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A Critical Perspective on the Global Political Ecology of Aquaculture and Sustainability

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International Environmental Studies

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A Critical Perspective on the Global Political Ecology of Aquaculture and Sustainability

Sustainable farming of the Ocean: A perspective on Sustainability
and Aquaculture

Per Ditlef Faye

International Environmental Studies

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Declaration

I, Per Ditlef Faye, declare that this thesis is a result of my research investigations and findings. Sources of information other than my own have been acknowledged and a reference list has been appended. This work has not been previously submitted to any other university for award of any type of academic degree.

Signature.....

Date.....

Acknowledgements

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Lastly, to Nature, Earth and Ocean, you bring life, adventure and joy.

This thesis marks the final submission of the Master of Environmental studies at NORAGRIC and the Norwegian University of Life Sciences (NMBU).

Abstract

This thesis takes a critical view of the perspective and discourse of UN and FAO on sustainable fed aquaculture by analysing the “World Ocean Assessment of United Nations” and the FAO “Report on the State of the World’s Fisheries and Aquaculture”. The assessment and the report are analysed by critical content, thematic and discourse analysis, and discussed in a political ecological framework based on critical theory.

The assessment of sustainability of fed aquaculture in UN and FAO were found to be framed by the environmental indicators of “conversion rates”, “sourcing” and “substitution”, and the socio-economic indicators of “income”, “employment” and “food and nutrition”.

This research gives insight into the discourse on, and the sustainability of, fed aquaculture, and aims to contribute to the efforts for sustainable development of aquaculture as well as engaging the critical discussion on the topic.

Acronyms

BGI – Blue Growth Initiative

CCRF – Code of Conduct for Responsible Fisheries

DA – Discourse Analysis

FAO – Food and Agriculture Organization of the United Nations

FCR – Feed Conversion Rate

GAAP – Global Aquaculture Advancement Partnership

GEM – Global Environmental Management

GNP – Gross National Product

SDGs – Sustainable Development Goals

UN – United Nations

WOA – World Ocean Assessment

RQs – Research Questions

QR – Qualitative Research

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1. Introduction

Sustainability of human activities related to the ocean is the key concept behind the publications of UN “World ocean assessment” (WOA 2016) and FAO “The state of world fisheries and aquaculture” (FAO 2016).

Since the 1992 United Nations Conference on Environment and Development (UNCED) sustainability has been dominating the discourses on environmental and developmental issues. The release of these publications were one of the pinnacle points in implementing sustainable development of ocean related sectors, from tourism to food production. The rhetoric of the UN and FAO promotes sustainability and sustainability science as concept and tool for global coordination to handle socio-economic and environmental concerns. This is, argued here to be, based on managerialism, standardisation of ideas and construction of reality. (Adger et. al. 2001; Scott 1999).

The issue examined here, sustainability of fed-aquaculture, is much debated as a food producing sector in relation to economic growth, environmental impacts and socio-economically to income, employment and food security at scales from local to global. Main reason for this current attention on the ocean is the narrative of it being a frontier for economic growth and sustainable development. Looking beyond fisheries, which in global terms are generally overexploited, the aquacultural development has seen substantially growth in economic terms, as well as raising growing socio-economic and environmental concerns for the last three decades.

Working towards better understanding of environmental and socio-economic issues related to aquaculture this master thesis in International Environmental Studies aims to critically engage the discourse on aquaculture and sustainability, in particular relevance to feed for fed-aquaculture. The way in which this thesis stakes its course to achieve this

is through discovering, analysing and describing the perspective, or narrative, of UN on the state of the ocean specifically related to sustainability, aquaculture and feed. (Adger et. al. 2001 p. 681)

The research process, analysis and discussion was led by critical theory and framed within an approach of political ecology based on an understanding of the field from Adger et. al. 2001; Blaikie & Brookfield 1987; Bryant & Bailey 1997; Peet & Watts 1996; Stott & Sullivan 2000.

One main aspects of this is the linking of discourses of environmental issues to institutions engaged in implementing environment and development. In this research discourses are understood as knowledge regimes that are co-produced in complex interactions between knowledge and policy. This approach is informed by Adger et. al. (2000) and Robbins (2012).

Political ecology is in this work understood in essence as a framework for critical and dynamic questioning of a subject used by social scientists when studying politicized environmental issues. (Benjaminsen & Svarstad 2010) This thesis recognizes that environmental management is influenced by interests and subjectivity, and will so take a critical stance on this issue as well as establish certain base assumptions. (Benjaminsen & Svarstad, 2010; Forsyth, 2003; Robbins, 2012).

Point of origin for this research is that the concept of sustainability, and the ways in which it influences how society interacts with the environment, is at its core a political issue. In addition the UN is a central part to global political ecology in that this institution is included in political and economic processes that affects the ideas we have about ecological systems and how we manage our interactions with these systems.

1.1 Objectives and RQ's

The objective of this thesis is to critically describe and explore the discourse on the topic of sustainability and fed aquaculture in the framing of United Nations and FAOs narratives. It is an attempt to understand, analyse and map this topic in a political ecological framework and through the use of thematic- and discourse- analysis (DA).

The objective is framed by the following research questions:

- 1) How does the UN address sustainability and fed aquaculture?
- 2) How are the sustainability indicators of this issue perceived and presented?
- 3) How can this perspective be critiqued and improved?

Discourse analysis (DA) in the framework of political ecology can help understand how the environment is debated, why these discourses are used and what power the discourses hold over the society and politics. This will aid in our quest to understand perspectives of the ocean, what the perspectives mean and what the power behind such perspectives may intend.

1.2 Thesis structure

Chapter 1 –contains the introduction, objective, RQs and structure of the thesis.

The CANVAS – Part 1, which consists of theoretical perspective and approach, and a background for the subject of this research.

Chapter 2 - introduces political ecology as a theoretical perspective, and further discusses its relevance for the case of the state of the ocean and fed aquaculture. This part also contains epistemological (study of knowledge/explanations – what sort of information is meaningful, and who is recognized as speaking with accuracy) and ontological considerations (underlying reality – causal mechanisms and realism) (Forsyth, 2003). In addition, chapter 2 introduces some critiques of political ecology, as well as a

clarification of the base assumptions in the thesis. Finally, it will give the reasoning for the use of DA as analytical tool.

Chapter 3 - is a background description of the subject of this research and identifies the key actors of interest and the relevant subjects of discourse. This gives an narrow historical background for the topic of the thesis. An explanation of historic perspectives on the ocean and fed aquaculture, and an account of the aquaculture industry, will be presented here. Lastly, it will shortly explore the concept of sustainability in terms of ecology and economics, and as it is presented by United Nations.

Chapter 4 - Methodology, presents the first part of the qualitative methodology that was used in the thesis, and will elaborate on case study as research strategy.

Chapter 5 - Analytical framework, explains the analytical framework of grounded theory, content and thematic analysis, and on how the DA was conducted and give the reasoning behind the analytical process.

The MAP – Part 2, containing methodology, analytical framework and theoretical framework.

Chapter 6 outlines the political ecology principles and theoretical framework used in understanding the subjects of discourse, and makes a summation of the principles in relation to thesis subject.

The VOYAGE - Part 3, presents the analysis of the documents and presents the contents, themes and subjects of discourse and the narrative perspective of UN and FAO.

Chapter 7 - is the description of the analysed content.

The DESTINATION - Part 4, is in part the finishing discussion, conclusion and conclusive remarks.

Chapter 8 - discusses sustainability of fed aquaculture

Chapter 9 - addresses the markers of sustainability

Chapter 10 - shows the conclusion of the findings and conclusive remarks of the research.

THE CANVAS - Part 1

2. Theoretical perspective and approach

This chapter portrays the theoretical assumptions of the thesis, and discusses certain central points for clarity. First the discipline of “political ecology” is presented. Second the term “critical realism” is explained. Lastly, DA as a theory and method are described.

The theoretical perspective, approach and framework applied in this thesis reflects the intention of critically engaging in the UN’s presentation of global environmental and socio-economic issues connected with fed aquaculture. In doing so, it commits to critical realism as the ontological approach and discourse analysis as analytical framework.

2.1 Political Ecology

Political ecology is about “evaluating and explaining environmental change as well as explaining and determining the impact of ideas about environmental change.” (Robbins 2012, p. 100).

This thesis critically examines the selected material using the framework of “Political Ecology”. The discipline of political ecology is concerned with examining the socio-economic and political context of environmental challenges. (Forsyth 2003).

Political ecology is described by Robbins (2012) as “a kind of worldwide community of skeptical practice united by certain kinds of critical texts,” (Robbins 2012, p. 252) in which the practitioners wish to explore, discover and describe the real and the represented natures. (Robbins 2012, p. 252).

Stott & Sullivan (2000: 2), political ecology is often “concern with tracing the genealogy of narratives concerning ‘the environment’, with identifying power relationships supported by such narratives, and with asserting the consequences of hegemony over, and within, these narratives for economic and social development, and particularly for constraining possibilities for self-determination’.”(Adger et. al. 2001, p. 682).

Furthermore, it takes a critical attitude towards the supposedly “neutral” environmental sciences, and points out that the science could be reflective of particular actors and that environmental science has a defining political foundation. (Forsyth 2003).

This research acknowledges the complex interactions of power and that people and our interactions with the environment are relatively governed by these (Robbins 2012). UN as an institution consisting of the world's nations are a central connecting point of these interactions of power on a global scale. Publications made by such institutions is of interests to political ecologists as documentations on how its power may govern people and the environment.

While political ecology would generally seek to explore multiple levels of power and interactions, the focus here is on an example of global discourse by a single institutional power. This is a chosen limitation due to the difficulties of addressing a global issue that would without this limitation demand a further insight into the levels and interactions of power relations.

A core approach in the research done here, comes from a commonly made assumption in political ecology on the relationship between power, actors and discourse.

Within the framework of political ecology, it is assumed that institutions, researchers, bureaucrats and other agents involved with the creation and presentation of scientific reports on environmental issues, will in certain contexts function as political actors.

As such, they and politics will in turn influence knowledge systems and further construct environmental discourse. (Benjaminsen & Svarstad, 2010).

This is assumed to be a largely non-explicit process, where actors themselves may be unaware of their political influence.

Political ecology does not argue that the actors responsible for producing scientific reports are intentionally attempting to influence course of politics, nor using the research to legitimize their own political views. Rather, it is here assumed that the research presented in these reports are largely understood and described as apolitical and “objective” by those involved. While recognizing the scientific endeavour to accurately depict our world as justified and real, it is also imperative to critically view the science in light of its context in relation to power, actors and discourse.

Several publications of political ecology research support the claim that institutions and reports of environmental science, that insufficiently address social and political factors, reduce their potential research credibility and effect. This may in turn sustain environmental problems. (Forsyth 2003).

As the UN is a central institution of political, economic and environmental power and knowledge, it is imperative to see their publications in light of its context. Further insight into political ecology, environmental problems and management are given by these texts: Blaikie, Brookfield 1987; Bryant, Bailey 1997; Peet, Watts 1996; Scott, 1998; Scott, Sullivan 2000; Robbins, 2012. A critical perspective on normative and mainstream descriptions of environmental issues are presupposed in this research based on previous political ecology research.

To continue on this course, it is necessary to take a brief look at critical realism, which is the ontological approach in this thesis.

2.2 Critical Realism

In accord with Forsyth's (2003) approach to political ecology, this thesis will be grounded in an ontological view that can be referred to as "critical realism". Critical realism can here be described as an attempt to understand the "...real' structures of society and the world, while acknowledging that any model or understanding of such structures will reflect only partial experience of them, and social and political framing within the research process." (Forsyth, 2003, p. 15).

As critical realism takes the course between constructivism and realism, this approach allows for the acknowledgement of both the independent reality of nature, and the constructs of social reality that shape the perceptions of nature.

Through this approach, the perspectives of a selected actor on a chosen subject, e.g. the UN's reports on the environmental and socio-economic consequences of fed aquaculture, could be studied by adopting a critical attitude to how explanations for environmental issues and ecological in reality are made, and address their social and political framing. (Forsyth 2003).

Fundamental constructivism would hold that the validity of any claim about the nature of reality has no more weight than the next one. Opposite stand the realists, who do not sufficiently address issues of power, actors and discourse in researching environmental issues, and so often stands in danger of neglecting the political aspects of environmental science. (Robbins 2012, p. 97).

In the context of this thesis, the United Nations is seen as an institution of power and an actor influential in environmental management, and the World Ocean Assessment is understood as a report of valid empiricism and science that has been shaped by social

constructs. This means that the UN is considered a political actor and WOA (2016) and FAO (2016) as a part of the discourse on global environmental management, and that the difference of “nature of reality” and our “knowledge of reality” is recognized. (Fairclough 2010).

2.3 Discourse Analysis

The field of political ecology has at its philosophical core a supposition that power creates truth. This is in accordance with Foucault ideas of knowledge, power and discourse. The analytical tool of discourse analysis has therefore been often used within political ecology. (Robbins 2012, p. 70).

In order to influence and direct policymakers, it is necessary for the institutions and researchers operating within the field of environmental sciences to create a normative representation of reality. In this representation there needs to be sets of concepts and descriptions of reality that are agreed upon. As discourse is a language used to create a representation of reality, the different agents that represent environmental science hold responsibility in creating and participating in environmental discourse.

With this in mind, it is here argued that discourse is a functional part of ideas and action, as it supports these through knowledge dissemination, standardized ideas and ways of constructing reality through text. (Bryman 2012; Scott 1999).

In broad terms discourse is a shared meaning of phenomenon, whether large or small, shared by a few or many, and occurring on any scale from local to global. The production, reproduction and transformation of the discourse is done through written and oral statements from the participation of actors adhering to the discourse. (Adger et. al. 2001).

The study is not oriented towards a phenomenon in itself, but rather on claims concerning the phenomenon, and those making the claims as well as the process of making the claims.

The concern here is on an environmental subject and discourse analysis is used to characterize prevailing and received wisdoms, as did Leach and Mearns (1996), and to critically address the discourse of development, as done by Ferguson (1990) or Peet and Watts (1996). (Found in: Adger et al. 2001).

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In “Advancing a Political Ecology of Global Environmental Discourses” by Adger, Benjaminsen, Brown and Svarstad (2001), a global environmental management (GEM) discourse is presented as an attempt to construct a set of normative and standardized ideas and a way of constructing reality. They argue that this is observed in “policy domains and in the role of the state in modernization and development”, and states that this is illegible in addressing local environmental problems. (Adger et al. 2001, p. 682)

The standard idea in GEM is that there are global environmental problems that can only be fixed by global efforts of coordinated action, which are often interventionist, technocentric and oriented towards neo-liberal market solutions (Adger et al. 2001). From this perspective, the UN, WOA and FAO constitute an crucial source of global environmental discourse and they attempt to reflect ecological realities of the human utilization of the environment. The DA in this thesis place both the WOA of UN and the FAO report in the context of GEM and further links these discourse narratives to critical sources of counter narratives.

3. Background

3.1 Global Perspectives and discourse on the state of the ocean

Aquaculture is now a global production sector that with its small to medium-scale systems are supplying food and income to millions of people in marginalized socio-economic conditions. In addition to this large-scale industrial aquaculture are supplying near the same amount of fish as wild fisheries to be traded in international trade of fish products. Fed aquaculture has particularly seen an immense increase in output the last few decades.

At the same time the global fish stocks and fisheries are generally deemed overexploited and threatened by illegal fishing and international fishing fleets, pollution and environmental changes. The state of the world's marine fish stocks has not improved overall, despite notable progress in some areas. Based on FAO's analysis of assessed commercial fish stocks, the share of fish stocks within biologically sustainable levels decreased from 90 percent in 1974 to 68.6 percent in 2013 (FAO 2016). The supply from these sources are above or near unsustainable levels. These trends are likely to continue unless drastic measures are taken and this requires critical engagement from the level of local groups to global institutions, e.g. UN. Despite efforts since the 1980s to reduce overfishing and increase production, both fishing and aquaculture industries now have

major issues relating to environmental concerns. The relation between fishing and aquaculture is in this instance related to the use of wild fish stock catch to produce feed for fed aquaculture.

This sets the foundation for the critical questioning of fed aquaculture as a potentially sustainable industry. While there are many sources of statistical data on the state of the ocean and fed aquaculture production, the United Nations reports, WOA (2016) and FAO (2016), are among the most influential documents in policy making and management of oceanic resources for member nations.

3.2 United Nations and the Food and agricultural organization

The United Nations (UN) is an international, treaty-based organization. It was founded in 1945 and is currently made up of 193 member states. Article 1 of the Charter of the United Nations states that one of its purposes is: “To achieve international co-operation in solving international problems of an economic, social, cultural, or humanitarian character...”(Found at: www.un.org).

The Food and Agriculture Organization (FAO) is a specialized agency of the UN. FAO’s describe their mandate as to “...support its members in their efforts to ensure that people have regular access to enough high-quality food to lead active, healthy lives”. (Found at www.fao.org).

3.3 Sustainability and Fed Aquaculture

Aquaculture is a major source of food and income for the world's population, and fed aquaculture is as one of the fastest growing food producing industries of importance to global institutions of influence, power and resources. (FAO 2016).

Aquaculture has been defined as:

“the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators. Farming also implies individual or corporate ownership of the stock being cultivated... ..aquatic organisms which are harvested by an individual or corporate body which has owned them throughout their rearing period contribute to aquaculture, while aquatic organisms which are exploitable by the public as a common property resources, with or without licence, are the harvest of fisheries. (FAO 1992).” (Cataudella, Massa & Crosetti 2005 p. 110).

The contemporary view of fed aquaculture raises the question of the potential for sustainable production of protein rich healthy food. In addition to this comes the questioning of pollution, genetics, disease and habitat destruction, to name a select few. (Cataudella, Massa & Crosetti 2005). This thesis focuses on the former, sustainability, with particular regard to sustainability and fed-aquaculture.

Global fisheries are under pressure to provide healthy nutritional food to the world's population. Recently, the global output of aquaculture production is close to equal with wild fisheries in producing food for human consumption. (WOA 2016; FAO 2016).

One major part of this is fed aquaculture production of species that demand high-protein value feed, in which one major component is fishmeal and fish oil made of fish from wild fisheries. The sustainability of this food production system is questionable based on the feed conversion rates, the sourcing of the protein, and the effect of substitution of the protein from wild fishery sources compared to alternative sources. (Jackson et al. 2012, Tacon et al. 2011).

The sustainability issue of feed is largely based on the use of catch from wild fisheries, whether it is sustainably managed or not. To address sustainable feed production, selected

markers are used as indicators of environmental and socio-economic aspects. The environmental markers to discuss were found to be, namely, sourcing, conversion rate and substitution. The socio-economic indicators are income, employment and food and nutrition.

Cataudella, S., Massa, F. & Crosetti, D. (eds.) (2005) have categorized issues related to capture fisheries and aquaculture. Two of those categorizes are the main issues here selected, namely the use of fishery products to supply the fish-feed farming industry and the feasibility of capture fisheries and aquaculture within a sustainable system. (WOA 2016; Cataudella, Massa & Crosetti (eds.) 2005).

4. Methodology

The research questions in this thesis are qualitative in nature, and the thesis thus relies on qualitative research (QR) methodology. This means the thesis will have a descriptive approach rather than focus on measurements and statistical inference. To find the best answers to the research questions, the thesis will mainly make use of a discourse analysis, with basis on a limited analysis of content and themes. (Berg & Lund 2012).

In this chapter, the methodological choices that have been made will be explained. It will describe the way towards the intended goal of this thesis, and as such the choices relates to the issue under study and its circumstances. To correctly address the research questions the following choices and limitations were made. Here is a brief account of qualitative research, the following research strategy of case study, the methods of content and thematic analysis, and a depiction of grounded theory before committing to discourse analysis as final method of data-collection and analysis. (Berg & Lund 2012; Bryman 2012).

Qualitative research is oriented around understanding the social world by examining those that participate in it and their interpretations of that world. (Berg & Lund 2012; Bryman 2012).

QR is central for this thesis, as it looks to investigate the meanings, concepts, definitions, characteristics and descriptions of an environmental issue portrayed by an actor, institutions of power (UN and FAO), that participates, influences and interprets the world's oceans and the way our societies are linked to them.

While centred in the social sciences and in line with political ecology, this study is interdisciplinary in that it is informed by and applies a few selected methods, concepts, ideas and information from various science disciplines: sociology, political science, environmental science, ecology, economics and sustainability science. It is however consistently oriented by social science, even if it discusses natural science aspects of the selected issues.

For the study to achieve this, it builds on an extensive literature review and research, and the findings are set in the context of political ecology and critical theory.

To strengthen the discussion and argumentation in this research, the use of secondary data were supplemented with sources from peer-reviewed articles, government documents and reports, as well as other publications such as books and news articles. This literature covers the interdisciplinary fields of study mentioned earlier.

In the process of gathering and researching the necessary literature, resources and data, databases and search engines such as Google Scholar, Springer, Bibsys and Sciencedirect were found to be helpful. Furthermore, the libraries at NMBU and UiO aided in accessing literature

4.1 Research Strategy: Case study

A ‘case study’ is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin 2003, p. 13). The issue is not explored through one lens, but rather a variety of lenses which allows for multiple facets of the phenomenon to be revealed and understood. (Baxter & Jack 2008). Two key approaches to guide the case study methodology are presented by Robert Stake (1995) and by Robert Yin (2003). This study is mainly informed by the second. The above definition allows for more than a single case in a study and case studies can contain both qualitative and quantitative elements. (Yin 2003, 14).

4.2 Type of case study

Yin (2003) shows three types of cases: Explanatory, exploratory and descriptive. In this research the question is “the how” and “why” of things, exploratory and descriptive cases, which are cases that “used to describe an intervention or phenomenon and the real-life context in which it occurred” (Baxter & Jack 2008, p. 548).

The approach here is that of a multiple case study, a study with two or more cases. When addressing this Yin (2003) states:

“A multiple case study enables the researcher to explore differences within and between cases. The goal is to replicate finding across cases. Because comparisons will be drawn, it is imperative that the cases are chosen carefully so that the researcher can predict similar results across cases, or predict contrasting results based on a theory”. (Baxter and Jack 2008, p. 548).

It was found that the case study is to be preferred when examining contemporary events while any relevant behaviour could not be manipulated. (Yin 2003).

4.3 Critique of case study

Strategic sampling is a strategic selection of a case, to increase the study's chance of producing results that can be generalized. The main advantage of this approach to case selection is that generated data is considered robust and reliable, although Flyvbjerg (2006: 226) argues that "formal generalization, whether on the basis of large scale samples or single cases, is considerably overrated as the main source of scientific progress". However, such a study might also be extremely time-consuming to conduct. To balance the scales, only two cases have been selected, and a wider generalization is not attempted.

4.4 Binding the case

This is an information oriented approach where the cases are not chosen randomly or on the basis of generality, but rather seen as critical cases. Flyvbjerg (2006: 229) defines a critical case as having strategic importance in relation to the problem of research. An issue facing attempts to understanding and document the cases is if the problem and questioning are too broad. To address this Yin (2003) have suggested placing boundaries on a case to narrow it down. Baxter and Jack (2008) shows that to bind a case, one can set limit on time and place, type of activity, by definition and context. Informed by these suggestions the following limitations have been put on all the cases selected here, in accordance with the research questions.

Firstly, the case should have a clear relevance to issue selected and clearly address the issue. Secondly, the case should be available and oriented towards the public domain and policy. Thirdly, the cases are of global perspective from international institutions and in the English language. Fourthly, they should be commonly recognised, referred to and used as sources of information.

4.5 Description of cases

1. WOA (2016). The First Global Integrated Marine Assessment, World Ocean Assessment 1. United Nations.

Webpage: <http://www.un.org/>

Document webpage:

http://www.un.org/Depts/los/global_reporting/WOA_RPROC/WOACompilation.pdf

Statement of document: *“The first World Ocean Assessment provides an important scientific basis for the consideration of ocean issues by Governments, intergovernmental processes, and all policy-makers and others involved in ocean affairs. The Assessment reinforces the science-policy interface and establishes the basis for future assessments. Together with future assessments and related initiatives, it will help in the implementation of the recently adopted 2030 Agenda for Sustainable Development, particularly its ocean related goals.”* (WOA 2016 p. foreword)

2. FAO (2016). The State of World Fisheries and Aquaculture 2016.

Contributing to food security and nutrition for all. Rome.

- Webpage: <http://www.fao.org/>
- Document webpage: <http://www.fao.org/3/a-i5555e.pdf>

Statement of the document:

“The State of World Fisheries and Aquaculture 2016 was prepared by staff of the FAO Fisheries and Aquaculture Department. General direction was provided by the Department’s Information Management and Communications Committee in close consultation with senior management and under the overall supervision of L. Ababouch, Director, Fisheries and Aquaculture Policy and Resources Division.” (FAO 2016 p.vi).
“...the 2016 edition of The State of World Fisheries and Aquaculture... Several recent major international developments will further strengthen its key function as a provider of

informed, balanced and comprehensive analysis of global fisheries and aquaculture data and related issues.” (FAO 2016 p. ii).

5. Analytical framework

5.1 Grounded theory

In the process of this research the theoretical framework was revisited and re-executed as data was collected and while discovering discourse. The need to generate new theory, or new ways of understanding the data and discourse, is common in qualitative research and is based on grounded theory. This guided the research in collecting data, information on the discourse, and revising the data and finding new ways of understanding it through discovery of alternative information on the same subjects of discourse. The information relating to this was then organised under the dimensions of A) perspective and B) critical, which are the basis of discussion in this research. (Ezzy, 2002; Strauss & Corbin, 1998; Bryman, 2012)

Grounded theory is often used for QR, and in this thesis it was used to create the themes, to generate the subjects of discourse and so inform the discussion. It did this in short by; continuously collect data, analyse it, create themes and generate subjects, then back to collecting data now better informed. While this began relatively free of theory in the beginning, it was quickly informed by relevant research, which is a common process in grounded theory. (Bulmer, 1979: found in Bryman, 2012)

While thematic analysis employ similar techniques for analyzing data as the more sophisticated model of grounded theory, “the term ‘grounded theory’ should be used only to refer to studies in which data collection and data analysis are conducted concurrently alongside theoretical sampling and other techniques distinctive of grounded theory. (Strauss and Corbin 1998).

According to Robert K. Yin “theory development prior to the collection of any case study data is an essential step in doing case studies (Yin 2003: 83). By this logic, theoretical sampling was mostly conducted before data collection and analysis. As such, this study does not clearly fit the model of grounded theory.

For the sake of clarity this process was in short: data gathering was conducted to find relevant information in the WOA document related to sustainability and fed-aquaculture. which was then used to inform the search for critical sources. Combined this constitutes the data used for the analysis, discussion and conclusion.

This study applies a limited content and thematic analysis of the UN and FAO documents in order to decipher the themes, biases, meanings and patterns in the material through systematic examination and interpretation (Berg & Lund, 2012).

5.2 Content and Thematic analysis

The general criticism against qualitative research is that it is too broad or too opinionated by the subjectivity of the researcher. This study seeks to go in-depth by placing strict thematic limits on the study. It is also sought to clearly show the researchers bias as much as possible by making conscious strategic and methodological choices before collecting and analyzing data. (Berg & Lund, 2012) In the following section this process will begin by arguing for the use of combination of content-, thematic- and discourse- analysis as analytical approach.

The quality of qualitative data analysis depends on following well-thought-out procedures. To ensure a minimum of such procedure the analytic framework of an initial content analysis was chosen, this will inform a more comprehensive thematic analysis.

This study applied a limited content analysis of the UN and FAO documents in order to decipher the themes, biases, meanings and patterns in the material through systematic examination and interpretation. (Berg & Lund, 2012).

The content analysis led on to the thematic analysis which identified themes within the data collected. It is inductive, since the categories into which themes that was sorted were not decided prior to coding the data, but instead “induced” from the data. The specific nature of the categories and themes to be explored are in this way not predetermined (Ezzy, 2002)..

A problem of theory development occurred here due to the process in case studies of developing theory before data collection, which goes against the process of grounded theory. In the case of this research it was attempted to combine both thematic and discourse analysis of which the former implies theory development initially, while the latter is oriented towards grounded theory. The chosen approach for this research was a initial data collection before theory development, then building on this data theory was developed while continuously collecting and analysing data.

5.2.1 Coding for analysis

In short coding in this research was a process of breaking apart the data into lines, paragraphs or sections, disassembling, and then rearranging, through coding, the data into a new understanding that both explores similarities and differences across cases. Ezzy (2002: 93).

A systematic analysis was conducted according to Corbin and Strauss’ three levels of coding. (Ezzy 2002: 86-94). At the first level of coding – the open coding – sentences were highlighted if deemed relevant to the research question. This initiated the construction of categories and their properties. (Glaser 1978, p. 56).

Second level of coding – the axial coding – involved more extensive analysis, modification and structuring of the codes and categories from the open coding. In essence this coding process searched for related structures and patterns in the themes. (Ezzy 2002, p. 91).

Third level of coding – selective coding – identified the core category and subject that the analysis evolves around. This occurred when the main themes had been identified and involved a verification, and slight revision, of the initial categories through checking the coded data, the document and related references. (Ezzy 2002, p. 92).

Such a schematic helped to structure and compress the data, and ensured an overview of the information. Guided by the themes found in the content analysis and the two first levels of coding, the data were categorized into a set of different themes (appendix 3) that was formulated into core categories.

The completed categories are: 1) WOA 2016, 2) FAO report 2016, 3) Sustainability and natural resources, 4) Aquaculture and aquafeed, 5) The environmental markers of sustainable aquaculture (Sourcing, conversion rate and substitution), 6) The socio-economic markers of sustainable aquaculture (Food and nutrition, Income and employment).

These categories were viewed along the dimensions of A) perspective and B) critique. The perspective of dimension A) represents the narrative of UN and FAO, while dimension B) is the opposing counter narratives, critique. In total, these four core categories and two dimensions were used as the basis for analysis. TA was then used as a primary analysis for the DA, in which the theory, data and results informed each other to constitute the analysis (voyage), discussion (voyage and destination) and the conclusion (destination).

5.3 Discourse Analysis as Framework

In this research discourses has been defined as knowledge regimes and recognises the complex development and interactions between science, knowledge and policy. The chosen documents represent versions of the knowledge regimes, discourses, that dominates the subject of research. The documents are seen as a part of a corpus of expressions in which there is homogeneity in message and in ways of expression. This means that there are shared knowledge and perception of the subject, or phenomenon in question. As Adger et. al. (2001) states, “the homogeneity in message constitutes the characteristics of a discourse as a truth system”. (Adger et. al., 2001 p. 685) Within the selected documents this research addresses how perceptions and concerns for the sustainability of aquaculture is expressed and how its development is perceived.

5.4 Range of Data

The choice of UN reports was limited to the most recent available in late 2016 in an attempt to collect the most contemporary up-to-date information. The WOA report is of special interest, as it is the first of its kind and has been in production since 2002, while holding the most updated global statistics. (WOA, 2016) The FAO report of 2016 is also of special relevance to this subject, and the two are linked (FAO, 2016).

For the sake of validity, it is crucial for the sources of the research to be firmly trusted. The literature, the assessment and the report used in this research are all peer-reviewed. In most cases, the texts studied here can also be said to reach and influence the public, policy-makers and the scientific community.

The UN scientific reports and assessments are among the most trusted sources of environmental information, and many researchers of environmental studies use these

sources as their source of data. The documents are held to high scientific standards and is considered by the UN to be standard documents, aiding in beneficial decisions for social, economic and ecological policy. (WOA, 2016)

5.5 The Process

Following grounded theory, the data collection and analysis were interwoven with the theoretical framework throughout the process. Beginning with interest in the state of the ocean and the role of fed aquaculture in environmental and social issues, it was in this research quickly realized that certain limitations and a specific angle of approach to this was needed. Initial research discovered the recently published WOA document of the UN, and its associated publication of FAO, and these provided a limited sample and specific angle for the research. Following the methodology and analytical framework of this research a sample of the process of analysis is described below. This process was then repeated until the data was completed, meaning the researcher found no more related data in the documents and thought the analysis finished.

5.5.1 Description of process for content and thematic analysis

With a PDF version of the WOA document, the keywords (Appendix 2), for example “feed”, was entered into the standard search function in the Microsoft Edge software. The result were too high to be of relevance, as the search result included connected words such as 'aqua-feed' and so they were listed together with any non-relevant use of the word 'feed'. To sort this out there was entered a space before and after the search word, in this manner; ' feed '. This limited the results to single words only and so made the search more relevant and specific. The connected words and irrelevant uses of the search word were still counted, checked and controlled to know if they belonged in the datasets. As the search findings were read and analysed, further adjustments were made to method of noting.

If a search finding was found not to be relevant it was skipped – not noted – and the next search finding was sought. Those of relevance were noted and marked important, both within the coding table and as references found in document. The process of noting and marked can be seen in Appendix 1. and it began by copy and paste of search word content and added to coding table. In the coding table it was numbered and marked for importance, before selected notes were made to clear up and show the specific relevance to the research.

5.5.2 Description of process for discourse analysis

After establishing a content and thematic data set, the research then, following Grounded theory, started the process of discourse analysis with theoretical sampling. The data came out by performing and returning to the collecting, coding and analysing of the material. The research and theory was informed by the discovered data and analysis, which then was adjusted to fit the newly enhanced theory.

It is here seen that the categories, concept, and theory came from the interaction of the research between the data and field of study. (Bryman, 2012). The coding of the data were entered into a protocol using open coding. Protocol aids in creating an overview of what is to be researched and what information holds value. The data were set into concepts and these concepts were placed together in relevance to create categories.

5.6 Reliability and Validity

This section evaluates the qualitative research and addresses the limitations of the study.

Making an evaluation of the reliability and validity of qualitative research constitutes a vital part of ensuring that the research is based on accepted science and in-depth study. (Bryman, 2012).

The reliability is increased in this research due to the accepted, trusted and well-known versions of the analytical framework, the theoretical framework and the methods described and applied here. DA is a commonly recognized and applied framework, and political ecology has a long history and a large community of researchers that can attest to the theory. Reliability also depends on justifying and explaining the research decisions and its structure, which would allow for a limited testing of the thesis. A distinction is made between internal reliability (the level of replicability in the findings) and external reliability (the level of application of the methods to secure similarities in observations). (Bryman 2012).

In its reach for validity, this thesis includes a short account of the social dimensions which places the analytical results in context, and in so doing, gives peers knowledge to review it. The use of the UN assessment and the FAO report adds additional validity since they are recognized as valid sources, refers to real, empirically observed conditions, and are based on peer reviewed scientific reports and articles.

In accordance with qualitative research questioning of reliability and validity, it is the quality and not the quantity of this research that counts. The quality is reflected in the in-depth study of the selected sample, as well as the investigation of the discourses with discussion on the content, perspective, ideas and meaning within the environmental and socio-economic aspects. An “auditing” approach is here applied, in that it attempts to be as open and honest in the description of the research process as possible.

Due to the large spatial, global and temporal frame of the issue, the research of this thesis is focused on the selected contemporary report and assessment. The research began in late 2016, so the publications of that year were the most recent and updated sources.

On a final note, while trust and neutrality is important, it is also essential that the text reflects an actual attempt at describing reality, which is as a subject for critical content, thematic and discourse analysis intends to within the framework of the research.

5.7 Ethical Considerations

For the ethical considerations, the guidelines of Berg and Lund (2012), have been adopted in this case. Since the UN, the FAO and the material is in the public domain, the use of these guidelines are considered ethically sound, as there is no need to safeguard voluntary participation, informed consent or confidentiality and anonymity. With a political ecology framework, the role of the researcher and the subject have been assessed in relation to each other by establishing assumptions and approaches (chapter 6). While the data sources are of public domain, the gathered data were only accessible to the researcher.

5.8 Limitations

The research was limited by the time frame of the study period and by the necessary limitations set by the research itself due to the potentially large samples and connected material. This has resulted in not all data and analysis that could be relevant being taken into account, rather limiting the focus to particular data. Lastly, it is not intended that the findings in this research present any claim outside the sample, and it does not see its findings as representative besides selected documents.

THE MAP - Part 2

The canvas constructed earlier allows this research to draw a map on which to navigate. Drawing a map requires a framework like longitude and latitude. This map, however, is drawn in order to discover the perspective, approach and markers of fed-aquaculture sustainability, both ecological and socio-economical. Following is a presentation of the map, which is framed by political ecology principles.

6. Theoretical framework

This section is an attempt at creating a result of literature review that has been interpreted and supplied with analysis of the data and discussion. Here, the political ecology principles initially functioned as a critical perspective to understand the data. This understanding then led to revision and improvement of the principles. Finally, the set principles and the discovered data was informed and revised by each other to the extent shown in chapter 10.

This chapter forms part of the background, justification and discussion of this research based on political ecology principles. The political ecology perspective asserts that modernist development can lead to unsustainable practises, and that hegemonic institutions (e.g. UN) have the influence and power to alter practices. In this view the way in which subjects such as fed aquaculture and sustainability are understood, described, presented and practical tools implemented, would have major significance for the health of the oceans and the global communities.

6.1 Political ecology

In this thesis, the principles of political ecology have been used as a framework to evaluate the socio-economic aspects of our use of the ocean, and in particular, fed aquaculture.

The framework constructed here establishes a common point of origin for analysis and discussion, and is built on the principles¹ of political ecology presented by Robbins (2012) in *Political Ecology: A Critical Introduction*. These principles inform the understanding and application of political ecology in this paper.

As a common point of origin, these principles do not constitute the analytical framework by itself. Rather, it is the framework in which the rest of the research is placed in context and forms the background foundation for the analysis and discussion.

These principles are directed by the “effort” of political ecology to:

“critically explain what is wrong with dominant accounts of environmental change.... a “hatchet” to take apart flawed, dangerous, and politically problematic accounts” and “...exploring alternatives, adaptations, and creative human action in the face of mismanagement and exploitation.... a “seed” to grow into new socio-ecologies”.

(Robbins 2012, p. 20).

6.2 Framework of political ecology

The first set of principles makes up the guidelines for the mission of the research, while the second set supports the justification of this research , and the third set of principles refers to previous theoretical and empirical science on which this research stands. The fourth set of principles gives the theoretical and methodical reasoning for treating WOA

¹ Principle: proposition that serves as the foundation for a chain of reasoning.

and FAO report as part of the UN's construction and co-production of aquaculture sustainability. In combination, these principles also function as a foundation for discussion of the environmental and socio-economic issues. These principles are here examined in greater detail and how they can be applied to the texts in this study are accounted for.

6.3 Principles

6.3.1 First set of principles

The first set of principles is built on the “fundamental and linked assumptions” and the “modes of explanation” of political ecology by Robbins (2012):

1. “accept the idea that costs and benefits associated with environmental change are for the most part distributed among actors unequally ... [which inevitably] reinforces or reduces existing social and economic inequalities ... [which holds] political implications in terms of the altered power of actors in relation to other actors” (Bryant & Bailey, 1997. P: 27).
2. Political ecology researches power and decision making at various scales. (Robbins, 2012).
3. Political ecology is not a theory or a method, rather a “community of practice united around a certain kind of text” (Robbins, 2012, p. 20).
4. Political ecology addresses “...the condition and change of social and or environmental systems, with explicit consideration of relations of power.” (Robbins, 2012, p. 20).
5. “...explores these social and environmental changes with an understanding that there are better, less coercive, less exploitative, and more sustainable ways of doing things.” (Robbins, 2012, p. 20).

6. "... stresses not only that ecological systems are political, but also that our very ideas about them are further delimited and directed through political and economic process.".(Robbins, 2012, p. 20)

From this, it is in this research assumed that the United Nations is an actor of power at various scales, and as such, influences environmental change as well as social and economic inequalities. It is critical to explore this influence to gain insight into more sustainable ways of doing things, highlight potential weaknesses and strengths, and seek alternative ways. The UN is acting on this power through the WOA document, and the FAO by the report, and as such, can be considered to exert influence on environmental, social and economic issues. This research interests lies in the related issues of sustainable fed aquaculture.

The investigation, research, analysis and discussion of UN aquaculture sustainability done here, is in line with the texts and practices of the political ecology community, in that it addresses the politicization of the environment by the UN.

6.3.2 Second set of principles

The second set of principles is built on the "five dominant narratives in political ecology". (Robbins, 2012, p. 21)

1. The degradation and marginalization thesis: Unsustainable modernist development.
2. The conservation and control thesis: Disable local socio-political organization.
3. The environmental conflict and exclusion thesis: "Socialized" and "ecologized" scarcity.
4. The environmental subjects and identity thesis: New environment systems, new people.
5. Political objects and actors thesis: Hegemonic institutions influence, creates resistance.

These narratives tell of previous research and empirical evidence that justifies critical research into the United Nations' assessment of aquaculture by asserting that the mainstream story is not the complete picture.

The second set, background and narratives of political ecology, gave the investigation its critical perspective. The incentive of critical research into UN aquaculture sustainability relates to the environmental condition and change of the ocean, natural marine resources and aquaculture production, to its ecologies and to aquaculture's larger political and economic context.

From the initial research it was deduced that the political ecology assumptions and principles here presented would best be applied to the concept of sustainable fed-aquaculture through defined markers of United Nations presentation of sustainability.

6.3.3 Third set of principles

The third set of principles is in short a limited toolbox based on selected "critical tools" of political ecology. For one the common property theory claims this: "Understand that fisheries, ..., environmental systems, [that were] traditionally managed as collective or common property"(Robins, 2012)(brackets added.) could experience reduced sustainability due to changes in environmental management.

Marxist political economy: "environmental degradation is inevitable in capitalism" (ibid.), and so any extractive activity for capital gain would potentially cause degradation. While "standing on the shoulders of giants", it is easier to have perspective which is what these "critical tools" bring. Two tools underline the discussion as background perspective in this research, namely, common property theory and Marxist political economy.

6.3.4 Fourth set of principles

The fourth set of principles is built on the “constructivism and co-production” in methodological issues of political ecology analysis:

“Concerns the conditions in which ideas about the environment are formed, about the discursive resources that make certain assumptions about the environment more possible or likely, and about the way political power, social habits, and cultural norms may set human beliefs about the way the world both is, and ought to be.” (Robbins, 2012 p. 97).

“...certain forms of knowledge, however egregiously problematic, thrive owing to their congruence with the political and institutional forms of organization and practice in which they were established and used.” (Robbins, 2012 p. 98).

“...an evidently natural object, idea, or process is, at bottom, an expression of the human imagination, suffused with political and cultural influences, is one that is fundamental to much explanation in political ecology.” (Robbins, 2012 p. 123).

“Political ecologists suggest, therefore, that because this stuff (processes, concepts, ideas, or entities) is not inevitable and has history, it can be unmasked for what it is, reinvented, and changed for a better and more sustainable future.” (Robbins, 2012 p. 124).

“landscape is produced from the very ideas through which it is apprehended, even while those ideas are rooted in the material activities and changes of the landscape.” (Robbins, 2012 p. 141).

The concept and understanding of environmental and socio-economic sustainability are co-produced in this view. The idea of sustainability is rooted in the material activities and

changes of the environment, but the environment is also produced from the very ideas through which it is apprehended. Here, critical realism is taken as the perspective on this issue.

THE VOYAGE - Part 3

In this part research question number one is addressed: 1) How does the UN address sustainability and fed aquaculture?

7. Analysis

In this chapter, the main characteristics, content, perspective and meaning of the discourse are presented and discussed. It is a prominent feature of the discourse and narrative found in the documents that the authors see the state of the ocean and fed aquaculture as being of great importance and consequence to economics and food security, and as such, a political and socio-economic issue.

The main part here is shows that these subjects of discourse were identified by using extracts from the documents representing the discourse. This is a qualitative issue, and the subjects were moulded by the presentation, content and arguments in the text, and structured by common and substantial material and references.

This was done so as to not expand into a new topic for every separate presentation of similar ones. While each subject has similar content, the presentation may vary and be in disaccord with each other. This is represented in the discussion. To clarify, there are several subjects of discourse, and each of these subjects may be critically approached and vary in its presentation, which then points to variation in perspective. In short, there are debates on the subjects of discourse with varying argumentation. These subjects are the themes discovered earlier in the thematic analysis.

Parts of the analysed documents that are referred to are representative of the coded data. To address the selected themes in concentrated format certain contents of the text are shown as representative for the documents at large. For the sake of clarity on certain subjects, the added quotes and footnotes give further insight and some further readings for special interest.

7.1 WOA (2016). The First Global Integrated Marine Assessment, World Ocean Assessment 1. United Nations.

The latest UN discourse on sustainability revolved around the “2030 Agenda for Sustainable Development” (ASG), a continuation of the “Sustainable Development Goals” (SDGs) agenda formed by the UN. To achieve a comprehensive understanding of what is needed to reach towards UN's SDG number 14, “Conserve and sustainably use oceans, seas and marine resources for sustainable development”, the “The First Global Integrated Marine Assessment” was published in 2016. (WOA, 2016).

This report also aims at following the course set by the 2002 Johannesburg World Summit on Sustainable Development, namely by establishing a “Regular Process for the Global Reporting and Assessment of the Marine Environment, including Socio-economic Aspects”. (WSSD, 2002) The UN General Assembly has endorsed the outline, terms of reference and working methods of the WOA document.

UN proposed intentions of such an assessment are to help in creating an integrated view of environmental, economic and social aspects of our activities related to the world's oceans. The information provided by the assessment is intended to further management practices through facilitating informed decision-making. The basis of the created information could be understood as an attempt to construct and identify a baseline

overview of the ‘nature of reality’ and interpret the overview into a perspective, ‘knowledge of reality’. This overview and perspective of the environment is then later extended to encompass trends of socio-economic and ecological aspects of the marine environment. The assessment is considered to be a necessary, integral part of adaptive management to enable appropriate responses by nations and competent regional and international organizations.

The defining character of the assessment of relevance here, is stated as such:

- “(a) Demonstrate the importance of oceans to human life and as a component of the planet.*
- (b) Integrate, analyze and assess environmental, social and economic aspects of all oceans’ components and interactions among all sectors of human activity affecting them; it could thus support sustainable, ecosystem-based management throughout the oceans;*
- (...)*
- (d) Promote international collaboration to build capacity;*
- (...)*
- (f) Support better policy and management at the appropriate scale by providing sound and integrated scientific analyses for decision-making by the relevant authorities;*
- (g) Build on existing assessment frameworks, processes and institutions and thus provide a base for cooperation among governments and at the level of international institutions.”*
- (WOA, 2016 ch. 2, p. 4-5).

Furthermore, a clear statement in WOA proposes that the “principles for sustainable governance of oceans are straightforward” (Costanza et al., 1998; Crowder et al., 2008). Stemming from the ‘Lisbon’ Principles for Sustainable Development of Oceans, the principles are as follows:

“1) Responsibility: ability to respond to social and ecological goals. 2) Scale-matching: ensuring flow of ecological and social information allows for timely and appropriate action across scales.

3) Precaution: in the face of uncertainty about potentially irreversible ecological impacts, decisions about natural capital err on the side of precaution. The burden of proof shifts to those whose activities potentially damage natural capital.

4) Adaptive management: decision-makers collect and integrate socio-cultural-economic-ecological information, adapting their decisions accordingly.

5) Full-cost accounting: where appropriate, external costs allow markets to reflect full costs.

6) Participation: foster stakeholder awareness and collaboration.”

(WOA 2016, part.3, 3, p.3).

Several developing countries are assessed to have far from adequate regulatory frameworks and institutional capacity for sustainable governance of the fishery sector. (FAO 2016; WOA 2016).

In addition it is noted that WOA is spatially a global assessment and temporally produced from 2013 to 2014, with initial consideration of issues from 2010 to 2012.

The ‘end’ to justify the ‘means’ of constructing a universalistic type of knowledge, understanding and framework to encompass all “benefits of the ocean to us humans, and the overall impacts of humans on the ocean” 5 is conceivably a noble one. The creation of such a framework would allow decision- and policy-makers to communicate, counsel and account for their interactions across levels of government, the market and environmental issues. The call for a “coherent overall approach” to sustainably manage human use of the ocean is attempted to be answered with WOA. To achieve this, the UN seeks to mind the gaps that exist in the science and management capacity of the marine environment.

(Worm et al. 2009). These characteristics and institutional practices inform to a large degree the management practices that are implemented by the UN. In accordance with

political ecology thinking, this represents the actual real-world power and knowledge, as the institutional organization is engaged in influencing and creating active policies and management practices.

7.2 FAO (2016). The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome.

This document was constructed by FAO in relation to SDGs and with special interest for the targets relevant to SDGs 2, “End hunger, achieve food security and improved nutrition and promote sustainable agriculture”, and SDG 14². (FAO, 2016) It is also a complimentary publication to WOA 2016, and an integral part of the UN overall approach to global sustainable management.

The FAO report is also similar to WOA (2016) in that it is in line with the 2030 agenda for sustainable development (2030 ASD) and the 2015 Paris Climate Conference (COP21). Reflecting the objectives of the SDGs the Blue Growth Initiative (BGI) of FAO is aiding in implementing the Code of Conduct for Responsible Fisheries (CCRF) and, same as with WOA, applies the ecosystem service approach to fisheries and aquaculture.³

The intention of this document is to function as an analytical, monitoring and reporting tool in the effort to implement the CCRF. It is furthermore oriented towards the “code for the sustainable management of living aquatic resources” and the “Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication”.

² 1SDGs: 2= End hunger, achieve food security and improved nutrition, and promote sustainable agriculture; 14= “Conserve and sustainably use oceans, seas and marine resources for sustainable development” (Found at: <https://sustainabledevelopment.un.org/sdgs>. 10.03.2018.

³ For more on Blue growth see Eikeset et. al. (2018)

FAO has several agendas, guidelines and agreements, as we have seen above, that are related to the global management of the ocean and aquaculture. The FAO Code of Conduct for Responsible Fisheries defined the global framework in which both capture fisheries and aquaculture are considered different part of the same productive system. (Cataudella, Massa & Crosetti 2005).

A part of FAO's strategic framework for the next decade includes facilitating "partnerships for food and nutrition security, agriculture and rural development between governments, development partners, civil society and the private sector". (FAO, 2016) This formulation has led to the establishment of the "Global Aquaculture Advancement Partnership" (GAAP), an organizational platform that seeks to "involve a wide range of potential partners including (i) United Nations agencies; (ii) inter-governmental and international financing institutions; (iii) international and national research organizations and academia; (iv) private-sector/civil society/NGOs; and (v) governmental and other relevant networks." (FAO, 2016). The goal of the GAAP "is to contribute towards attainment of the sector's sustainable development goal." (GAAP, 2013).

Sustainability is here reflected similarly as it is in WOA and in relation to the ocean and aquaculture it is in essence the "management of living aquatic resources, balancing their use and conservation in an economically, socially and environmentally responsible manner." The term sustainability is thus composed of three dimensions: economic, social and environmental.

These three are the dimensions of sustainability which encompass the socio-economic and environmental aspects. Economically, fed aquaculture provides income through revenue, taxes and other forms of earnings. Socially the most important aspects are employment and food security. In relation to these two, FAO writes that the "...emphasis is on producing benefits to society; in terms of fisheries, these are primarily food, employment, income and nutrition" (FAO, 2016).

In relation to the dimension of environmental issues with the fisheries, there are concerns about overfishing at unsustainable levels and reduced fishery production. There are also the specific concerns of sourcing of ingredients to feed, the conversion rate of biomass and the development and effectiveness of substituting in the fed aquaculture industries.

The reports, guidelines and agreements function as the practical use of the ideas, concepts, perspective and tools that FAO has constructed. Furthermore, these reports, guidelines and agreements are informing, referring to and legitimizing each other.

7.3 Sustainability

Sustainability is seen by UN as a concept that could merge the relatively dichotomous idea of supplying for the needs of the present while maintaining resources for the future, and its foundation stands on the natural capability of ecosystems to regenerate the same resources that we extract. (WOA, 2016).

Sustainability in relation to the ocean and aquaculture is in its essence the “management of living aquatic resources, balancing their use and conservation in an economically, socially and environmentally responsible manner.”. (FAO 2016, p. 82).

In this way sustainability addresses more than the ecology of natural resources and the management of extractive activities, it also includes the socio-economic aspects of natural resources, e.g. food security, income and employment.

The term sustainability is then composed of three dimensions: economic, social and environmental. Economically, fed aquaculture provides income through revenue, taxes and other forms of earnings. Socially the most important aspects are employment and food security. In relation to these two, FAO writes that the “...emphasis is on producing

benefits to society; in terms of fisheries, these are primarily food, employment, income and nutrition". (FAO 2016, p. 40).

In relation to the dimension of environmental issues with the fisheries, there are concerns about overfishing at unsustainable levels and reduced fishery production. There are also the specific concerns of sourcing of ingredients to feed, the conversion rate of biomass and the development and effectiveness of substituting in the fed aquaculture industries.

7.3.1 Natural resources and sustainability

Sustainable natural resources⁴, e.g. timber and fish, are conversely naturally regenerating at a temporal and spatial scale that is within the realm of human extractive activities. In relation to fed aquaculture the fish species of sardines and anchovies are used in producing fishmeal and fish oil, and are capable of repopulating in three to eight years, if their population is retained at an amount conducive for repopulation.

The ecosystem functions and associated services have to be maintained through management in order for them to continue providing for human use, unless the environment is to fall under stress from pollution, habitat degradation, and overfishing. To monitor the use of natural resources the UN has created a global standard, the "system of environmental-economic Accounting" (SEEA)⁴ (FAO, 2016).

The United Nations promote ecosystem-based managerialism which states that human production systems should be managed to function within the carrying capacity of the biophysical system to uphold long-term sustainability. This derives from Rockstrom emphasises the importance of managing "the scale of the human system relative to its natural capital base" when it comes to "receiving a sustainable flow of ecosystem

⁴ The Millennium Ecosystem Assessment (2005) classified ecosystem services as: provisioning services (e.g., food – including food traded in formal markets and subsistence trade and barter -, pharmaceutical compounds, building material); regulating services (e.g., climate regulation, moderation of extreme events, waste treatment, erosion protection, maintaining populations of species); supporting services (e.g., nutrient cycling, primary production) and cultural services (e.g., spiritual experience, recreation, information for cognitive development, aesthetics) (WOA 2016 Part 3, ch. 3, p. 6-7.)

services". (Rockstrom et al., 2009). In the analysed documents this is in short understood as a limited holistic approach that considers the three dimensions of sustainability and their drivers (FAO, 2016).

"The ecosystem services approach acknowledges natural capital as the paradigm in which the human subsystem exists, highlighting (but not limiting to) the anthropocentric aspect of this concept." (Costanza et al., 2014).

This approach is presented to have a normative goal of supporting human well-being in accordance with sustainable use of the environment. The instruments or mechanics of the ecosystem service approach is to set up an "organizing principle to consider multi-scale and cross-sectoral synergies and tradeoffs" or, simply put, the creation of "common ground and shared values". A key principle is to highlight the benefits that ecosystems provide, as ecosystem services, to the people/actors that interact with the ecosystem directly or indirectly through the use of the services or otherwise engaging in activities related to the ecosystem.

"...people, governments and businesses are increasingly using this approach as an organizing principle for finding new ways to invest their human, social and built capital in this common goal." (Döring and Egelkraut, 2008).

The ecosystem service approach is stated to recognize "that 'price' is not equal to 'value'", which addresses the issue of externality by accounting for the benefits and costs not associated with the market directly, but still holds value through services to human society and costs of reduced natural production due to human activities. UN applies a framework for valuation that includes ecosystem services for socio-economic and ecological aspects of sustainability, not limited to, but of main concern is food security, income, overexploited fisheries, and implications of alternative sourcing of nutrients. The effort of creating a normative system for measurement and valuation is aimed at creating a "currency" or organizing principle that will aid in the process of encapsulating

the complex nature of multi-scale and cross-sectoral synergies and trade-offs. This currency or principle is then applied to measure and put value on the ecosystem services that provides for the socio-economic and environmental aspects of sustainability. In relation to large scale industrial fed aquaculture the major beneficial prospect is income through employment and from international trade, this is due to the high monetary value of certain species, e.g. carnivorous species such as salmon and cod. A balanced valuation system that does not overvalue in or is limited to, monetary terms, is needed so as not to exacerbate power asymmetries and increase socio-ecological conflicts. The valuation system will only be generally beneficial if it is able to include the value of monetary, spiritual, cultural and other values important to people, in its valuation spectrum. If this is achieved it could potentially sufficiently address the connectivity and trade-offs between the various actors, e.g. stakeholders, governments, and the economic sectors and the human uses of the ocean (Butler et al., 2013).

FAO recorded in 2013 that as much as 31.4 percent of fish stocks in the world marine fisheries are overfished, while 58,1 percent are fully exploited and only 10,5 percent is underfished (FAO, 2016). Maximum sustainable yield is an adjustment to the goal of maximum yield, in that it accounts for the resource's capability to compensate for the removals, and so adjusts the yield accordingly. Unsustainable rate of exploitation is one that is quicker than reproduction and growth of the stock and causes decline, a trade-off between harvest levels and population recuperation. If to be considered sustainable the stock should have an abundance of population above the MSY level, due to uncertainty and risks which often is not substantially assessed and included in MSY. There are also critique of the concepts as it could potentially be very limited and not include several ecological aspects, such and multispecies and ecosystem interactions. Sustainable fisheries is deemed to have abundant fish that supplies extensive nutrition and sufficient income to dependent human societies.

Sustainability addresses more than the ecology of natural resources and the management of extractive activities, it also includes the socioeconomic aspects of natural resources, e.g. food security, income and employment. To gain the benefits in a sustainable fashion the claim in WOA is to “appropriately plan(ned) and manage(d)” (Ed. by author)..., “the intensity and nature of harvesting and culture” and to give “access to the potential benefits”. (WOA 2016). The latter statement is oriented towards socio-economic issues of resource access, the second to the practices and the first on management.

This is representative of these documents, which mainly have a managerial stance and take a relatively strict technological approach that is classified as GEM – global environmental management discourse (Benjaminsen & Svarstad, 2001). This approach, put into practice, is reflected by the “Initiative European Union MSFD (2008): “Directive 2008/56/EC” 5. This is basically a legislative framework on the “management of human activities; supports the sustainable use of marine goods and services; and integrates the value of marine ecosystem services into decision making” which incorporates an “ecosystem-based approach”. (WOA 2016).

In the FAO report the sentiment is slightly different due to the food security aspects that are central for the FAO in the discourse on state of the ocean and aquaculture. Food security, poverty, rural, small-scale and livelihoods take a central place here, while in WOA this is rather a secondary concern. The FAO promotes the use of small to medium scale aquaculture, and to a lesser extent fed aquaculture, to support the goal of enhancing food and nutrition security as well as rural livelihoods.

7.4 Aquaculture

Aquaculture has gained increasing recognition as a major food producing industry, with its benefits like increased food supply, but also negative effects, such as ecological impacts. Aquaculture itself poses some environmental challenges, including potential pollution, competition with wild fishery resources, potential contamination of gene pools,

disease problems and loss of habitat. Examples of those challenges, and measures that can mitigate them, have been observed worldwide.

As the fastest growing animal food producing sector (FAO, 2014; FAO, 2016) aquaculture raises certain concerns in general, yet it is the fed aquaculture sector that uses high-protein feed, from fishmeal and feed additives of fish oil, that are most controversial. The production of fish feed should not occur at the expense of providing fish for direct human consumption, or lead to deliberate fishing that could be undesirable for conservation of biodiversity. (WOA, 2016: Chapter 12, p. 7).

7.4.1 Fed aquaculture

Aquaculture has gained increasing recognition as a major food producing industry, with its benefits like increased food supply, but also negative effects, such as ecological impacts.¹ As the fastest growing animal food producing sector (FAO 2014; FAO 2016) aquaculture raises certain concerns in general, yet it is the fed aquaculture sector that uses high-protein feed, from fishmeal and feed additives of fish oil, that are most controversial.

Aquaculture that is dependent on external nutrient inputs in the form of fresh feed items, farm-made feeds or commercially manufactured feeds is considered fed aquaculture. (Tacon et al. 2011). Other external inputs are antibiotics and pesticides or other chemicals (against for example *Lepeophtheirus salmonis* in Salmon production), and with high input of resources like this, it is oriented towards efficiency and high output to compensate for costs. (Tacon et al., 2011).

It is basically the aquatic equivalent of industrial husbandry or intensive animal farming which seeks to maximize production output and minimizing production costs through

fully controlling the life cycle, from domestication, growth in large scale farming systems, to artificial selection of desirable traits. (WOA 2016, 12, p. 4).

Farmed food fish – a generic term “farmed food fish” used here, and by WOA and FAO, includes finfishes, crustaceans, molluscs, amphibians, freshwater turtles and other aquatic animals (such as sea cucumbers, sea urchins, sea squirts and edible jellyfish) produced for intended use as food for human consumption. (WOA 2016, 12, p. 2).

Of all farmed food fish produced, 69.2 percent is from fed aquaculture, and finfish species constitutes a third of the total, with high value carnivores, e.g. Salmon, (FAO, 2014) having the most increase in share. Main global fed fish species:”grass carp (Ctenopharyngodon idellus), common carp (Cyprinus carpio), Nile tilapia (Oreochromis niloticus), catla (Catla catla), crucian carp (Carassius carassius), Atlantic salmon (Salmo solar), pangasiid catfishes (striped/tra catfish [Pangasianodon hypophthalmus] and basa catfish [Pangasius bocourti]), and rohu (Labeo rohita)” (Tacon et al. 2011; WOA 2016, 12, p. 3).

So as aquaculture now produces between 40 and 50 percent of total fish produced by capture fisheries and aquaculture combined, (WOA 2016) it is clear that fed aquaculture accounts for a significant part of the production of fish for human consumption.

In the FAO report the international trade numbers estimate that aquaculture represents 20-25 percent in quantity, and 33-35 percent in value of all internationally traded fish products. (FAO 2016, 64).

The WOA report of the UN clearly states that aquaculture “is providing an increasing contribution to world food security.” (WOA 2016, 12, p. 1) and while fed aquaculture is the major producing sector it does not receive the same positive depiction as non-fed

aquaculture. “...production of non-fed species can be more beneficial in term of food security and the environment” (FAO 2016, p. 25).

The main issue here is the use of fishmeal and fish oil, which will be described in more detail later with the markers: source, conversion rate and substitution.

7.4.2 Aquafeed

The scope of this issue and the growth that this industry has seen, can shown by the total industrial compound aqua-feed production which increased from 7.6 million tons in 1995 to 29.2 million tons in 2008, (Tacon et al. 2011). This feed used in fed aquaculture is in part based on fishmeal “fishmeal are that it is high in protein with an excellent amino acid profile as well as being highly digestible with no anti-nutritional factors.” and fish oil “Fish oil is the major natural source of the long chain omega-3 polyunsaturated fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)”. (Jackson et al. 2012). The use of fish oil by the aquaculture sector may increase slowly and estimates say that total usage will increase by 16 percent or more, which means the increase from 2008 to 2020 will be from 782,000 tons (2.7 percent of total feeds by weight) to 908.000 tons (1.3 percent of total feeds for that year). (Tacon et al., 2011).

The source of fishmeal and fish oil are from capture fisheries, mainly by harvesting stocks of small, fast reproducing fish, for example anchovies, sardines and menhaden. (WOA 2016). To produce fishmeal the captured fish are dried and milled into crude flour, and often mixed with flour from fish remains and other fish by-products. Fish oil is produced through the pressing of cooked fish, remains and by-products. (FAO 2016; 49; FAO 2016; 70). There is insufficient capacity for increasing industrial production of fish feed using low-value or trash fish, including by-catch that would otherwise be discarded. (WOA 2016).

The use of small pelagic fish (e.g. anchovies and sardines.) for fishmeal and fish oil were promoted by FAO in the 1950's as additives to feeds for all animal food production. (FAO 2014).

The share of global fishmeal and fish oil production used by fed aquaculture is significant, and was in 2008 reported by the FAO to account for 60.8 percent of fishmeal and 73.8 percent of fish oil. (FAO 2008; Tacon et al. 2011).

THE DESTINATION - Part 4

This part addresses research question: 2) How are the sustainability indicators of this issue perceived and presented?

8. Sustainability of fed aquaculture

The utilization of capture fisheries are, in a global context, generally internationally assessed and recognized to be approaching the productive capacity of the oceans. Hence it is of both importance and necessity that aquaculture – and specifically fed aquaculture – does not diminish the natural capacity of the ecosystem to provide its services as well as increase the supply of food for human consumption. The increase in economic value of fish products of the last decade are primarily attributed to aquaculture, and it is generally agreed upon that capture fisheries can not sustainably supply the growing demand for fish products. The aspects highlighted here are the impacts of aquaculture, both directly (e.g. aquaculture facilities displacing capture fisheries or aquaculture adversely affecting capture fisheries, through modification and pollution of coastlines and habitats) and indirectly (e.g. unsustainable capture of fish for fishmeal and fish oil in feed for fed aquaculture), and the benefits of aquaculture as the sector of food production that could potentially have a future of sustainable growth.

A selected few are the main issues of concern for this thesis and is reflected in the six markers which will now be further explored in relevance to sustainability.

9. The Markers of sustainability

The environmental indicators that have been constructed by the analysis and theory markers of sustainability in this research are sourcing, conversion rate and substitution. The socio-economic indicators and here set as the markers of sustainability are income, employment and food security.

9.1 The environmental markers

9.1.1 Sourcing

The marker of sourcing could basically be assessed at a sustainable level if fish used for fishmeal and fish oil are caught in capture fisheries that are managed sustainably.

“Sourcing” links the place that the contents of feed, such as fishmeal and fish oil, comes from, how it is gathered, and what it contains. For example two of the major sourcing areas are fisheries in Chile and Norway, where fish are caught by fishing trawlers and contain among others, Chilean jack mackerel (*Trachurus murphyi*) and Blue whiting (*Micromesistius poutassou*) (Jackson et al., 2012).

Aquaculture and capture fisheries are co-dependent in some ways, as feed for cultured fish is in part provided from capture fisheries. They are also competitors for space in coastal areas, for markets, and potentially for other resources (e.g. labour, governmental support and capital investments). (FAO 2016, p. 25-34).

Statistically the percentage of fish from capture fisheries used in fishmeal compared to by-products and waste is as high as 60-70 percent, but is assessed to declining to “16 percent by 2025”. (FAO 2016, p. 174). A contributing factor to the decline is the continued high cost of fishmeal and fish oil, and since the supply is not likely to increase as much as potential demand, the prices will stay high. (FAO 2016, p. 172).

In the quest for reduced costs in fed aquaculture production there has been a development of utilization of by-products and a reduction of waste. Furthermore the industry has made efforts to reduce the use of fishmeal and fish oil in compound feeds by more precision feeding, and through selective use of strategic ingredients in specific stages of production, e.g. hatchery, broodstock and finishing stage. (FAO 2016, 6, 178).

The positive development that have come from the increased efforts in fed aquaculture stems from the fact that in industrial fish processing, as much as 70 percent of the fish is in the end regarded as by-products and waste, e.g. heads, viscera and backbones, which presents an opportunity. If the increase in efficiency of handling by-products and reduce waste is continued this could potentially be a substantial source of input to feed, and so aid in reducing fishmeal and fish oil from whole fish and capture fisheries. (FAO 2016, p. 154).

9.1.2 Conversion rate

The fed-aquaculture rate of feed conversion to farmed food fish could reach sustainable levels “if there is a net biomass production and not loss”. (Tacon et al 2011; Jackson et al. 2012).

“Feed conversion ratio (FCR) measures the productivity of different protein production methods. It demonstrates the kilograms (kg) needed to increase the animal’s body-weight by 1 kg.” (Welch et. al. 2010). (FCR) is the amount of feed necessary in relation to

growth, basically how many kg feed is needed for kg fish, and specifically the amount of fishmeal and wild-caught fish used. (Bendiksen et. al. 2011).

The Salmon farming industry has been criticised for being a net consumer of marine resources, in the form of fishmeals (FMs) and fish oils (FOs) used in feeds. Despite the efforts made to replace FM and FO with alternatives, such as vegetable proteins and oils, the balance is still generally negative, with calculated fish in–fish out (FIFO) values often being over 4. (Bendiksen et. al. 2011). Salmon given the feed with the highest level of fishmeal replacement (FM10) had a net production of fillet protein relative to feed input in the form of protein derived from FM, indicating that FM supply is not a major factor that would impose serious limits on the quantity and efficiency of production.

There was net consumption of marine fish resources when assessed as FIFO calculated on the basis of the amounts of fish required to produce all FOs (FIFO 3.03–3.59) and on fish needed to produce pristine FOs included in the feeds (FIFO 1.53–1.83). Calculations based upon nutrient ratios gave positive outcomes, and salmon in all treatments deposited more fillet fat than the amount of pristine FO consumed. It is concluded that supplies of FOs impose greater limitations on the formulation of salmon feeds than do supplies of FMs. The results of the study also indicate that increased use of fish processing by-products has the potential to reduce some of the predicted short-fall in FOs resulting from reductions in the amounts of small, pelagic marine fish species rendered directly for the production of FMs and FO's. (Bendiksen et. al. 2011, p. 1).

The WOA and FAO considers the FCR by referring to Tacon and Metian (2008) and Tacon et al. (2011) who claims that one of the main estimates states that the FCR of salmon is 4:1, meaning that it takes 4-5kg wild fish for 1kg of salmon. This results in a considerable net biomass loss, and if the wild fish used were suitable for human consumption, this would be a potential decrease in food security.

There are other estimates that lowers this rate near and below 2:1, and this is assessed to further decrease as substitution and alternatives are researched and developed. FAO and WOA supports the claim of 2:1 even if other sources shows 4:1, which incentivizes the status quo instead of taking a critical stance. The trend of decreased rates are considered to continue, yet limited. (Jackson et al. 2012; Tacon & Metian 2008; Tacon 2011).

Several conditions affects the efficiency of the food that are artificially fed to the farmed food fish and so influences the rate at which the fish grow in comparison to the amount of feed given. For example the Sea lice (Copepoda, Caligidae) which is a proliferant pathogenic marine parasite is serious cause of decreased conversion efficiency. (Sinnott, 1998; WOA 2016). This problem is a major concern in Chilean, Norwegian and Canadian fed aquaculture of salmon.

The output of naturally-fed aquaculture represents a net increase of world animal protein stock, while the contribution of fed aquaculture, consuming plant and animal protein and fat, “depends on conversion rates controlled by the physiology of the species and the effectiveness of the farming system”. (WOA 2016, 12, p. 6). The presentation of the development of feed efficiency in fed aquaculture claims that there has been an improvement in the FCR as the industry invests in research and development to reduce costs and increase profits. (FAO 2016). This is leading towards a more sustainable fed aquaculture production due to the increased feed efficiency.

9.1.3 Substitution

Sustainability is increased if feed contains substitutes for fishmeal and fish oil from industrial fisheries by-catch, waste material, or from agricultural sources, at a level that will produce a positive net biomass.

“Substitution” refers to the different methods and sources of alternative proteins (nutrients) in the feed that substitutes the wild-caught fish (e.g. soy or genetically modified plants). Use of modified plants to produce EPA and DHA see (FAO 2016).

Due to the “current absence of cost-effective alternative lipid sources that are rich in long-chain polyunsaturated fatty acids”. (Tacon et al. 2011). The research and development of substitutions are receiving attention, support and capital.

Significant progress has been made in replacing feed sources from capture fisheries with agricultural production (e.g., soybeans), although more work is certainly needed. (WOA 2016, 16, p. 2)

FAO states that “35 percent of raw material for producing fishmeal and fish oil” are now from the residues and by-products and that the trend of substitution could reduce the dependency on fish meal and fish oil from wild sources even further. (FAO 2016, p. 31, 153). This indirectly supports food security by utilizing what would otherwise be waste. However the estimates puts this to 38 percent in 2025 and there are further complications because of the varying composition of the feed due to the lower nutritional value of by-products compared to whole fish. Fishmeal produced from higher levels of residues and by-products will in general contain more minerals and small amino acids (e.g. glycine, proline, hydroxyproline), and less protein. (FAO 2016, p. 31, 174).

If fed aquaculture is to expand its production globally and this form of substitution will decrease the growth rate and productivity due to ineffective feed, it seem the industry will have to find some more alternative sources. There are some potential alternative sources for fish oil, containing highly unsaturated fatty acids, such as marine zooplankton and copepods, but this has yet to be cost effective. (FAO 2016). The question of whether the extraction of these alternative sources is sustainable also arises, as this has not been

assessed at the scale that is needed to supply the demand for the nutrient value of fishmeal and fish oil.

For example, Atlantic Salmon, is still being rigorously researched in relation to substitution and its effect on production and quality of produce. For Bendiksen et. al. (2011) and Crampton et. al. (2010) the conclusion is that the supply and intake of substitutive replacements of fishmeal and fish oil from marine resources can make farmed atlantic salmon a net producer of marine nutrients. The supply of fish oil is of more importance than fishmeal as the supply of this can more efficiently be replaced by vegetable sources, while the use of by-products as potential to reduce the limitations fish oil has on the salmon feeds. Torrissen et. al. (2011) goes as far as calling salmon the “super chicken of the sea” due to its comparatively efficient output compared to feed input when considering other farmed animal production sectors.

This example is two among several that uses various methods of assessing the potential for sustainability of fed aquaculture with interests in substitution or replacement development. Ellingsen, Olaussen and Utne (2009) and Winther et. al. (2009) discusses the CO₂ emissions of Norwegian farmed salmon and shows that the feed production are the main concern. Pelletier et. al. (2009) orients their research on a global-scale life cycle assessment of farmed salmon were the main aspects of potential improvement lies in “least-environmental cost feed sourcing patterns” and feed conversion efficiency. Similar point is made by Papatryphon et al. (2004) in their environmental impact assessment of salmonid feeds. Here a life cycle assessment shows that the resources from capture fisheries used to produce feed are one main concern in the environmental impact of salmonid aquafeeds. Directly on substitution Opstvedt et. al. (2003) addresses the efficiency of feed utilization in salmon, and shows how increased substitution fish meal with vegetable proteins in general reduces feed efficiency.

9.2 The socio-economic markers

If fed aquaculture is to become the major sustainable food producing sector it has to take into account these three environmental markers. The socio-economic indicators and here the markers of sustainability are income, employment and food security

The assessment and the report follows the framework by “The 2030 Agenda” and is engaged with the processes, stakeholders and partnerships that would according to their goals, allow both the present and the future societies to gain the benefits of marine resource extraction. These benefits includes nutritious food, income, employment and well-being as by the principles of ecosystem service approach. (FAO 2016).

9.2.1 Food and nutrition

FAO makes the claim that while production of non-fed species can be more beneficial in terms of food security and the environment since it does not rely on external feed inputs, fed aquaculture produces higher monetary value farmed food fish and is experiencing faster growth. (FAO 2016).

Still the importance of non-fed species should not be undermined as it supplies around 50 percent of the world’s aquaculture production of animals and plants. The issue of nutritional value of fish is complex and non-fed species, such as bighead carps, contain as much nutrients as equivalent nutritionally valued fed species. (FAO 2016).

9.2.2 Income

As a large food producing sectors fisheries and aquaculture is central to income for many people of coastal societies. FAO estimates that as many as 12 percent of the world's population is supported by these sectors. (FAO 2016). This is a substantial amount and while capture fisheries do not have much potential for increase, it is still a critical sector for developing countries and small scale fisheries are a primary source of income for coastal societies and rural livelihoods. Aquaculture without the use of feed are described as more beneficial for income generation as it requires less costly input. (FAO 2016, p. 152).

9.2.3 Employment

Fed-aquaculture, both marine and in-land, could potentially employ a large number in marginalized populations with the right policies and investments. In developed nations and regions this industry has increased substantially the last few decades and is likely to continue this trend. Processing facilities have more capacity for employment, but certain forms of fed aquaculture that are not highly automated could need a large quantity of skilled labour. (FAO 2016; WOA 2016).

10. Conclusion

Here research question number three is addressed: 3) How can this perspective be critiqued and improved?

10.1 Findings

This chapter is composed of the political ecology framework of principles (chapter 6) as it is applied to the analysed data (chapter 7). Due to the general quantitative nature of the analysed documents the content of these documents rarely addressed the qualitative issues of interest in this research. The argumentation here is therefore partly based on the thematic and discourse analysis and oriented within the theoretical framework, while also consisting of a broader discussion on the issues relating to the political ecology oriented issues of interest.

10.1.1 First principle

The first set of principles, guidelines of the research, gave insight into what where explored and what is of importance. An essential part that is central to this discourse, is that the distribution of costs and benefits of environmental change needs to be a part of any account of sustainability. It is not only asked how we can secure the future, but also how management and environmental changes influence the distribution of costs and benefits in the present. The control of distribution is a tool through which power could affect the material conditions of societies, and potentially cause or limit the marginalization of groups of people. In relation to the socio-economic aspects of aquaculture, food security, income and employment, and in particular fed aquaculture, this comes into play with the decision of who has access to capture fisheries and the employment opportunities presented.

As a multilateral institution of global proportions, the UN has power and influence at

national, regional and global levels of decision making. Their influence comes into play as it affects the way in which the cost and benefits are distributed. Several formal agreements, guidelines, partnerships and initiatives have been implemented in support of this, and constitute an extension of the power and knowledge of the UN.

It is here argued that the UN assessment and the FAO report is a depiction of the “nature of reality” and “knowledge of reality” that is influenced by the social and cultural context in which it was created. This context is considered as established mainstream scientific community, and global hegemonic institution, that frames a their description of reality in a global environmental management perspective. The research reflected the concern of political ecology by questioning the knowledge behind the power and decision making of the UN in relation to sustainable fed aquaculture as a social and environmental system.

Highlighted weaknesses includes the dependency on technocratic and dogmatic scientific considerations, and a limited approach to local knowledge, livelihoods and conditions. Initial perspective on the UN and WOA (2016) stresses their orientation towards global, regional and national benefits, such as gross national product (GNP) and international trade.

While the FAO is more considerate of local issues, like income and livelihoods, and small scale operations. The FAO approach is arguably more on the course of what political ecology stresses, which is the crucial need for more bottom-up approaches, on a local scale, with participation, livelihoods and capabilities as core points.

This could potentially strengthen the UN approach to sustainability by allowing more local informational input and self regulation. FAO describes that food security and poverty alleviation receives more benefits from small and medium scale operations in capture fisheries and in aquaculture, than from industrial capture fisheries and large scale industrial fed aquaculture.

10.1.2 Second principle

The research adheres to “the degradation and marginalization thesis: Unsustainable modernist development” and states that there clearly are some cases of environmental degradation and overexploitation, and social marginalization in relation to aquaculture and marine resources. Certain developmental agendas have for example increased the use of international fishing fleets in which large scale industrial fishing boats outcompete the small and medium scale local fishers. Aquaculture development and infrastructure may also negatively impact local fisheries due to spatial and functional requirements. This is claimed happening due to state development intervention, regional and global market integration, and is related to sustainable community management and modernist development efforts. (Robbins 2012) The UN sustainability framework is an integral part of the global development efforts.

The claim is that, in places where continued economic exploitation occurs under conditions of marginality and social change, degradation intensifies (Robbins 2012). Capture fisheries are continually overexploited and this trend has not been reversed. This is especially the case with large and highly valued fish species, but also fisheries and species that have been traditionally important for local food security and income. Small and medium scale fisheries and aquaculture are also a vital source of employment and livelihoods, yet are seen to be outcompeted and overexploited. In effect this amounts to that environmental change and degradation first affects the marginalized due to their close connection and dependency on the natural resources.

Marginalized populations under environmental change may start to use new and untested methods to support themselves, which may increase extraction and demand on the ecosystems. This points out the importance of marginalization and degradation issues in relation to UN sustainable aquaculture and capture fisheries.

The UN's views on sustainability are related to conservation and control of natural resources, and so it is of importance to investigate the perspectives that guide sustainability and conservation efforts and outcomes. This points to the claim that control of resources has shifted through the "implementation of efforts to preserve 'sustainability', 'community', or 'nature'". This is reflected by the UN framing in that local, traditional and small- to medium-scale operations are usually difficult to measure, control and assess, which is necessary for sustainable practices. The changes that have been implemented are then often presented in a manner that is difficult for local actors to understand, and thus hard to use in regulating their practices. The control may then shift away from traditional and local managers, toward the benefits of elite communities that are unassociated with the resource according to Robbins (2012).

In support of this claim is research done on the history of failures in environmental conservation. This could be further backed up by the WOA and FAO's evidence, which shows that the trend of overexploitation of fisheries has not been reduced, but that overfishing and fully-fished capture fisheries have instead increased.

It is in this sense that conservation efforts may lead to the opposite, and sustainability efforts may cause loss of sustainability, especially if the traditional managers of local resources are replaced with elites, global market or foreign interests as Robbins (2012) argues. Fed aquaculture is portrayed as a high income generative sector of the food producing industries, which attracts investors and external influence, which in turn does not automatically invite careful considerations of local socio-economic and environmental issues. If traditional managers of local resources could be empowered through investments in accord with conservation and sustainability efforts, the reallocation of resources to unassociated elites will be reduced, while the potential for income and employment could still be realized. It should be stated that non-fed

aquaculture, or naturally fed aquaculture, holds better potential to serve local and traditional resource managers and their societies.

The way in which UN sustainability efforts address the access to the environment and natural resources, has effects on the larger society and can cause environmental conflicts. These environmental conflicts can relate to larger gendered, nationalistic, classed, and raced struggles. Conflict over access to marine resources and aquaculture is influenced by UN sustainability policies.

The argumentative claim from Robbins (2012) is that scarcities produced through resource enclosure and appropriation accelerate conflict between groups, politicize environmental problems through allocation of resource control, and cause ecologized social conflict through changes of policy. This is shown through both the ways in which social and economic power are expressed anew and reframed by conflicts over environmental issues, and as new political divisions arising from environmental conflicts. For the sake of the research done here, it is argued that as environmental issues become political, political issues become environmental. The issue of sustainable aquaculture and UN is both an environmental issue 'politicized', and a political issue 'ecologized'. As the state of the ocean and resource allocation to aquaculture is clearly dependent on ecological parameters, it is in the political sphere that the policy of allocating those resources are made. And as nations and local populations struggle to maintain and keep control over oceanic and aquaculture resources, the resources themselves are influencing the politics, so that it in turn becomes part of the ecological and environmental issues.

The UN and FAO are leading entities of institutional environmental management and influential actors in global environmental actions, behaviors and rules systems. As such, UN and FAO are through their discourse, power and knowledge, affecting both environmental regimes and conditions, as well as people's beliefs and attitudes.

The argument: “institutionalized and power-laden environmental management regimes”, create new kinds of people through “new environmental actions, behaviors and rules systems” (Robbins 2012, p.23). There are also opportunities or imperatives created for local groups to “secure and represent themselves politically” due to “new environmental regimes and conditions” (Robbins 2012, p. 216). In essence this relates to ways of being in the material world the way in which we use the natural resources and how they support our society, which influences our culture.

To support this claim Robbin (2012) states that:

“Cases from around the world demonstrate that the contestation of ecological priorities is also one of identities. Enacting certain environmental behaviors, it has been observed, comes to direct who and what people are, while rejecting or challenging certain practices, conversely, runs afoul of hegemonic expectations tied to identity, and vice versa”. (Robbins 2012, p.219)

The implications of this in regard to sustainability in aquaculture is that it has the potential to directly influence not only the environment and management regimes, but people's identities and politics. UN and FAO is would in this perspective firmly improve any measures of sustainability by addressing this issue in their efforts to implement policy and management practises.

The argument for this is that nature, the environment and its components, which are the “material characteristics of non-human nature and its components”, and so nature “impinge upon the world of human struggles and are entwined within them, and so are inevitably political... People, institutions, communities, and nations assemble and participate in the networks that emerge, leveraging power and influence” (Robbins, 2012 p. 232).

This suggests that new ways of managing natural resources, such as newly adapted

aquaculture technologies, create new social formations, corporations and institutions. Within this transformation and control of the material conditions, there is power and influence to be gained and exerted. There are further argumentations that the limit to accumulation of capital and power is set by the material conditions in themselves.

This non-human agency, their set conditions that limit our actions and institutions, is of consequence to our social world and influences our institutions. In this case, the reduced fish stocks in capture fisheries and the growth and development of aquaculture, have called for new institutions and management, giving new social orders (e.g. GAAP).

10.1.3 Third principle

The third set of principles, the Critical tools, informed certain sections of the analysis and the following discussion of the research. At certain times in the analysis, the critical perspective of political ecology highlighted common assertions in the data that informed the following argumentation..

The UN's aquaculture sustainability efforts is in danger of falling subject to the "tragedy of the commons" theory, and is so in fault according to "common property theory" which then is reason for critique. The CPT goes against the "tragedy of the commons" theory, and is supported by "exceptions" to this theory, based on "locally organized techniques, rules, and decision-making structures that organized extraction, defined user communities, and maintained harvests and yields". (Robbins 2012, p. 53).

A central observation in political ecology is the way in which "tragedy of the commons" theory places the blame of environmental degradation on the marginalized and local communities and so hides the true reason for degradation, as well as giving support of resource control to "elites, non-residents, and other distant parties". Robbins 2012, p. 54).

FAO (2016) is argued here to have further understanding of and is considering this problem at a more balanced way than WOA (2016). One main reason for this is the focus of the FAO on food security which is often more linked to local human populations and small and medium scale operations of natural resource extraction. WOA, on the other hand, is more considerate of international trade, GNP and in general capital and market oriented, in line with the more nationally and internationally focus of the UN main institution.

Hadjimichael, Bruggeman & Lange (2014) shows that political ecology perspective on the expansion of marine aquaculture can suggest that within the current institutional and decision-making structures, there is the danger of continuously undermining the rights of coastal communities and other user of the sea. The Blue Growth Initiative has received critique on this issue and others by Barbesgaard (2018) and Hadjimichael (2018). The main critical argument is that “the rise of blue growth represents the latest stage in a broader process of ‘capturing of control by powerful economic actors of crucial decision-making...including the power to decide how and for what purposes marine resources are used, conserved and managed’ (WFFP 2014a, 3).” (Barbesgaard 2018, p. 131) The conclusion from this is that there is low environmental conservation value of the proposed blue growth policies and a continued promotion of large scale and capital intensive uses, while lacking in support for small scale users.(Barbesgaard 2018, p.145).

In effect of this a Marxist Political Economy perspective informs some of the argumentation and critical views taken by critical theory and political ecology. The idea that “environmental degradation is inevitable in capitalism” (Robbins 2012, p. 54) is not fully explored in this research, but it underlines and strengthen the argument that small scale non-fed aquaculture is more conducive in increasing food security and potentially less environmental degrading. Fed aquaculture is more closely related to the statement, as it is found to be more often developed for income and capital accumulation rather than

food security, and could cause more environmental invasive implications, like that of habitat destruction and nutrient input from unsustainable wild sources.

10.1.4 Fourth principle

In the context of where the ideas about the environment are formed and based on the analysed documents it is argued that the UN environmental discourse is following the current of technocratic and institutionalized science. This allows for certain assumptions about the environment to be prevalent, and influences the way power, social habits and cultural norms presents the world as it is and ought to be. UN and FAO both expresses optimism on technological progress and their belief in global environmental managerialism. The format of the UN institutions, forms of organization and practice, is reflected in the way the environmental issues are addressed and perceived.

Fed aquaculture is portrayed by UN in the frame of its social habits and cultural norms and politics. Investigation into the UN perspective of sustainability and fed aquaculture found that the history of this tells of overexploitation of capture fisheries, net-nutrient loss and habitat destruction, but also of food security, waste recycling and international trade.

The world ocean is an immense landscape that human activity is utilizing in an abundance of ways. The perspective of UN on sustainable fed aquaculture is based on concepts like those of ecosystem services, MSY and fish population theory. These are considered highly technical and requires serious observations, measurement, valuation and analytics. Tools like these are not readily available for local and marginalized populations that are under pressure of policies for environmental management, politics and environmental degradation. This would potentially make the FAO approach of local income, employment and food security more recommendable in the view of political ecology, than does the UN approach of international trade, industrial research and development, and GNP.

Lastly, as a defining statement, it is from the departure point of the three assumptions of Bryant R. L. & Bailey, S. (1997) here argued and stated that the cost and benefits associated with environmental change due to proliferation of fed aquaculture are distributed unequally ... that these changes does not affect our global society in a homogeneous way... and that this is accounted for by political, social and economic differences... and that political power, such that of the UN, plays an important role in such inequalities.

10.2 Conclusive remarks

This study has investigated a limited sample of the UN discourse, the socio-economic and ecological aspects, and the contemporary conditions of the state of the ocean in specific relevance to fed aquaculture. The study has furthermore engaged in how these issues relates to the discourse on issues of environmentalism and political ecology. The aim of this thesis was to investigate the environmental and socio-economic aspects of human use of natural resources from the ocean in the context of fed aquaculture framed within the UN. A combination of content-, thematic- and discourse analysis were used as methods to understand the content, perspective and meaning of environmental and socio-economic issues related to the ocean and fed aquaculture.

Findings of particular interest in this research are chosen to present the conclusive remarks of this thesis. Firstly that fed aquaculture could potentially release some of the pressure on capture fisheries, and supply for the demand of high value food fish. Secondly, the potential for fed aquaculture to feed the world is limited by the lacking supply of efficient and sustainable feed, due to issues of sourcing, feed conversion rate and substitution. Thirdly, the difficulties of producing efficient and sustainable feed are continually being intensely researched and solutions have been developed and more are under development. Fourthly, these new solutions needs to be considerate of the complexity of the numerous associated socio-economic and environmental issues.

This is a daunting project that requires continued critical investigation and considerations.

This thesis has highlighted some selected indicators and have shown that there is a simplification of the subjects which is necessary, as Scott (1999) argues, for efficient governance. Furthermore it has been argued that the issues have become very technically and are presented in a managerial and apolitical manner. In political ecology this diminishes the value to society of this assessment and report, and further this apolitical perspective is criticized for extending the power of governance above local scale, and causing dogmatizing of the mainstream discourse of global environmental problems and of scientific knowledge. (Adger et. al. 2001).

Further research by political ecology oriented researchers should be done to increase the critical assessment of UN approach to sustainability of capture fisheries and fed aquaculture. Use the hatchet to cut down on flawed presentations and practises of environmental issues and management. Plant a seed to create wider and more inclusive representations and management practises.

Global environmental management and sustainability of fed aquaculture are now leading the way to the future of farmed food fish and our use of oceanic natural resources. This requires careful considerations of prioritization on all aspects of our activities.

References

Adger, W.N., Benjaminsen, T.A., Brown, K. & Svarstad, H. (2001). *Advancing a political ecology of global environmental discourses*. *Development and change*. 32 (4), 681-715. Oxford: Blackwell Publishers.

Barbesgaard, M. (2018). *FORUM ON CLIMATE SMART AGRICULTURE: Blue growth: savior or ocean grabbing?* *The Journal of Peasant Studies*, Vol. 45, No. 1, 130–149. <https://doi.org/10.1080/03066150.2017.1377186>.

Baxter, P. and Jack, S. (2008). *Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers*. *The Qualitative Report* 13(4).

Bendiksen, E.Å., Johnsen, C.A., Olsen, H.J. & Jobling, M. (2011). *Sustainable aquafeeds: Progress towards reduced reliance upon marine ingredients in diets for farmed Atlantic salmon (Salmo salar L.)*. *Aquaculture*, 314 (1-4), 132-139. (<https://doi.org/10.1016/j.aquaculture.2011.01.040>).

Benjaminsen, T.A. & Svarstad, H. (2010). *Politisk økologi – miljø, mennesker og makt*. 1st ed. Oslo: Universitetsforlaget.

Berg, B.L. & Lund, H. (2012). *Qualitative research methods for the social sciences*. London: Pearson.

Blaikie, P. & Brookfield, H. (1987). *Land degradation and society*. London: Methuen.

Bryant, R.L. & Bailey, S. (1997). *Third world political ecology*. London: Routledge.

Bryman, A. (2012). *Social research methods*. 4th ed. Oxford: Oxford University Press.

Cataudella, S., Massa, F. & Crosetti, D. (eds.) (2005). *Interactions between aquaculture and capture fisheries: A methodological perspective*. Studies and Reviews. General Fisheries Commission for the Mediterranean. No. 78. Rome: FAO.

Crampton, V.O., Nanton, D.A., Ruohonen, K., Skjervold, P.O. & El-Mowafi, A. (2010). *Demonstration of salmon farming as a net producer of fish protein and oil*. *Aquaculture Nutrition*, 16, 437–446. (<https://doi.org/10.1111/j.1365-2095.2010.00780.x>).

Costanza, R., Andrade, F., Antunes, P., van den Belt, M., Boersma, D., Boesch, D.F., Catarino, F., Hanna, S., Limburg, K., Low, B., Molitor, M., Pereira, J. G., Rayner, S., Santos, R., Wilson, J. & Young, M. (1998). *Principles for sustainable governance of the oceans*. *Science*, 281.

Crowder, L.B., Hazen, E.L., Avissar, N., Bjorkland, R., Latanich, C. & Ogburn, M.B. (2008). *The impacts of fisheries on marine ecosystems and the transition to ecosystem-based management*. *The Annual Review of Ecology, Evolution and Systematics*, 39, 259-278. Center for Marine Conservation, Duke University Marine Laboratory, Nicholas School of the Environment, Beaufort, North Carolina. (<https://www.annualreviews.org/doi/10.1146/annurev.ecolsys.39.110707.173406>).

Doring, R. & Egelkraut, T. M. (2008). *Investing in natural capital as management strategy in fisheries: The case of the Baltic Sea cod fishery*. *Ecological Economics*, Elsevier, 64 (3)

Eikeset, A.M., Mazzarella, A.B., Davíðsdóttir, B., Klinger, D.H., Levin, S.A., Rovenskaya, E. & Stenseth, N.C. (2018). *What is blue growth? The semantics of*

“Sustainable Development” of marine environments. *Marine Policy*, 87, 177-179.
(<https://doi.org/10.1016/j.marpol.2017.10.019>).

Ellingsen, H., Olaussen, J.O. & Utne, I.B. (2009). *Environmental analysis of the Norwegian fishery and aquaculture industry - a preliminary study focusing on farmed salmon*. *Marine Policy*, 33, 479–488. (<https://doi.org/10.1016/j.marpol.2008.11.003>).

Ezzy, D. (2002). *Qualitative analysis: Practice and innovation*. London: Routledge.

Fairclough, N. (2010). *Critical discourse analysis: The critical study of language*. 2nd ed. Longman applied linguistics.

FAO (2014). *The state of world fisheries and aquaculture 2014*. Rome: FAO.

FAO (2016). *The state of world fisheries and aquaculture 2014*. Rome: FAO.

Flyvbjerg, B. (2006). *Five Misunderstandings About Case-Study Research*. *Qualitative Inquiry* 12(2): 219-245.

Forsyth, T. (2003). *Critical political ecology. The politics of environmental science*. London: Routledge.

GAAP (2013). (Available at:

<https://www.afdf.org/wp-content/uploads/12d-Global-Aquaculture-Advancement-Partner-ship-GAAP-Program.pdf>).

Glaser, B.G. (1978). *Theoretical sensitivity: Advances in the methodology of grounded theory*. Mill Valley, California: Sociology Press.

Hadjimichael, M., Bruggeman, A. and Lange, M.A. (2014). *Tragedy of the few? A political ecology perspective of the right to the sea: the Cyprus marine aquaculture sector*. *Marine Policy* 49, 12–19.

Jackson, A.J. (2012). *Fishmeal and fish oil and its role in sustainable aquaculture*. International Aquafeed, September/October. (Available at: <https://www.slideshare.net/IntAquafeed/fishmeal-fish-oil-and-its-role-in-sustainable-aquaculture>).

Opstvedt, J., Aksnes, A., Hope, B. & Pike, I.H. (2003). *Efficiency of feed utilization in Atlantic salmon (Salmo salar L.) fed diets with increasing substitution of fish meal with vegetable proteins*. *Aquaculture*, 221, 365–379.

Papatryphon, E., Petit, J., Kaushik, S.J. & Van DerWerf, H.M.G. (2004). *Environmental impact assessment of salmonid feeds using life cycle assessment (LCA)*. *Ambio*, 33, 316–323.

Peet, R. & Watts, M. (1996). *Liberation ecologies: Environment, development and social movements*. London: Routledge.

Pelletier, N., Tyedmers, P., Sonesson, U., Scholz, A., Ziegler, F., Flysjo, A., Kruse, S., Cancino, B. & Silverman, H. (2009). *Not all salmon are created equal: Life Cycle Assessment (LCA) and global salmon farming systems*. *Environmental Science & Technology*, 43, 8730-8736. (<https://pubs.acs.org/doi/abs/10.1021/es9010114>).

Robbins, P. (2012). *Political Ecology: A Critical Introduction*. 2nd ed. Wiley-Blackwell.

Scott, J. C. (1999). *Seeing like a state: How certain schemes to improve the human condition have failed*. Connecticut: Yale University Press.

Sinnott, R. (1998). *Sea lice – watch out for the hidden costs*. Fish Farmer, 21 (3).

Stott, P. A. & Sullivan, S. (2000). *Political ecology: Science, myth and power*. London: Arnold.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, Calif., Sage.

Strauss, A. & Corbin J.M. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. 2nd ed. Thousand Oaks, Sage Publications.

Tacon, A.G.J., Hasan, M.R. & Metian, M. (2011). *Demand and supply of feed ingredients for farmed fish and crustaceans – trends and prospects*. FAO Fisheries Technical Paper, No. 564. Rome, FAO.

Tacon, A.G.J. & Metian, M. (2008). *Global overview on the use of fish meal and fish oil in industrially compounded aquafeeds: Trends and future prospects*. Aquaculture, 285, 146–158.

Torrissen, O., Olsen, R.E., Toresen, R., Hemre, G.I., Tacon, A.G.J., Asche, F., Hardy, R.W. & Lall, S. (2011). *Atlantic Salmon (Salmo salar): The “Super-Chicken” of the Sea?* [Fisheries Science, 19-3, 257-278.](https://doi.org/10.1016/j.fishsci.2011.05.001) (Available at: <https://www.tandfonline.com/doi/abs/10.1080/10641262.2011.597890>).

Winther, U., Ziegler F., Skotorp Hognes, E., Emanuelsson, A., Sund, V. & Ellingsen, H. (2009). *Project report: Carbon footprint and energy use of Norwegian seafood products*. (<https://www.sintef.no/prosjekter/miljoregnskap-og-klimasporing-av-sjomat/>).

Trondheim, Norway: SINTEF Fisheries and aquaculture.

(https://www.sintef.no/globalassets/upload/fiskeri_og_havbruk/fiskeriteknologi/filer-fra-erik-skotorp-hognes/sintef-fiskeri-og-havbruk---energibruk-og-klimautslipp-i-eksport-av-norsk-sjomat---final-apnet---2011_04_07.pdf).

WOA (2016). *The first global integrated marine assessment*. World Ocean Assessment 1. United Nations. (Available at:

https://www.un.org/Depts/los/global_reporting/WOA_RegProcess.htm).

Worm, B., Hilborn, R., Baum, J.K., Branch, T.A., Collie, J.S., Costello, C., Fogarty, M.J., Fulton, E.A., Hutchings, J.A., Jennings, S., Jensen, O.P., Lotze, H.K., Mace, P.M., McClanahan, T.R., Minto, C., Palumbi, S.R., Parma, A.M., Ricard, D., Rosenberg, A.A., Watson, R. & Zeller, D. (2009). *Rebuilding global fisheries*. *Science* 325, 578. (Available at: <http://science.sciencemag.org/content/325/5940/578>).

WSSD (2002). *Report of the World Summit on Sustainable Development*. Johannesburg, South Africa, 26 August-4 September 2002. (Available at: <https://sustainabledevelopment.un.org/milestones/wssd>).

Yin, R. K. (2003). *Case study research: design and methods*. Thousand Oaks, Calif., Sage.

Appendices

Appendix 1 - Initial protocol concepts

- a. Part
- b. Chapter
- c. Page
- d. Headline
- e. Author(s)
- f. Topic(s)
- g. References
- h. Content on subject
- i. Keywords - search words - descriptions related to subject
- j. General perspective on subject
- k. Critical perspective on subject
- l. Found positive narrative
- m. Found critical narrative
- n. Additional notes

Appendix 2 - Keywords and search words

- a. Aquaculture
- b. Aquafeed
- c. Farmed food fish
- d. Feed
- e. Fed
- f. Finfish
- g. Fishmeal

- h. Fish oil
- i. Mariculture
- j. Salmon
- k. Sustainable
- l. Sustainability

Appendix 3 - Themes as basic categories for subjects of discourses

- a. Standardization of sustainability in WOA 2016
- b. Standardization of sustainability in FAO report 2016
- c. Governance and managerialism
- d. Construction of aquaculture
- e. Construction of aquafeed
- f. Aquaculture and fisheries
- g. Aquaculture and sustainability
- h. Aquaculture and the environment
- i. Sourcing of aquafeed content
- j. Conversion rate of aquaculture production
- k. Substitution in aquafeeds
- l. Aquaculture and society
- m. Income in the aquaculture sector
- n. Employment in the aquaculture sector
- o. Food and nutrition from aquaculture
- p. Aquaculture, source of economic growth and food security



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