewpoints towards the ecological aspect, some conflicts were already mentioned. These included viewpoints of lobster fishers and other fishermen who have competing interests with kelp forests, not knowing about their importance for their jobs. This has to be taken into account and many people are eager to learn. “[T]hat was really interesting because then I understood a little bit more about what we’re actually doing when we’re framing natural sciences into this policy world” (RES#3).

4.3.3 Economic-Ecological

This section has received the most attention and inputs throughout the interviews. “[T]he science approach to a carbon budget, how we do a carbon budget is quite different to how environmental management and policy do these carbon accounting systems” (RES#3). All interviewees are aware of these conflicts and try to mitigate them within their discourse, yet sometimes that is a complex undertaking itself. “[T]hey want only managed changes, and they want - it’s a different understanding of how it’s done. So, we’ve worked quite a bit in [this direction] and trying to bridge a little bit that gap” (RES#3). It is also an issue with a strong relation to the case, as a big portion of the Norwegian identity is within the fishing and aquaculture sector. “[O]n the protection side of things there is a bit of a conflict between healthy kelp forests and fish farming. And also, in Norway it’s one of the very largest industries in Norway” (RES#6). Within larger projects, the experts from the various fields are brought together. “[W]e try to write a little bit about this Blue Carbon on the science-policy-interface. [The government agencies] are saying that what we deliver from the science side is a carbon budget. And then we need the discussion on how the carbon budget is translated into the carbon accounting that they need” (RES#3). This is often met with resistance of ‘hardliners’ on both fronts and also features an emotional component. Thus, finding a first middle ground is often the first step towards a solution. “And that’s also where our ethical considerations come in” (RES#3).

4.4 Contextually Relevant Findings

With regard to the second type of coding mentioned in the methods section, relevant data to explain the context to the reader is presented.

As for the special role and importance that kelp forests take up in Norway, opinions differed. One interviewee mentioned that it is not that important from the economic perspective but rather important in the socio-cultural sense. “It’s habitat for fish, it’s habitat for crab. And since we have a lot of fisheries there is big - I mean it’s not economically important but it’s culturally important” (RES#1). This again focuses on the connection between the humans and the kelp ecosystem, albeit from the specific kelp angle. Furthermore, the way and the extent they are researched in Norway is brought up. “First off, they are some of the best studied kelp forests in

the world. So, they have really substantial long-term monitoring plans for these ecosystems, where you have scientists that I worked with at [a Norwegian research institute] that would go out every summer and actually be taking measures on the ground over this incredible spatial scale which is really impressive" (RES#2). Further interviewees also concur with this view. "[T]here is a lot of focus, I would say, on Norwegian [...] water management about this" (RES#3). Noteworthy implications about the current health and reasoning behind these factors were also delivered. "[W]e have this enormous coastline [...] and we have [...] kelp ecosystems which are in better or worse shape in southern Norway, [...] up to mid-west Norway the kelp has been struggling a lot with the side-effects of eutrophication" (RES#5)

Some insights about further documents and documentations and the apparent language barrier is addressed as well. This makes it more complicated for non-speakers of Norwegian to go more in-depth about the topic. "There's actually a very substantial grey literature from Norway. Because a lot of the time series and [...] environmental monitoring of more quality and coastal ecosystem [...] is published in Norwegian reports (RES#6).Furthermore, researchers deal with the SDGs of the UN. This belongs to the effort that is made towards future policies and action plans. "[I]f you look at [a policy paper] that was published earlier this year [...] you will see that seaweeds in general and kelp forests and kelp farming being many of those opportunities that have a potential to deliver on something like [up to 10] out of the 17 Sustainability Development Goals" (RES#6). Yet, the way towards actionable governance is complicated and partly conflicted. This has also to do with the role that the scientists and researchers play. As mentioned, it is more in the context of consulting and more distanced from the decision-making process. "Well, I am mostly in the scientific role. And often, there seems to be some sort of delay between - or upright *ignorance* disregardful to what the scientists say in terms of governance" (RES#6). Again, this discussion is fueled by the more recent uptake in the idea of Blue Carbon and using this for carbon credits. This brings another competing idea to the discourse of how to make use of kelp forests as a resource in the marine space. "I would say that the carbon side of things is a growing interest. It is probably the biggest economic driver *yet*, but it's certainly a growing area of interest" (RES#6).

5. DISCUSSION AND REFLECTION

Synthesizing efforts of bringing theory, literature and qualitative data together follow in this chapter. Its content deals with a number of discussion topics that emerged from the gathered data. First off, the EBA characteristics are revisited. Later, various discussions from the economist vs. ecologist debates to spatial issues and potential uses for kelp in planning to the role of the (marine spatial) planner are discussed. Ultimately, the research is critically reflected.

5.1 Revisiting Ecosystem-Based Approaches

One of the tasks of the discussions chapter, is to re-visit the original characteristics from ES, EA and EBM. For data collection purposes, these were grouped into (1) the role of humans, (2) communication, understanding and transparency, (3) benefits drawbacks and tradeoffs and (4) economics, feasibility, governance and action. This gave varying emphases to these different viewpoints.

First off **Ecosystem Services (ES)** were a point of discussion for every interviewee. ES is a topic that emerged naturally within each of the talks, since they are a major component of current ecological research and projects. Communicating the non-market value (ES#1) is becoming more of a norm in recent times, along with the acknowledgement of the indirect benefits received from these ecosystems (ES#3). In terms of competition for space (ES#4), kelp does not significantly interfere with other use-scenarios. On the contrary, it is a good addition to existing uses regardless of the goal being the (sustainable) harvest of kelp or using many of its positive impacts. It is noteworthy to mention that even the cultural and heritage aspect (ES#2) of kelp was discovered in the interviews. This leads back to times decades or centuries ago, where kelp already played an important role for the coastal Norwegian people. Kelp was used regularly as feed for the animals and was also consumed by the locals during long periods of cold.

Next, **Ecosystem Accounting (EA)** is analyzed. The balancing act to find feasibility of socio-economic systems (EA#1) was partly mentioned in the context of finding economic uses of kelp forest ecosystems that are publicly acclaimed. The large alginate industry – despite its foreign origin – yields a high number of jobs in the more sparsely populated Norwegian regions and is recognized accordingly. The interplay between the natural ecosystems and human activities (EA#2) has been briefly mentioned yet was neither clearly confirmed nor attested. The enhancement of transparency in governance (EA#3) is a delicate topic where the interviewed researchers would like to see their work in this regard acknowledged and utilized in higher

hierarchies and entities. The increase of understanding the underlying economics (EA#4) is something very acute in the case of the NBKF. Currently, several research projects are aimed at diving into more detail about the underlying economics. Important in this context was that kelp forests in general are considered large economic drivers. Not only in the carbon capture and storage sense, but also in the alginate production and the food industry. Noteworthy is the fact that the interviewees are all advocating for a sustainably governed use and harvest of kelp, yet it has not been uniformly agreed on what sustainable means for all involved in this context.

Finally, **Ecosystem-Based Management (EBM)** was mentioned by name on its own. "Ecosystem-Based Management is more about the Spatial Planning [...] of the different activities and how you [designate] off some areas for some activities and not others" (RES#6). In terms of recognizing stakeholders that show interest about the health of coastal ecosystems (EBM#1), this has been mentioned by the interviewees to be constantly rising. One example of this is incorporating the topic early in the Norwegian education system. In terms of systems-level action (EBM#2) and management strategies on higher-hierarchy levels, this yields a similar result to the transparency in governance (see EA#3). Thus, the interviewed researchers would welcome more transparency, yet feel that they are only reporting their findings and recommendations to the next level of hierarchy. Acknowledging humans as a factor (EBM#3) has been mentioned. The increased awareness about this human-ecosystem interface has become more popular through the aforementioned educational integrations and people are becoming more aware in general about their role in this context. Bringing together all of the dimensions of NRM (EBM#4) is mentioned mostly concerning the amount of effort this takes to accomplish. The corresponding tensions between social, economic and ecological dimensions were also discussed with a stronger emphasis on the economic-ecological tension.

5.2 The Ecologist vs. Economist Debate

As one of the more diversely attested topics of data collection can be placed in the *ecologist vs. economist* debate. This is not new in the marine space as other novel endeavors like deep sea mining face a similar struggle (The Economist, 2018). Ultimately, this debate is an issue that stems from different and merely semi-compatible viewpoints. This also goes to show, that within the NRM results, this tension has received the most data points throughout data collection. Hence, it shall be discussed further to see which implications this has for the case and the (marine spatial) planning aspect.

That is to say, that none of the ecology-focused interviewees were strictly against using kelp as a natural resource. Merely the way to go about the harvest, the recovery times and the amount of wild and cultivated kelp that is harvested are main critiques mentioned. All interviewees are

aware of the economic benefits that can be derived from the kelp forest, be it for the alginate production or other industries. At the time of the interviews, there was a general assumption that the recently spiked interest from the economic side had to do with carbon issues, hence the *blue* terminology in this case. Yet, the exact origins of drivers were debated by the interviewees. There was no common consensus as to which exact driver is responsible for the recent strong interest in kelp.

Ultimately, a possible scenario is that with a more EBA-focused approach, the ecologist perspective may have more sustained effect for decision-making and planning. This improves the chances of more ES being incorporated through the EBAs.

5.3 The Spatial Debate and Potential Uses

Despite the fact that restrictions of space on the land side are debated regularly, the marine space is also not free of conflicting ideas, use-scenarios, interests and clashes. Conflict for space is a challenge, independent of land or sea. Yet, kelp forests could deliver many aspects, that could ease this struggle. As already stated, kelp cultivation for bioenergy purposes, for instance, is not part of the food vs. energy debate known from the terrestrial space. This corresponds directly with the questions of awareness and acceptance.

Another important aspect is not merely the high ratio of *services to dis-services* that kelp forests provide. Recent research tries to differentiate clearly between the primary and secondary services. Among the latter are the provision of fish breeding habitats, for example. This fact has reached the Norwegian education system as well, where children at a young age learn that kelp is extremely important for the fish stocks (RES#2). Furthermore, professionals which deem kelp to be more of an inconvenience, like the mentioned lobster fishermen, have increased their interest in the kelp forests. This leads to more acceptance among the professionals, an important step in a bottom-up governance style region like Norway. Ultimately, the goal should be to make the most out of the space available. In the case of kelp forests, this means looking past the primary benefits alone and taking into account the wider implications for other sectors.

Throughout the interviews it has been mentioned that the number or services kelp forests provide far outrank the number of dis-services. This is also true for the economic side. Similarities to the terrestrial space are often referenced in a way where kelp could benefit many factors. “Essentially, a kelp forest or kelp farm doesn’t compete with a natural kelp forest in terms of biodiversity conservation, it actually *adds* to it. So, you have some synergies in the sea but if you farm kelp you are also facilitating delivery on, for instance, sustainable development

goals on preservation and biodiversity. Whereas on land, if you sell off a piece of land to have a natural forest then you cannot grow crops there" (RES#6). The fact that kelp forests have been deemed as so-called no-regret measures underlines this aspect. Even when competition for space is tight, there is factually no downside to using kelp forests if a suitable area is designated for it. This makes the deliberate use of kelp forests from the planning angle beneficial. Yet, it is strongly dependent on how the planning entity is informed as it ultimately leads to a policy and action plan. Therefore, kelp forests often remain outside of the scope of the coastal planners even if they may be an optimal fit: "[O]f course it competes with recreational fishing and diving and ship traffic and houses and harbors and windmills and offshore – everything. But it's a political question, it's not an environmental question" (RES#4).

Potential uses for kelp in planning can be seen in the EBA focused MSP. Several of the experts stated that they rather see themselves as informants to other professions like planning. Fundamentally, it is beneficial to incorporate kelp forests into planning in early stages. This can happen via its natural resource status along with the services it provides in the NRM context. Adding context in an angle that two interviewees mentioned: Kelp is a non-regret measure - there are hardly any downsides. Thus, the question remains why kelp is not incorporated to a higher degree in planning yet. From the preliminary reading, it was not directly apparent that a link between kelp forests and planning exists. This combination has thus been labeled as a *niche* research topic throughout this thesis. During the interviews, it arose that many researchers were wondering where this combination originated. In addition, some of the interviewees were intrigued by the opportunity to work directly with the planning entity. Yet, seemingly, this has not been done before in this regard and within the confines of this case. This thesis thus marks an attempt to bridge this gap. One interviewee underlined this fact when explained how the research topic came to be and what its goal is: "Interesting, that's definitely a niche" (RES#6).

The researcher's role remains of informative character, also in the spatial planning connection. Blue Growth terminology is used in this context in the marine space, also in Norway. "[A] follow-up project […] is now the county councils are making these GIS-type maps and trying to set off, find some areas that are available for Blue Growth and then they want us to come in and say what they can be used for" (RES#3). Yet, kelp forests deliver services that exceed the ideas of pure Blue Growth. "[W]e talk a lot about carbon because there is a lot of focus on climate and climate mitigation but there's a lot of other services associated with kelp forests" (RES#6) Some of these services and their implications were directly stated. "For instance the support of biodiversity, the support of coastal fisheries and many kelp forests also provide some level of coastal protection so some risk hazard reduction elements" (RES#6). Yet, these

opportunities are not all taken up on, the focus right now remains on the carbon sequestering aspect, since this is a big driver of economic interest. Economically, however, many of the attributes of kelp forests have primary and secondary effects on many other economic areas, for instance the basis for fish breeding grounds which then stabilize the fish population in the long-term. "[T]here is a lot of other financial incentives for preserving and [...] looking after kelp forests and being interested in this, it's not just the carbon angle. But that is at the forefront of a lot of conversation at the moment simply because of [...] the interest in climate mitigation" (RES#6).

5.4 The Role of the (Marine Spatial) Planner

Responses with respect to MSP were ambiguous und for that part rather unexpected. The range of knowledge about MSP from the interviewees started with not being familiar with the term at all in some cases. After a quick and basic explanation of MSP this typically sparked reminiscence about its existence, yet not having heard the term before. Others have knowledge about it and have experienced it throughout their professional life. Some go so far as to downright try and avoid it, since its many viewpoints bring too many variables to the discussion table. This leads to the questioning the proper role of the marine spatial planner in this context.

The majority of the interviewees were active in research and not in the direct planning realm. Yet, comments about their role in comparison to that of the planner were made, nonetheless. "I really hope that our research is relevant for those kinds of questions, because that's obviously one of the reasons why we do it. But, because the ultimate driver for what we do is, well I guess curiosity but more fundamental questions" (RES#6). This delivers a first insight into the way information is handled and handed on. In this context again, it is important to stress the *Norwegian* factor within the case. This became very clear when it was stated that Norway's governance models function in a more bottom-up fashion as opposed to the top-down procedures in Germany or the Netherlands, for instance. Yet, this does not automatically generate benefits. Each of the roughly 375 coastal municipalities (RES#5) are thus in charge of their own coastal planning and not every municipality can afford to fill this position from an organizational and monetary point of view. Because of this, "they don't have the capacity or the competence to do anything properly" (RES#5).

Other conflicts arise as to the resilience of implemented coastal planning and their effectiveness. Norway has already advanced quite far in terms of water quality preservation (Dirnat,2002). Yet, how more preserved kelp forests directly benefit is contested, as many of the man-made borders are not thought to bring the sought-after effect to preserve that ecosystem. "[Y]ou could draw a box around a kelp forests but are you really removing the

driver? The main driver is climatic stress" (RES#2). This also synthesizes with the complexity aspect delivered in Chapter 2. The marine space is so complex, that a simple border will not make a big impact on a larger scale. Understanding the natural processes behind the ecosystems can result in a bigger impact, when considered in practice. At this stage again, it is important which information gets passed onwards to the planning stage.

It has to be stated, that planning of the coastal zones does of course take place, despite the limitations of human resources in some remote areas. "[ICZM] or [MSP] - we have a system in place" (RES#5). And even though Norway is not part of the EU, the wish to remain both independent of the choices made on EU level, yet simultaneously to retain *compatibility* with the EU agendas. "Which is essentially […] a very high-level Norwegian policy not to the let the EU have any ability to steer our, or direct or govern our Norwegian Marine resources. *Sadly speaking* I would say" (RES#5). This leads Norway to adopt their own system, yet the ratio of marine space to govern vs. the number of professionals available is a barrier. Especially in the complex transition areas of the coastline - also the places where kelp forests are found - is where the ratios between social, economic and ecological factors needs to be the most balanced out, also because these regions are accessible by the population. "We have that out in the […] open sea far away from the coast. But they are not so specific when getting closer to the coast where the municipalities' jurisdictionality of the coastal marine waters [starts]" (RES#5). Yet, considering kelp forests in the EBA focused MSP sector could benefit many people. It could create jobs, retain jobs for fisheries in the long-term and restore ecosystems that got damaged through overexploitation of single natural resources, for instance through excessive aquaculture.

One interviewee summed up the role of the marine spatial planner in this framework. "[T]he sea will be - and that's also […] from your perspective, from a planning perspective - that's where you will need to be acting now because this is taking off now" (RES#6). This hint towards a future growth in the sector is further underlined by the interviewee. "The coastal zone is the next zone, the next area that is going to expand rapidly and I think seaweeds and seaweed farming, kelp forests, kelp farming are at the forefront of that development" (RES#6). This quote sums up this call for action to achieve sustainable end goals and governance in the MSP sector.

5.5 Critical Reflection

Upon choosing such a multi-disciplinary thesis topic it is important to reflect the outcome of the conducted research. It has to be put into context that one can only scratch the surface of all the interconnected issues that go along with this topic within the confines of a thesis. Despite considerably demarcation and a specific set of experts on a singled out case, the whole extent of the problem complex remains hard to fathom in its entirety.

One limitation is the emergent character of kelp industry and all the information that is present in non-English languages. This is also the case for the NBKF. Most information about the rising industry and harvest techniques are published in Norwegian - a fact that was learned during the qualitative data collection as a side note. Similar things can be attested to the involved reports and publications from the research facilities' side. In those cases, depending on who is on the receiving end, extensive research reports will mostly only be published in Norwegian.

The results that emerged from the research seem convincing, some details were more expected than others. In terms of the role of the planner, the discussions surrounding MSP were the most diverse in terms of viewpoints. Therefore, a stringent and single conclusion about kelp and planning from this angle was not possible. Yet, the EBA seem to be in favor of all interviewees. Depending on the viewpoint, there is an underlying emphasis towards either the economic or ecological points of view. Yet and more surprisingly, there were also contact points in between, stemming from where the economic drivers originated. All interviewees do not categorically oppose kelp farming and kelp harvest, for example. There is merely concern in regard to the amounts harvested and allotted recovery times for wild kelp harvest. Pressures from the economic Blue Carbon side in Norway are not seen as a direct threat, despite the market domination by a single company.

In hindsight, narrowing down the scope further and to less EBAs would have benefitted the compactness of this research. Yet, it would have also barred the very broad information gathered throughout data collection.

6. CONCLUSION

Up to this point, the goal of this thesis research was to find out whether more traditional MSP or a more ecosystem-based focus is more adept at achieving sustainable end goals. For this purpose, a case study around the NBKF was used and qualitative data collected accordingly.

6.1 Answering the Research Questions

The first important step in the concluding chapter of this thesis lies in answering the research questions posed at the beginning of the research. For this purpose, the secondary research questions will be answered first. This will naturally lead to answering the primary research question in the end.

What are the characteristics of the current traditional MSP approach?

The current and more traditional MSP approach is mostly characterized by multi-sectoral attributes. This naturally leads to a high-complexity undertaking for governance. Achieving socially, economically and ecologically sound outcomes is a further characteristic, yet finding a proper balance between these aspects is a further addition to the already complex MSP. Since MSP is defined as a marine governance tool, the governance aspect is inherent. MSP delivers a basis for policies in the marine context and accompanies their revisions. The framework surrounding MSP is complex. The number of stakeholders and actors involved in the marine space that need to be addressed is very high. Furthermore, the jurisdiction might change from area to area and resulting hierarchy levels. Noteworthy is the fact that the interviewed experts used expressions like *daunting* or working with MSP being a *massive effort*. Thus, the critiques discussed in the theory section have been identified and a call for a revised framework for MSP has emerged throughout data collection.

What are the characteristics of EBAs in the marine context?

In the marine context, ecosystem-based planning approaches are based on the ecosystem services that are provided by the respective marine ecosystem. Depending on the emphasis taken, this can lead to either their direct implementation in planning efforts, a take on the economic route (see EA) or the management route (see EBM). ES are the building blocks of these approaches and include direct or indirect benefits. Direct benefits are for example the production of food or other resources like alginate. Among others, climate stabilization is regarded as an indirect benefit. EA emphasizes the economic background of ES, from

understanding the underlying trends, increased transparency, the connection to humans and feasible solutions to the socio-economic systems for example. EBM focuses on management strategies and hierarchies, acknowledgement of humans as a factor as well as interested stakeholders. Lastly. EBM aims to unite social, economic and ecological aspects. EBAs seem to be a way to connect ecosystems to the planning realm. Making use of the many services that ecosystems provide is a goal of the future more ecosystem-centered way of MSP. Noteworthy in this context is the way information is gathered, since many researchers knowledgeable about EBAs see themselves in a mere informative role.

What are characteristics and demands of sustainable end goals?

Sustainable end goals are a debatable construct. The term sustainable is very ambiguous on its own. In this context however, the sustainability context can be argued to stem from the ecological side. Thus, moving toward a more ecosystem-centric viewpoint can already aid in a more sustainable type of end goal, like marine governance. Incorporating ecosystem services (ES) and acknowledging the variety of services that ecosystems can provide long-term are arguably important demands of sustainable marine governance.

What are the tensions between the traditional MSP approach and the EBAs?

Tensions that arise between the more sector-focused, traditional MSP approach and the EBAs stem from the emphasis that the ecosystem has within the planning process. In the more typical sectoral-focused MSP, it is decided which area is designated to which purpose. Often, this includes issues like offshore power through windfarms and the cable routing towards the landside or oil and gas pipelines. In the case of traditional MSP, ecosystem issues are often merely raised if something is designated as an MPA or if there are concerns about wildlife or marine species. EBA on the other hand is based first and foremost on the ecosystem itself along with the services and dis-services they provide. This change in magnitude thus results in tensions between the MSP and the EBA approach. Due to the EBA catering to different NRM tensions, compatibility between MSP and EBAs are not always apparent from first glance. Yet, bridging the tensions between social, economic and ecological factors can benefit both sides.

What are the tensions of NRM as an interface between (traditional) MSP and EBAs?

Achieving a balance of social, economic and ecological factors can be seen as a goal of marine governance through MSP. In addition, EBAs have this similar goal. Points of tension are thus mostly in the realization of said balance and the difference of entities involved. In traditional MSP, there may be more non-ecosystem-based actors focused on realizing their individual

goals, whereas in EBA, the constant focus on the ecosystems brings a different set of stakeholders together. This tension is underlined in the interviews, where two of the interviewees see their roles as researchers purely in the informative role. Thus, they try to avoid MSP because of the large efforts needed to reach consensus among the actors.

Is Marine Spatial Planning able to achieve sustainable end goals better through its current approach or through ecosystem-based approaches?

Finally, the primary research questions shall be answered. This answer is one of the main takeaway messages from this explorative look into MSP and kelp forests. Simply put, it seems that MSP may be better able to achieve sustainable end goals through more EBAs than through its traditional approach. This became especially apparent, when trying to incorporate an up-and-coming ecosystem like the NBKF. Kelp forests experience an uprise in social awareness and acceptance due to their many positive benefits for local ecosystems and attached industries. Among those is the fish population of cod for instance, which is an industry that is part of the Norwegian identity. Thus, preserving existing kelp on the one hand would be a more *passive* way to implement it in more traditional MSP. Yet, through the more EBA, more of the beneficial attributes that have surfaced throughout this research alone can be directly addressed and utilized. Kelp helps to stabilize the local ecosystems, sequesters carbon and delivers important habitats and breeding grounds for the fish stock. *Actively* incorporating these characteristics into planning adds to the aforementioned benefits in the sense of actively trying to *revive* coastal regions that have had a loss of biodiversity. This also paves the way for finding potential synergies between the terrestrial and marine space in terms of socially accepted economic and ecological benefits. EBAs deliver the points of entry better than traditional MSP, coming from both the economic and ecologically driven viewpoints and putting the ecosystem services - which kelp forests deliver plenty of - in the center of attention. All interviewees do not categorically oppose kelp farming and kelp harvest. There is merely concern in regard to the amounts harvested and allotted recovery times for wild kelp harvest. Pressures from the economic Blue Carbon side in Norway are not seen as a direct threat, despite the market domination by a single company. Moving towards a new ecosystem-focused framework in the future, MSP will deliver a broad basis for new policies and sustainable marine governance. Furthermore, a sustained effect on the ecologist view (vs. the economist view) may lead to more adopted planning solutions that make use of ES and EBAs in general.

6.2 Summary and Concluding Remarks

In terms of generalized findings, the majority of findings and lessons learned from answering the RQ is adaptable to other regions outside the scope of the case. Yet, within the case study, the most intriguing results were delivered through a combination of case-specific details, the MSP framework and EBAs with NRM as a bridging element. I argue this to be the case for two reasons. First, NRM has been used with the idea in mind, that three major tensions are present. The socio-ecological branch is not as prone to conflicts as priorly expected, yet this could also be argued to be case-related. With the Norwegians being a coastal people, they are both aware and *forgiving* when it comes to conflicts in their marine space. Socio-economically, there are different currents within the tensions of what the main economic drivers are in relation to kelp forests. On the one hand, there is clearly an uprise in interest due to the idea that kelp sequesters carbon and that this can be used to offset the carbon credits in a positive way if this is deemed to be true. On the other hand, kelp cultivation and the harvest of both cultivated kelp (roughly 200 tons annually) and wild kelp (roughly 200 thousand tons annually) are on the rise as well (RES#4). Norway as a country needed to diversify its assets in the form of resources away from the receding oil market towards its abundant natural resources. With the fish stocks like the coastal cod and the aquaculture industry already quite saturated and in parts declining (among others due to the loss of kelp in the south), the view turned to kelp as a resource. This is often in direct conflict with the ecologically focused professionals. Thus, the economic-ecological branch of NRM is the most abundant in terms of data collected. This leads me to argue, that bridging the tensions between these opposing forces, i.e., coming to a conclusion that has benefits both economically and ecologically is the first step to bring kelp forests and planning closer together. This does not downplay the potential use of EBAs to bridge the gap between planning and kelp forests. Yet, NRM - thought to help connect EBAs and MSP - also delivered pointers towards where and which issues need to be tackled to even out the discourse. Afterwards, kelp forests have the chance to be incorporated directly into planning. The interviewed experts delivered many datapoints that synthesize the ideas behind the EBA core characteristics within the case of the NBKF. In a planning scenario, this can ultimately build upon synergies that first and foremost bridge the gap between the economic and ecological viewpoints.

In terms of benefits it has been stated several times that kelp forests are considered to be no-regret-measures. As the name implies, there are basically no downsides to using kelp. From a marine spatial planner's point of view, this leads to several implications. Firstly - provided that there is no direct use-conflict - kelp forests could always be implemented through seaweed cultivation efforts. The research project *green gravel* as mentioned in the case context delivers a solid foundation to easily sow large amounts of kelp with no explicit machinery required.

This leads to massive potentials for cultivation, ecosystem restoration or any of the mentioned benefits that can be found within this thesis research.

As mentioned in the introduction, Norway's coastline is vast and its predominantly rocky shores and other ecological factors - apart from the warming waters in the south - make it a perfect habitat for kelp forests. Hence, the great abundance of available kelp biomass. On the other hand, it appears that a bottleneck for using this for planning could be argued to be part of the bottom-up nature of Norwegian governance. While the larger municipalities may have the resources to sustainably govern their coastal zones and combining all factors from the economic, ecological and social viewpoints, smaller municipalities struggle. Some of the over 375 coastal municipalities have less than 1,500 inhabitants (RES#5) yet feature a potentially viable coastline. Collaboration in planning and governing these coastal stretches can be a viable solution going forward.

6.3 Future Research and Recommendations for Practice

As it appears from the conducted research, there is an connection, albeit indirect, between kelp forests and the planning realm through the use of EBAs. Therefore, all discussed positive impacts through the EBAs can be argued to be a massive potential for the planning sector, when streamlining this process. It is not too unrealistic to have designated areas of kelp forests as a tool in the marine spatial planner's toolbox in the future. Kelp forests serve many purposes at once and could therefore streamline the planning process and discourse, since they bring together many aspects like the economic, ecological and social factors. Depending on the exact scenario, kelp forests could simultaneously benefit, the replenishment of fish stocks, carbon uptake, coastal erosion, sustainable economic harvest of a natural resource or function as an MPA. It is the epitome of a *non-regret measure* as described by many of the experts during the interviews. Yet, the multi-sectoral framework that MSP provides prohibits bringing all viewpoints together. This holds especially true when newer economic drivers like Blue Carbon stir up the discussions about kelp forests.

Furthermore, and also within the scope of the case, a more detailed actor analysis could also aid in identifying more drivers and barriers as to what role kelp forests play for different public and governmental stakeholders. Especially the role of the kelp farming industry starting midway up the Norwegian coast toward the north is an interesting undertaking. When this is coupled with the latest research in regard to sustainable farming, the valuation of kelp forests as an ecosystem, further pointers and implications for planning can be given.

REFERENCES

Afrokomi-Afroula, M., Stefanakou, A., & Nikitakos, N. (2015, June 24). *Blue Economy: Offshore Wind Energy as a Means of Development in Greece, and the need for Marine Spatial Planning.*

Anderson, M. R., & Rivkin, Richard B. (2009). *Oceans as Major Reservoirs of Protein*. 7.

Arkema, K. K., Abramson, S. C., & Dewsbury, B. M. (2006). Marine ecosystem-based management: From characterization to implementation. *Frontiers in Ecology and the Environment*, *4*(10), 525–532. https://doi.org/10.1890/1540-9295(2006)4[525:MEMFCT]2.0.CO;2

Arthur, C. (2018, August 24). *The tide is coming in for Indonesia's seaweed | UNIDO*. https://www.unido.org/stories/tide-coming-indonesias-seaweed

BlueConnect. (2021). *BlueConnect Project*. BlueConnect. https://www.blueconnectproject.com

Bricker, S. B., Grizzle, R. E., Trowbridge, P., Rose, J. M., Ferreira, J. G., Wellman, K., Zhu, C., Galimany, E., Wikfors, G. H., Saurel, C., Landeck Miller, R., Wands, J., Rheault, R., Steinberg, J., Jacob, A. P., Davenport, E. D., Ayvazian, S., Chintala, M., & Tedesco, M. A. (2020). Bioextractive Removal of Nitrogen by Oysters in Great Bay Piscataqua River Estuary, New Hampshire, USA. *Estuaries and Coasts*, *43*(1), 23–38. https://doi.org/10.1007/s12237-019-00661-8

Chen, W., Van Assche, K. A. M., Hynes, S., Bekkby, T., Christie, H. C., & Gundersen, H. (2020). Ecosystem accounting's potential to support coastal and marine governance. *Marine Policy*, *112*, 103758. https://doi.org/10.1016/j.marpol.2019.103758

Christiansen, R. C. (2008, October 31). *British report: Use kelp to produce energy | Biomassmagazine.com*. http://www.biomassmagazine.com/articles/2166/british-report-use-kelp-to-produce-energy/

CoastAdapt. (2017, April 27). *Ocean acidification and its effects | CoastAdapt*. https://coastadapt.com.au/ocean-acidification-and-its-effects

Day, J. C. (2002). Zoning—Lessons from the Great Barrier Reef Marine Park. *Coastal Management*, 18.

de Groot, R., Fisher, B., & Christie, M. (2010). *Integrating the ecological and economic dimensions in biodiversity and ecosystem service valuation*. 422.

DellaSala, D. A. (2018). The Carbon Cycle and Global Change: Too Much of a Good Thing. In *Encyclopedia of the Anthropocene* (pp. 7–10). Elsevier. https://doi.org/10.1016/B978-0-12-809665-9.05874-2

Dirnat. (2002, July). *Environment and water resources management—The Norwegian Way*. https://www.regjeringen.no/globalassets/upload/kilde/md/bro/2002/0002/ddd/pdfv/159960-t-1411.pdf

Domínguez-Tejo, E., & Metternicht, G. (2018). Poorly-designed goals and objectives in resource management plans: Assessing their impact for an Ecosystem-Based Approach to Marine Spatial Planning. *Marine Policy*, *88*, 122–131. https://doi.org/10.1016/j.marpol.2017.11.013

Domínguez-Tejo, E., Metternicht, G., Johnston, E., & Hedge, L. (2016). Marine Spatial Planning advancing the Ecosystem-Based Approach to coastal zone management: A review. *Marine Policy*, *72*, 115–130. https://doi.org/10.1016/j.marpol.2016.06.023

Douvere, F. (2008). The importance of marine spatial planning in advancing ecosystem-based sea use management. *Marine Policy*, *32*(5), 762–771.

Douvere, F., & Ehler, C. (2009). Ecosystem-Based Marine Spatial Management: An Evolving Paradigm for the Management of Coastal and Marine Places. *Ocean Yearbook*, *23*, 1–7. https://doi.org/10.1163/22116001-90000188

Douvere, F., & Ehler, C. (2010). An International Perspective on Marine Spatial Planning Initiatives. *Environments*, *37*, 9–20.

Ehler, C. (2008). Conclusions: Benefits, lessons learned, and future challenges of marine spatial planning. *Marine Policy*, *32*(5), 840–843. https://doi.org/10.1016/j.marpol.2008.03.014

Ehler, C., & Douvere, F. (2008). Special Issue on the Role of Marine Spatial Planning in Implementing Ecosystem-based Sea Use Management. *Marine Policy*, *32*, 759–843.

Ehler, C., Zaucha, J., & Gee, K. (2019). *Maritime/Marine Spatial Planning at the Interface of Research and Practice: Past, present, future* (pp. 1–21). https://doi.org/10.1007/978-3-319-98696-8_1

Essington, T. E., Sanchirico, J. N., & Baskett, M. L. (2018). Economic value of ecological information in ecosystem-based natural resource management depends on exploitation history. *Proceedings of the National Academy of Sciences*, *115*(7), 1658–1663. https://doi.org/10.1073/pnas.1716858115

European MSP Platform. (2016, May 21). *Process and content of Latvian MSP*. European MSP Platform. https://www.msp-platform.eu/practices/process-and-content-latvian-msp

European Parliament. (2020, December). *Integrated Maritime Policy of the European Union | Fact Sheets on the European Union | European Parliament*. https://www.europarl.europa.eu/factsheets/en/sheet/121/integrated-maritime-policy-of-the-european-union

FamilySearch. (2015, December 4). *Norwegian Kommune*. FamilySearch Wiki. https://www.familysearch.org/wiki/en/Norwegian_Kommune

FAO. (2021). *Cultural services*. Food and Agriculture Organization of the United Nations. http://www.fao.org/ecosystem-services-biodiversity/background/cultural-services/en/

Fernandes, M. da L., Quintela, A., & Alves, F. (2018). Identifying conservation priority areas to inform maritime spatial planning: A new approach. *Science of The Total Environment*, *639*. https://doi.org/10.1016/j.scitotenv.2018.05.147

Flannery, W., Clarke, J., & McAteer, B. (2019). Politics and Power in Marine Spatial Planning. In J. Zaucha & K. Gee (Eds.), *Maritime Spatial Planning: Past, present, future* (pp. 201–217). Springer International Publishing. https://doi.org/10.1007/978-3-319-98696-8_9

Florida Tech. (2018, February 15). *5 Factors Impacting Marine Ecosystems*. Florida Tech News. https://news.fit.edu/archive/5-factors-impacting-marine-ecosystems/

Foley, M. M., Halpern, B. S., Micheli, F., Armsby, M. H., Caldwell, M. R., Crain, C. M., Prahler, E., Rohr, N., Sivas, D., Beck, M. W., Carr, M. H., Crowder, L. B., Emmett Duffy, J., Hacker, S. D., McLeod, K. L., Palumbi, S. R., Peterson, C. H., Regan, H. M., Ruckelshaus, M. H., … Steneck, R. S. (2010). Guiding ecological principles for marine spatial planning. *Marine Policy*, *34*(5), 955–966. https://doi.org/10.1016/j.marpol.2010.02.001

Franzese, P. P., Liu, G., & Aricò, S. (2019). Environmental accounting models and nature conservation strategies. *Ecological Modelling*, *397*, 36–38. https://doi.org/10.1016/j.ecolmodel.2019.01.015

Froehlich, H. E., Afflerbach, J. C., Frazier, M., & Halpern, B. S. (2019). Blue Growth Potential to Mitigate Climate Change through Seaweed Offsetting. *Current Biology*, *29*(18), 3087-3093.e3. https://doi.org/10.1016/j.cub.2019.07.041

Fulton, E., Smith, A., & Johnson, C. (2003). Effect of Complexity of Marine Ecosystem Models. *Marine Ecology Progress Series*, *253*, 1–16. https://doi.org/10.3354/meps253001

Geange, S., Townsend, M., Clark, D., Ellis, J. I., & Lohrer, A. M. (2019). Communicating the value of marine conservation using an ecosystem service matrix approach. *Ecosystem Services*, *35*, 150–163. https://doi.org/10.1016/j.ecoser.2018.12.004

Gibbs, G. (2007). *Analyzing Qualitative Data*. SAGE Publications, Ltd. https://doi.org/10.4135/9781849208574

Gopnik, M., Fieseler, C., Cantral, L., McClellan Press, K., Pendleton, L., & Crowder, L. (2012). Coming to the table: Early stakeholder engagement in marine spatial planning. *Marine Policy*, *36*, 1139–1149. https://doi.org/10.1016/j.marpol.2012.02.012

Green Gravel. (2021). *About Green Gravel*. Green Gravel. https://www.greengravel.org

Gundersen, H. (NIVA), Bryan, T. (GRID-A., Chen, W. (NIVA), Moy, F. E. (IMR), Sandman, A. N. (AquaBiota), Sundblad, G. (AquaBiota), Schneider, S. (NIVA), Andersen, J. H. (NIVA), Langaas, S. (NIVA), & Walday, M. G. (NIVA). (2017). *Ecosystem Services*. Nordic Council of Ministers. https://doi.org/10.6027/TN2016-552

Hartje, V., Klaphake, A., & Schliep, R. (n.d.). *The International Debate on the Ecosystem Approach: Diffusion of a Codification Effort*. 53.

Häyhä, T., & Franzese, P. P. (2014). Ecosystem services assessment: A review under an ecological-economic and systems perspective. *Ecological Modelling*, *289*, 124–132. https://doi.org/10.1016/j.ecolmodel.2014.07.002

Hirsh, H. K., Nickols, K. J., Takeshita, Y., Traiger, S. B., Mucciarone, D. A., Monismith, S., & Dunbar, R. B. (2020). Drivers of Biogeochemical Variability in a Central California Kelp Forest: Implications for Local Amelioration of Ocean Acidification. *Journal of Geophysical Research: Oceans*, *125*(11). https://doi.org/10.1029/2020JC016320

Hurtigruten. (2021). *About Norway's Coastline*. https://global.hurtigruten.com/destinations/norway/inspiration/attractions/norways-coastline/

Interreg Europe. (2017). *Policy Brief: The potential of cross sectoral value chain innovation*. https://www.interregeurope.eu/fileadmin/user_upload/plp_uploads/policy_briefs/2017-08-28-Policy_brief_Value_chain_innovation_01.pdf

Jay, S. (2017). *Issue Paper: Marine Spatial Planning—Assessing net benefits and improving effectiveness*. https://www.oecd.org/greengrowth/GGSD_2017_Issue%20Paper_Marine%20Spatial%20Planning.pdf

Jay, S., Alves, F. L., O'Mahony, C., Gomez, M., Rooney, A., Almodovar, M., Gee, K., de Vivero, J. L. S., Gonçalves, J. M. S., da Luz Fernandes, M., Tello, O., Twomey, S., Prado, I., Fonseca, C., Bentes, L., Henriques, G., & Campos, A. (2016). Transboundary dimensions of marine spatial planning: Fostering inter-jurisdictional relations and governance. *Marine Policy*, *65*, 85–96. https://doi.org/10.1016/j.marpol.2015.12.025

Karimi, F., & Khalilpour, R. (2015). Evolution of carbon capture and storage research: Trends of international collaborations and knowledge maps. *International Journal of Greenhouse Gas Control*, *37*, 362–376. https://doi.org/10.1016/j.ijggc.2015.04.002

KELPEX. (2021). *Background to the KELPEX project*. Website. https://www.kelpex.org/about

Kim, B. M., Jeon, Y. H., & Yoon, H. S. (2016). A Hydraulic Experiment Using Artificial Seaweed for Coastal Erosion Prevention. *Journal of the Korean Society for Marine Environment and Energy*, *19*(4), 266–273. https://doi.org/10.7846/JKOSMEE.2016.19.4.266

Krause-Jensen, D., & Duarte, C. M. (2016). Substantial role of macroalgae in marine carbon sequestration. *Nature Geoscience*, *9*(10), 737–742. https://doi.org/10.1038/ngeo2790

Kuckartz, U. (2018). *Qualitative Inhaltsanalyse: Methoden, Praxis, Computerunterstützung* (4. Auflage). Beltz Juventa.

Lamy, T., Koenigs, C., Holbrook, S. J., Miller, R. J., Stier, A. C., & Reed, D. C. (2020). Foundation species promote community stability by increasing diversity in a giant kelp forest. *Ecology*, *101*(5). https://doi.org/10.1002/ecy.2987

Langaas, S. (2017). *The role of blue forests to capture and store atmospheric carbon and other ecosystem services, nationally and globally*. https://www.un.org/depts/los/consultative_process/icp18_presentations/langaas.pdf

Lareau, A., & Rao, A. H. (2016, March 19). *it's about the depth of your data—Contexts*. https://contexts.org/blog/its-about-the-depth-of-your-data/

Lavrakas, P. (2008). *Encyclopedia of Survey Research Methods*. Sage Publications, Inc. https://doi.org/10.4135/9781412963947

Lawton, R. N., & Rudd, M. A. (2014). A Narrative Policy Approach to Environmental Conservation. *AMBIO*, *43*(7), 849–857. https://doi.org/10.1007/s13280-014-0497-8

Leenhardt, P., Teneva, L., Kininmonth, S., Darling, E., Cooley, S., & Claudet, J. (2015). Challenges, insights and perspectives associated with using social-ecological science for marine conservation. *Ocean & Coastal Management*, *115*, 49–60. https://doi.org/10.1016/j.ocecoaman.2015.04.018

Leslie, H. M., & McLeod, K. L. (2007). Confronting the challenges of implementing marine ecosystem-based management. *Frontiers in Ecology and the Environment*, *5*(10), 540–548. https://doi.org/10.1890/060093

Lester, S. E., Costello, C., Halpern, B. S., Gaines, S. D., White, C., & Barth, J. A. (2013). Evaluating tradeoffs among ecosystem services to inform marine spatial planning. *Marine Policy*, *38*, 80–89. https://doi.org/10.1016/j.marpol.2012.05.022

Levin, P. S., Fogarty, M. J., Murawski, S. A., & Fluharty, D. (2009). Integrated Ecosystem Assessments: Developing the Scientific Basis for Ecosystem-Based Management of the Ocean. *PLoS Biology*, *7*(1), e1000014. https://doi.org/10.1371/journal.pbio.1000014

Lomas, P. L., & Giampietro, M. (2017). Environmental accounting for ecosystem conservation: Linking societal and ecosystem metabolisms. *Ecological Modelling*, *346*, 10–19. https://doi.org/10.1016/j.ecolmodel.2016.12.009

McIntyre, S., Dalkir, K., Paul, P., & Kitimbo, I. C. (Eds.). (2015). *Utilizing Evidence-Based Lessons Learned for Enhanced Organizational Innovation and Change:* IGI Global. https://doi.org/10.4018/978-1-4666-6453-1

National Geographic. (n.d.). *Human Impacts on the Environment*. Retrieved May 19, 2021, from http://www.nationalgeographic.org/topics/resource-library-human-impacts-environment/

NOAA, N. (2020, September 28). *Seaweed Aquaculture | NOAA Fisheries* (National). NOAA. https://www.fisheries.noaa.gov/national/aquaculture/seaweed-aquaculture

Nordic Blue Carbon. (2021). *Nordic Blue Carbon*. https://nordicbluecarbon.no/

NWO. (2018, October 1). *Netherlands Code of Conduct for Research Integrity | NWO*. https://www.nwo.nl/en/netherlands-code-conduct-research-integrity

OPTIMAKELP. (2021). *OPTIMAKELP*. OPTIMAKELP. https://www.optimakelp.net

Pendleton, L., Donato, D. C., Murray, B. C., Crooks, S., Jenkins, W. A., Sifleet, S., Craft, C., Fourqurean, J. W., Kauffman, J. B., Marbà, N., Megonigal, P., Pidgeon, E., Herr, D., Gordon,

D., & Baldera, A. (2012). Estimating Global “Blue Carbon” Emissions from Conversion and Degradation of Vegetated Coastal Ecosystems. *PLoS ONE*, *7*(9), e43542. https://doi.org/10.1371/journal.pone.0043542

PMR. (2021). *Kelp Market: Global Industry Trend Analysis 2012 to 2017 and Forecast 2017 - 2025*. Persistence Market Research. https://www.persistencemarketresearch.com/market-research/kelp-market.asp

Rocchi, M., Scotti, M., Micheli, F., & Bodini, A. (2017). Key species and impact of fishery through food web analysis: A case study from Baja California Sur, Mexico. *Journal of Marine Systems*, *165*, 92–102. https://doi.org/10.1016/j.jmarsys.2016.10.003

Salt, A. (2019, August 29). How kelp protects coasts « Botany One. *Botany One*. https://www.botany.one/2019/08/how-kelp-protects-coasts/

Schiel, D. R., & Foster, M. S. (2015). *The biology and ecology of giant kelp forests*. University of California Press.

Schubert, M. (2018). *Marine Spatial Planning*. https://www.researchgate.net/publication/322951791_Marine_Spatial_Planning

Schupp, M. F., Bocci, M., Depellegrin, D., Kafas, A., Kyriazi, Z., Lukic, I., Schultz-Zehden, A., Krause, G., Onyango, V., & Buck, B. H. (2019). Toward a Common Understanding of Ocean Multi-Use. *Frontiers in Marine Science*, *6*. https://doi.org/10.3389/fmars.2019.00165

ScienceDirect. (2021). *Kelp Forest — An overview | ScienceDirect Topics*. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/kelp-forest

Simons, H. (2009). *Case Study Research in Practice*. SAGE Publications, Ltd. https://doi.org/10.4135/9781446268322

Smale, D., Burrows, M., Moore, P., O’Connor, N., & Hawkins, S. (2013). Threats and knowledge gaps for ecosystem services provided by kelp forests: A northeast Atlantic perspective. *Ecology and Evolution*, *3*, 4016–4038. https://doi.org/10.1002/ece3.774

Stake, R. E. (2005). Qualitative Case Studies. In *The Sage handbook of qualitative research, 3rd ed.* (pp. 443–466). Sage Publications Ltd.

Stefanie—Marine Spatial Planning—Assessing net benefits a.pdf. (n.d.).

Steneck, R. S., Graham, M. H., Bourque, B. J., Corbett, D., Erlandson, J. M., Estes, J. A., & Tegner, M. J. (2002). Kelp forest ecosystems: Biodiversity, stability, resilience and future. *Environmental Conservation*, *29*(4), 436–459. https://doi.org/10.1017/S0376892902000322

Stévant, P., Rebours, C., & Chapman, A. (2017). Seaweed aquaculture in Norway: Recent industrial developments and future perspectives. *Aquaculture International*, *25*(4), 1373–1390. https://doi.org/10.1007/s10499-017-0120-7

Szekalska, M., Puciłowska, A., Szymańska, E., Ciosek, P., & Winnicka, K. (2016). Alginate: Current Use and Future Perspectives in Pharmaceutical and Biomedical Applications. *International Journal of Polymer Science*, *2016*, 1–17. https://doi.org/10.1155/2016/7697031

Tallis, H., & Polasky, S. (2009). Mapping and Valuing Ecosystem Services as an Approach for Conservation and Natural-Resource Management. *Annals of the New York Academy of Sciences*, *1162*(1), 265–283. https://doi.org/10.1111/j.1749-6632.2009.04152.x

Teagle, H., Hawkins, S. J., Moore, P. J., & Smale, D. A. (2017). The role of kelp species as biogenic habitat formers in coastal marine ecosystems. *Journal of Experimental Marine Biology and Ecology*, *492*, 81–98. https://doi.org/10.1016/j.jembe.2017.01.017

The Economist. (2018, November 8). Mining the deep ocean will soon begin. *The Economist*. https://www.economist.com/science-and-technology/2018/11/08/mining-the-deep-ocean-will-soon-begin

Troell, M., Naylor, R. L., Metian, M., Beveridge, M., Tyedmers, P. H., Folke, C., Arrow, K. J., Barrett, S., Crépin, A.-S., Ehrlich, P. R., Gren, Å., Kautsky, N., Levin, S. A., Nyborg, K., Österblom, H., Polasky, S., Scheffer, M., Walker, B. H., Xepapadeas, T., & de Zeeuw, A. (2014). Does aquaculture add resilience to the global food system? *Proceedings of the National Academy of Sciences of the United States of America*, *111*(37), 13257–13263. https://doi.org/10.1073/pnas.1404067111

UN SDG. (2021). *Biodiversity and ecosystems: Sustainable Development Knowledge Platform*. https://sustainabledevelopment.un.org/topics/biodiversityandecosystems

UNEP. (2017, July 20). *Blue Forests: Finding Coastal and Marine Solutions to meet the Paris Agreement*. UNEP. http://www.unep.org/news-and-stories/story/blue-forests-finding-coastal-and-marine-solutions-meet-paris-agreement

UNESCO, & IOC. (2018). *Concepts and Terminology*. http://msp.ioc-unesco.org/msp-good-practices/concepts-and-terminology/

VARAM. (2020, May 4). *Maritime Spatial Planning | Vides aizsardzības un reģionālās attīstības ministrija*. https://www.varam.gov.lv/en/maritime-spatial-planning

Vilas, D., Coll, M., Pedersen, T., Corrales, X., Filbee-Dexter, K., Pedersen, M. F., Norderhaug, K. M., Fredriksen, S., Wernberg, T., & Ramírez-Llodra, E. (2020). Kelp-carbon uptake by Arctic deep-sea food webs plays a noticeable role in maintaining ecosystem structural and functional traits. *Journal of Marine Systems*, *203*, 103268. https://doi.org/10.1016/j.jmarsys.2019.103268

Visbeck, M. (2018). Ocean science research is key for a sustainable future. *Nature Communications*, *9*(1), 690. https://doi.org/10.1038/s41467-018-03158-3

Wang, 21 December 2020 Xinxin, & December 2020, P. J. J. 21. (n.d.). Kelp farming: A great opportunity for northern Norway and the world. *Nofima*. Retrieved May 19, 2021, from https://nofima.no/en/mening/kelp-farming-a-great-opportunity-for-northern-norway-and-the-world/

Weiskopf, S. R., Rubenstein, M. A., Crozier, L. G., Gaichas, S., Griffis, R., Halofsky, J. E., Hyde, K. J. W., Morelli, T. L., Morisette, J. T., Muñoz, R. C., Pershing, A. J., Peterson, D. L., Poudel, R., Staudinger, M. D., Sutton-Grier, A. E., Thompson, L., Vose, J., Weltzin, J. F., & Whyte, K. P. (2020). Climate change effects on biodiversity, ecosystems, ecosystem services, and natural resource management in the United States. *Science of The Total Environment*, *733*, 137782. https://doi.org/10.1016/j.scitotenv.2020.137782

Wernberg, T., Krumhansl, K., Filbee-Dexter, K., & Pedersen, M. F. (2019). Status and Trends for the World's Kelp Forests. In *World Seas: An Environmental Evaluation* (pp. 57–78). Elsevier. https://doi.org/10.1016/B978-0-12-805052-1.00003-6

WHO. (2005). *WHO | Ecosystem goods and services for health*. WHO; World Health Organization. https://www.who.int/globalchange/ecosystems/en/

Wolsink, M. (2018). Social acceptance revisited: Gaps, questionable trends, and an auspicious perspective. *Energy Research & Social Science*, *46*, 287–295. https://doi.org/10.1016/j.erss.2018.07.034

Wüstenhagen, R., Wolsink, M., & Burer, M. J. (2007). Social Acceptance of Renewable Energy Innovation: An Introduction to the Concept. *Energy Policy*, 26832691. https://doi.org/10.1016/j.enpol.2006.12.001

IMAGE REFERENCES

Images last accessed May 22nd, 2021

Image0 (Title Page)

https://i2.wp.com/www.baresports.com/wp-content/uploads/2019/11/Kelpforest-1.jpg?resize=1200%2C630&ssl=1

Image1

https://www.rcinet.ca/eye-on-the-arctic/wp-content/uploads/sites/30/2019/05/kelp-forest-2-1024x716.jpg

Image2

https://www.profor.info/sites/profor.info/files/GettyImages-498168463-3f77f75%20%281%29.jpg

Image3

https://images.squarespace-cdn.com/content/v1/52e1b262e4b06ef060506756/1480545560514-TEGMO8EP0C51C1UP7U1T/ke17ZwdGBToddI8pDm48kPG1NNr9uO4BVXyZlPsCQ-h7gQa3H78H3Y0txjaiv_ 0fDoOvxcdMmMKkDsyUqMSsMWxHk725yiiHCCLfrh8O1z4YTzHvnKhyp6Da-NYroOW3ZGjoBKy3azqku80C789l0tVhKpQvO7ZNFCm3tBizrBXQ-8W8HD5swhNACAjobiJ6j-Fih82ceA1qHL8lGDfQVw/image-asset.png?format=1500w

APPENDIX A: INTERVIEW GUIDELINE

Context	Main Question	Probes
Informed Consent	Before we begin, I would like to inform you about what this interview is for and how data and personal information are going to be handled. Your consent is an important factor in ethically handling this research and its data collection and is imperative going forward. This is - as it should be - standard procedure. For my research, I would like to make a recording of this interview. I would afterwards like to anonymize and transcribe it to use it for my thesis. It will be handled discretely and professionally and be used for the purpose of my research only. Personal details will be stored separately from the interview and will be deleted after the handing-in of the thesis. On the other hand, you of course have the right to alter your response, not respond to the question at all or withdraw your consent to participate at any time. Also, you may of course have the transcript made available to you upon request with the option to ask for changes to be made to said transcript. Would you please confirm that this is okay for you?	- Would you like me to clarify anything?
INTRO	Thank you for taking the time to do this interview with me today. As you may have similarly experienced throughout your career, for this interview I will follow a pre-set structure and guideline. I hope I do not sound too robotic while doing this, do not be alarmed in any case. As I have mentioned in our email contact, the main theme of this interview revolves around the case of the Norwegian Blue Kelp Forests in the context of my research of Ecosystem-Based approaches and Planning. But we will get to that step my step. **If you would be so kind, could you please briefly introduce yourself?**	- Occupation? - Position? - How long? - Field of research? - Past and current projects?
Case	As I also mentioned before, the case of the Norwegian Blue Kelp Forests is a central point in my thesis research. **Could you please elaborate on your involvement with the Norwegian Blue Kelp Forests?** What is the **aim** of Blue Kelp Forests in general and what is special about the Kelp Forest population on the Norwegian coast? What are typical characteristics that you associate with Blue Kelp Forests?	- Research? - Projects? - (Local) knowledge? - Awareness?

Ecosystem-Based Approaches	I would like to talk about some ecosystem-based approaches next. For my research I have split some characteristics of different approaches up into 4 different categories. These categories offer different viewpoints on the matter and I am eager to find out the connection between them and the Blue Kelp Forests. Starting off, I would like to begin with the role of humans. **Where do you see the role of humans in conjunction with the Blue Kelp Forests?**	
	Where do you see the factors like communication, understanding and transparency in connection with the Blue Kelp Forests? **Where do you see benefits, drawbacks or tradeoffs in connection with the Blue Kelp Forests?**	
	Where do you see factors like feasibility and action in conjunction with the Blue Kelp Forests?	
	Summing up the Ecosystem-Based Approaches, I would like to let you know that I have covered three approaches. These are Ecosystem Services, Ecosystem Accounting and Ecosystem-Based Management. Have you come across these terminologies before? Is there anything you would like to add, now that you know which approaches I have researched?	
MSP	Since I am studying a planning-related master's this angle inevitably made its way into my thesis. For this I have researched Marine Spatial Planning in this context. Have you come across this term before in your professional life and made use of it in projects maybe?	
OUTRO	Thank you so much for your time and contributing to my research. It has helped me in comprehending the situation in more detail and will greatly benefit my thesis! As a final question for this interview - is there anyone else involved with the Norwegian Blue Kelp Forests that I could/should contact in your opinion?	

Quick follow-ups:

- Could you please elaborate on this further?
- What exactly do you mean by that?
- Can you give an example?

APPENDIX B: INFORMED CONSENT

The following informed consent was either sent in written form before the semi-structured interviews or it was read prior to the interview to obtain consent from the interviewees.

"Before we begin, I would like to inform you about what this interview is for and how data and personal information are going to be handled. Your consent is an important factor in ethically handling this research and its data collection and is imperative going forward. This is - as it should be - standard procedure.

For my research, I would like to make a recording of this interview. I would afterwards like to anonymize and transcribe it to use it for my thesis. It will be handled discretely and professionally and be used for the purpose of my research only. Personal details will be stored separately from the interview and will be deleted after the handing-in of the thesis.

On the other hand, you of course have the right to alter your response, not respond to the question at all or withdraw your consent to participate at any time. Also, you may of course have the transcript made available to you upon request with the option to ask for changes to be made to said transcript."

APPENDIX C: KELP CHARACTERISTICS

Characteristic	Description
Carbon Capture and Storage (CCS) Source	Carbon Capture and Storage (CCS) is a very modern topic regarding the global carbon cycle. Humanity is on the search for different ways to store carbon. Biologically this is mainly done in plants, flora and fauna. Physical extraction processes are also possible but require a lot of energy.
Biological Stability Provider	Regions with a large kelp population tend to be more diverse and biologically stable. Marine permaculture is one idea that uses kelp to restore and regenerate marine ecosystems by mimicking natural kelp forests through algae farming.
Detoxing Provider	Kelp is able to absorb nutrients and toxins out of the water. Studies have shown that kelp forests are able to partly compensate over-eutrophication from surface runoff of farms on the coastline.
Habitat Provider	Kelp forests deliver a broad basis for habitats. The species that can take advantage of vast kelp forests span throughout the whole food web. Kelp forests can also serve as refuge for distressed species.
Economic Value Source	Kelp is marketed throughout the world and plays important roles for example in the pharmaceutical industry and blue bio-industry.
Global Seafood Industry Source	Kelp is very nutritious. It has been part of the South-East-Asian culture for centuries and has entered the global seafood market through globalization. The mariculture industry has focused on kelp production and continuously increased its yield, especially in the local waters of the Americas.
Renewable Energy Source	There have been ongoing tests using kelp (and algae in general) as a source for bioenergy. Either directly as a synthesized fuel or as a substrate used in biogas plants. The energy yield from kelp in addition to its fast growth makes it a viable and potentially sustainable energy source going forward.

Coastal Erosion Inhibitor	Kelp that is embedded into the rocky shorelines is able to absorb a portion of the force exerted by agitated water. In storm situations and floods, kelp forests can aid in reducing the stress on the shoreline - effectively slowing down coastal erosion.
Ocean Acidification Inhibitor	It is apparent from ongoing research that the higher the uptake of carbon in the oceans, the more acidic the ocean becomes. This has many negative implications for the ecosystems. Kelp Forests are very basic (non-acidic) environments from the pH-levels and are able to counteract a fraction of the acidity.
Climate Change Inhibitor	Through its abilities to store carbon from the atmosphere and deliver important stabilizing effects, kelp forests are often linked to dampen and slow down the effects of climate change.
Ecosystem Service Provider	Kelp forests are important providers of ecosystem services. These are mentioned throughout the EBAs and the collected data.

Kelp itself has a broad range of use scenarios in the marine space. Additionally, it contributes to the trifecta of pillars within natural resource management, tending to social, economic and ecological benefits alike. Its global upward trend has gathered interest among many actors invested in the maritime and non-maritime space. The literature review revealed many potential benefits, which are depicted in more context below.

What is kelp?

Kelp is a type of seaweed of algae that potentially grows almost everywhere in our oceans where its basic requirements are met. This holds true from the warm waters at the equator to the arctic seas. Large conglomerates of kelp are typically named kelp forests. Adult kelp can reach heights of up to 80 meters, depending on several environmental factors and the depth of the water. Within the kelp family, there are about 30 sub-types of these seaweeds. It is important to note that kelp is not considered to be a plant per se but belongs to the family of heterokonts. (Schiel and Foster, 2015).

Carbon Capture and Storage

Kelp plays a key role in the global carbon cycle. In one exemplification of ecosystem services, kelp aids in regulatory services like carbon sequestration. Kelp's ability to store massive amounts of carbon is only furthered by the fact that it is abundantly spread across the globe. It grows in many different areas, water types, depths and salinity levels. Carbon can be cycled

through “living organisms to ecosystems [...]. In the global carbon budget, carbon sinks are those that store or sequester atmospheric carbon while sources are emitters of CO_2. Plants, soils, and oceans act as natural carbon sinks, soaking it up from the atmosphere” (DellaSala, 2018, p.7).

The stored carbon in a kelp plant is brought back into the carbon cycle when the plant dies. This plays an important role in the carbon balance, as the location and movement of the remnants of the plant is not always apparent. When the kelp dies, its carbon counts towards the non-living carbon detritus. This flow is “considered an important process because it connects ecosystems and fuels benthic communities. In Norwegian kelp forests, 90% of the kelp production is exported to adjacent ecosystems where it can play a significant role in shaping benthic communities” (Vilas et al., 2019, p.2). The inclusion and re-introduction of carbon, the so-called uptake, fuels the local ecosystem. It is transported through the food web, stabilizes the adjacent ecosystems and aids directly in improving biodiversity. Carbon capture and storage is a very up and coming topic in the scientific community. Research on this topic, also in conjunction with issues regarding global warming has been constantly ongoing. “From the number of annual CCS publications, it seems that CCS research has closely followed the trend of international negotiations on climate change mitigation” (Karimi and Khalilpour, 2015, p.362). This carbon capture and storage side-effect of kelp forest is what ultimately makes them into Blue Kelp Forests, following the analogy of the terrestrial “blue forest” counterpart.

Biological Stability Provider

It has become apparent, that areas with a large kelp population tend to be more biologically stable, also pushed through its diversity. The research efforts by Lamy et al. (2020) go one step beyond and also classify kelp forests as foundation species. “Foundation species structure communities, promote biodiversity, and stabilize ecosystem processes by creating locally stable environmental conditions” (Lamy et al., 2020, p.1). This underlines the need of these type of species that also display a resiliency to change. Steneck et al. (2002) continue this direction. “It is possible that functional redundancies among predators and herbivores make this most diverse [kelp forest eco-]system most stable” (Steneck et al., 2002, p.436). They argue, that kelp is a good and diverse habitat in itself but it also supports a widespread community of food web actors. Therefore, kelp forests lead to a more biodiverse area in its vicinity and environment. Higher biodiversity also adds resilience towards the kelp itself, giving potential predators a broader range of prey to choose from and therefore limiting local extinction processes. Kelp is consumed by herbivore and omnivore aquatic wildlife. A lower level of biodiversity or removal of a key species can in turn lead to negative implications as well as extreme changes in water quality levels. Typical pointers for this are the concurrent populations of sea urchins, which consume high amounts of kelp, independent of which area

the kelp was found. A mass sea urchin outbreak has impacted the kelp population on the Norwegian coastline in the 1970s, bringing kelp to the edge of extinction in some areas. “There are two major kelp species [...] along the coast of Norway. Both species of kelp forests have been lost for different reasons since 1970, mainly due to the sea urchin grazing along the Northern coast and eutrophication along the Southern coast” (Chen et al., 2020, p.4).

Detoxing Provider

Algae and other members of the seaweed family clean their surrounding water through the absorption of nutrients and photosynthesis. The latter makes the algae more productive if more light reaches down the water column. It is therefore dependent on factors like the local turbidity, which can in turn also be strongly affected by tidal currents. This characteristic can also aid localities, where eutrophication levels are above normal, but still within manageable range for the ecosystem. These are typical symptoms for water bodies with a high density of expansive fish farms where excess feed and excrements build up the eutrophication levels over time. Kelp forests as a foundation species also serve as a habitat for a multitude of filter feeders like mussels and clams. Suspended materials and biomass in the water is constantly filtered by these benthic organisms. As a scalable effect, large quantities of these colonies can therefore have a significant impact on water quality. “Importantly, seaweed farming can provide other benefits to coastlines affected by eutrophic, hypoxic, and/or acidic conditions, creating opportunities for seaweed farming to act as “charismatic carbon” that serves multiple purposes” (Froehlich et al., 2019, p.3087). This is a proven concept that has impacted for example estuaries that are doing oyster farming, like in the USA (Bricker et al., 2020). Above all, near-shore kelp forests are thought to counter excess nutrient run-off from terrestrial agriculture close to the shoreline (Christiansen, 2008). Kelp flourishes in nutrient-rich waters if the eutrophication levels stay within tolerated levels mentioned above.

Habitat Provider

Kelp forests are the basis for habitats of many members of the local food web. They also function as stabilizers, also for re-inhabitation of local species that might have fled due to human-induced changes in the ecosystem. They are “ecologically important primary producers and ecosystem engineers and play a central role in structuring nearshore temperate habitats. They play an important role in nutrient cycling, energy capture and transfer, and provide biogenic coastal defence” (Teagle et al., 2017, p.1). Even the economic sector is beginning to understand the role of these habitats, describing them as one of the most biologically diverse and ecologically productive habitats globally (PMR, 2021).

Economic Value Source

Kelp has proven to be of high economic value globally. Wernberg et al. (2019) have valued the benefits of kelp in their chapter about the status and trends of kelp forests. In terms of net worth, from the direct benefits alone, this leads to a rough estimate of 1,000,000 USD per kilometer of shoreline that harbors kelp. The economy has led to a global increase of farmed kelp in the form of mariculture models. Kelp can grow up to a meter per day and reach heights of up to 80m (Schiel and Foster, 2015) The potential to grow a lot of biomass on a comparatively small footprint makes kelp forest cultivation versatile and efficient. Around 2,5 acres of seafloor can potentially yield an estimated 130 wet metric tons of kelp annually (Christiansen, 2008).

Global Seafood Industry Source

Kelp is considered to be very nutritious; it is considered a "rich[er] source of iodine, potassium, magnesium, calcium, and iron as well as vitamins, amino acids, omega-3 fats, and fibers than other herbal or a natural supplement like kale which is expected to increase the market for kelp" (PMR, 2021). While in the European context kelp may not have the level of recognition for its value yet, in Asia it has been used for centuries.

In some regions, kelp is already industrially farmed, processed and marketed. It is meant both for human consumption as well as for fertilization efforts and animal feed. Industrialized kelp farms are found in South East Asian waters but also on both Atlantic and Pacific coasts of the US (Arthur, 2018; NOAA, 2020). Kelp is a contributor both to the consumer food industry but also in the cosmetics industries. It is a common ingredient in the healthcare industry due to anti-inflammatory and anti-microbial effects that benefit humans (PMR, 2021). Kelp has a set place in the typical Asian cuisine, especially in Japan and China. The seaweed is available for purchase fresh, dried, as powders, flakes or extracted liquids to the consumer. It therefore takes part in many Blue Growth related and rising industries mentioned above.

Renewable Energy Source

Algae has been used as a source of bio-fuels. During its decay, kelp algae give off veritable amounts of methane, making it a viable candidate for biomass plants. It has distinct advantages over terrestrial biomass input due to its lack of lignin, which is hard to digest for the bacteria of biomass fermenters (Christiansen, 2008). Furthermore, its naturally occurring sugars can be processed to bio-ethanol. Kelp as a biomass source for renewable energy is not as conflicted as its terrestrial counterparts. It requires no irrigation with freshwater and it does not conflict with terrestrial space in the food vs. energy debate.

Coastal Erosion Inhibitor

Eroding coastal zones in a common occurring phenomenon, often connected to extreme weather events and therefore also linked to climate change. Extensive kelp forests show great buffering capabilities for these events, taking momentum and energy out of the water (Kim et al., 2016). This mechanical property of kelp can assist in minimizing the effects of strong currents and wave build-ups that erode the shoreline (Salt, 2019). While fully adult kelp has a very firm and stable connection to the sea floor, extreme currents can detach it if the seafloor does not give enough support. This will then serve as a food source for other marine species.

Ocean Acidification Inhibitor

An important biproduct of the CCS benefit of kelp is that it can relieve ocean acidification. Ocean acidification is one of the major changes and issues that are occurring in our oceans today. It is linked to the decay of coral reefs and other (mostly shelled) organisms that deteriorate in more acidic waters (CoastAdapt, 2017). The extraction of carbon from the oceans through kelp can lead to a change in pH-levels. Hirsh et al. (2020) have also discovered this context in their research, denoting that an increase of pH-levels was found in regions of kelp, thus making the surrounding waters less acidic (Hirsh et al., 2020).

Climate Change Inhibitor

Linking many of the abovementioned benefits together, kelp is thought to be a major player in the inhibition of climate change. Through its fast growth rate and CCS, it reduces greenhouse gas emissions which in turn reduce global warming. Krause-Jensen and Duarte (2016) have estimated the amount of sequestered carbon through macroalgae to be around 200 million tons of carbon dioxide per year. In her Harvard blog post about how kelp naturally combats climate change, Hurlimann (2019) concludes the “importance of protecting valuable marine ecosystems such as kelp forests” (Hurlimann, 2019).

Ecosystem Service Provider

Kelp forests deliver a large amount of direct and indirect ES. Many of these services are discussed within this thesis and also this overview of kelp characteristics. Gundersen et al. (2017) have summarized this in the following way: “[K]elp forests provide several important ecosystem services including regulating (e.g., carbon storage and cleaning of the water), primary production, creating habitats including for commercial species, providing raw material for commercial harvest, farming, and industry, and cultural (ecotourism and recreational fishing)” (ScienceDirect, 2021).