Green Feed In The Marine Fish Farming

How to communicate water benchmarks to stakeholders

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Grön Föda Till Havsfiskeodlingen

Hur kommunicerar man riktvärden inom vatten till intressenter

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Therese A. M. Jansson
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Abstract

Global catch fishery is said to been oppressed to its limit (Boyd & Schmittou, 1999), further implying aquaculture might be the only solution to the world demand for fishery products. The applied term *aquaculture* in this paper refers to the one used by NOAA (2008); *breeding, rearing, and harvesting of plants and animals in all kind of water environments, including but not limited to ponds, rivers, lakes, and the ocean.*

According to Shamshak & Anderson (2008, p. 74) aquaculture has over the past 20 years been the fastest growing food sector with an average annual growth rate of 8.7%. It further represents approximately 37 % (Shamshak & Anderson, 2008, p. 73) of total fisheries production worldwide. But even though aquaculture has taken off, the practice has its critics. The industry must counter criticism about the lack of sustainability. If the industry is able to successfully do this, the farming technique can more easily fulfill its potential role as a world food supplier (Boyd &, Schmittou, 1999). But first the aquaculture industry needs better environmental management for a continued growth.

One practice that needs to be curtailed is the choice of using unsustainable (limited) and expensive fishmeal and fishoil. The challenge is to identify more environmentally friendly and cheap substitutes for the unsustainably fishmeal and fishoil. Several trials have been made to reduce the quota of unsustainable fishmeal in farming the deep blue, and where e.g. feed has been substituted to one extend by soybeanmeal. Nonetheless, it is crucial that the substitutes for fishmeal and fishoil maintain both the quality and quantity of production that the original products achieve. Also, further importance and essentials must be paid to make these practices transparent to the industry's stakeholders.

Pittenger *et al*., (2007, p. 98) has shown that advances in both feed formulation and feed management on a farm level have led to increased fish growth, reduced production costs, and reduced feed conversion ratios but where research is still in progress to continue developing alternative feed ingredients. Of importance is to note that even though progress has been made in identifying substitutes for fishmeal and fish oil, there is currently no commercially available product that can completely substitute for fishmeal and fishoil *(Ibid)*.

A fish farm needs to efficiently deal with the environmental issues it causes, or the effects will be deleterious. This thesis shows that less use of fishmeal (substituted by Soybean Protein Concentrate) can improve waterquality in some parameters used in this thesis. Further this thesis shows how sustainable benchmarks (with respect to watermetrics) efficiently can be managed and communicated to the industry's stakeholders by business managers.

A farm managed with environmental awareness and a willingness to share the experiences in the process of finding a more sustainable production method (also referred as the case farm in this thesis) is; Kona Blue Water Farm, HI, USA.

Key terms: *Aquaculture, benchmarketing, communication, metrics, sustainability, waterquality*

Sammanfattning

Vilt fångad fisk sägs vara överutnyttjad i ett globalt perspektiv (Boyd & Schmittou, 1999), därför förutspås odlad fisk (aquaculture) vara den enda lösningen på den globala efterfrågan på fiskprodukter.

Begreppet "aquaculture" i denna uppsats hänvisar till den beskrivning NOAA (2008) förespråkar; *avel, uppfödning och skörd av växter och djur i alla typer av vattenmiljöer inklusive men inte begränsat till dammar, floder, sjöar och hav.*

Enligt Shamshak & Anderson (2008, sid. 74) är "aquaculture" den snabbast växande livsmedelssektorn och har så varit under de senaste 20 åren, med en genomsnittlig årlig tillväxt på 8,7 %. Dessutom utgör sektorn ca 37 % (Shamshak & Anderson, 2008, sid. 73) av den globala fiskeriproduktionen. Även om "aquaculture" har haft en stor tillväxt har den varit utsatt för hård kritik och industrin måste bemöta denna kritik om bristen på hållbarhet. Om industrin lyckas med detta, kan denna typ av odling lättare komma att uppfylla dess potentiella roll som världens mat leverantör (Boyd & Schmittou, 1999). Men först måste "aquaculture" branschen upprätta en bättre miljöförvaltning om en fortsatt tillväxt skall vara möjlig (*Ibid).*

En praxis som måste förbättras är det produktionstekniska vägvalet av foder som i dagsläget huvudsakligen innehåller fiskmjöl och fiskolja. Detta är varken ekonomiskt försvarbart eller förenligt med hållbarhetsmål. Utmaningen är att hitta ett mer miljövänligt och billigt substitut än det ohållbara fiskmjölet samt fiskoljan. Flera försök att istället använda sojamjöl i varierande mängd har gjorts för att minska kvoten av det ohållbara fiskmjölet i odlad havsfisk. Dock vill man att substitutet för fiskmjöl och fiskolja skall medverka till en bibehållen nivå av både kvalitet och kvantitet i den odlade fiskeproduktionen (aquaculture). Vidare är det viktigt att göra dessa lösningar tillgängliga och synliga för industrins intressenter.

Pittenger et al., (2007, s. 98) har påvisat framsteg i utvecklingen av fodersammansättning och foderhanteringen på gårdsnivå som lett till ökad fisk-tillväxt, minskade produktion kostnader samt minskad foderomvandlingsförmåga men där forskning fortfarande pågår med att utveckla alternativa foderingredienser. Även om framsteg har gjorts för att identifiera substitut för fiskmjöl är det viktigt att notera att det förnärvarande inte finns någon kommersiellt tillgänglig produkt som helt kan ersätta fiskmjöl och fiskolja.

En fiskodlingsanläggning har ett stort behov att effektivt hantera miljön, annars kommer effekterna att vara skadlig. Denna uppsats påvisar att mindre användning av fiskmjöl (substituerat med sojaprotein koncentrat) kan förbättra vattenkvaliteten i vissa av de studerade parametrarna. Vidare behandlar denna uppsats frågan om hur företagschefer inom den odlade havsfiske industrin effektivt kan skapa en hållbar omgivning samt kommunicera sina hållbara riktmärken med avseende på vattenkvalité till branschens intressenter.

En fallgård har identifierats Kona Blue Water Farm, HI, USA. Här drivs verksamheten med högt ställda mål som innebär att finna hållbara lösningar för fiskodling till havs samt att dela med sig av sina erfarenheter som detta arbete innebär.

Nyckelbegrepp: Aquaculture, riktvärden, kommunikation, indikatorer, hållbarhet, vattenkvalité

List of Abbreviations and Acronyms

ACC	Aquaculture Certification Council
CERES	Coalition for Environmentally Responsible Economics
CR	Corporate Responsibility
CSR	Corporate Social Responsibility
DHA	Docosa Hexaenoic Acid
EAA	Essential Amino acid
EPA	Eicosa Pentaenoic Acid
FAO	Food and Agriculture Organization of the United Nations
FCR	Feed Conversion Ratio
FIN	Fishmeal Information Network
FM	Fishmeal
GAA	Global Aquaculture Alliance
IFFO	International Fishmeal & Fish Oil Organization Ltd
IISD	International Institute for Sustainable Development
KBWF	Kona Blue Water Farm
LA	Linoleic Acid
NELHA	Natural Energy Lab of Hawaii
NGO	Non profit Governmental Organization
NOAA	The National Oceanic and Atmospheric Administration
NSRL	National Soybean Research Laboratory
SCP	Sustainable Corporate Performance
SME	Small and Medium sized Enterprise
SPC	Soy Protein Concentrate
SWOT	Strength-Weakness-Opportunities-Threats
TBL	Triple Bottom Line
TN	Total Nitrate
TOC	Total Organic Carbon
TP	Total Phosphorous
TSS	Total Suspendid Solids
WCED	World Commission on Environment and Development (the Brundtland Commission)
WQL	Waterquality Laboratory
WWF	World Wildlife Fund

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1 Introduction

This chapter presents a brief introduction to the key areas and problematic background of the marine aquaculture farming industry. Furthermore the management and communication obstacles that companies face are addressed.

About 20 years ago, an emerging technology started to explode in the U.S. waters. Open ocean farming or offshore aquaculture started gaining popularity (www, NOAA, 1, 2008). The United States was in the forefront of this revolution, developing dependable cage systems, remote feeders, monitoring systems and brood stock for species that could prosper in a marine environment *(Ibid)*. Many were inspired by the great successes they witnessed in this field. But questions started to be raised such as: "Could aquaculture be brought online safely?" "Would it be economically viable?" "What about licensure to operate?" *(Ibid)*.

Currently, there are other concerns, such as sustainability and environmental friendliness. The conversion of small wild fish into fishmeal and fish oil for use in formulated diets for farmed fish and crustaceans has become an ardently debated topic. Some argue that the practice of using wild fish in the form of fishmeal and fishoil to feed farmed fish species potentially competes with their direct use for human consumption and their value in the ecosystem (Schipp, 2008). It is important that the public knows of the environmental risks. One reason is because when farmers know the public be aware of risks, they will be more encouraged to be responsible for their environmental activities (Yamagata *et al.,* 2008). Also business partners, business to business (B2B) and organizations all want their health and safety risks understood and effectively managed (Spedding; Rose, 2008).

Putting this sustainability concept into action requires identifying and selecting practical indicators and having an understanding of how these indicators can be measured over time so it can be determined if progress is being made. Sustainability indicators should be designed to consolidate key measures of environmental, economic and social performances. The purpose of these sustainability metrics of the water quality while finding a greener feed in the growing marine open ocean aquaculture industry is to:

- Communicate sustainability reports and engage the primary stakeholders, such as shareholders/investors, customers, employees, governments and communities
- Find a way to improve the health (longevity) and sustainability standards of the company and industry as in whole
- Branding

1.1 Problem background

Sustainable development was originally presented by the *World Commission on the Environment and Development* (WCED) also known as the Brundtland commission, which titled its 1987 report *Our Common Future* (Wåhlstedt, 2001). The aim of this report was to deal with the growing environmental problems. The concept of sustainable development was further explained at the Rio Convention, 1992. The conference in Rio resulted in two different

reports, The Rio Summit and Agenda 21. Both reports declared the importance of sustainable development as a fair allocation of resources for the current population and future generations (Larsson, 2002).

According to Stratos (2007), companies manage sustainability issues for sound business reasons, to manage new risks, to gain business opportunities and to position themselves for the long term by extending the company's role in society. Communicating how and why actions for sustainability are made is crucial if businesses and other organizational stakeholders are to understand and accept changes in behavior and approach. Communication for sustainability within a business is vital to achieving commitment and inclusion from employees. Communication of innovations, best practices, working partnerships and many other aspects of sustainability progress from and to businesses, governments, NGO's, academics and others is a key to enhancing rapid progress (Brass, 2006).

For those businesses that have recognized the need to embrace sustainable development, the next step is to understand how to implement the practice (Schwarz *et al.,* 2002). Clearly a strong disconnection exists between the power stakeholders and the company. Companies are hearing skepticism in their stakeholders' voices and responding with actions that build a link between power and responsibility. Also, communication between different groups is important because faster implementation of new, safe technologies will be the result (Zaryabova and Israel, 2007).

A company's governance and accountability structure is an important pre-condition for integration of sustainability. Clear accountabilities, which explicitly address sustainability factors, define the respective roles and relationships between the governance levels in a company, including the shareholders, Board, officers and executives, and employees. These relationships help improve sustainability performance (Stratos, 2007).

With support from Kona Blue Water Farm (KBWF), a case study was set up, to assess how KBWF can integrate sustainability benchmarks into business processes, as well as communicate these practices to the stakeholders. The result presented in this thesis is to demonstrate the range of processes and tools which can be used or adapted also by other companies interested in further integrating sustainability into their businesses.

Sustainability also provides a framework for integrating environmental, social and economic interests into effective business strategies. But how does this framework look for KBWF? This is considered to be the new challenge for organization leaders. In recent years, many companies have adopted the concept of sustainable development as a core business value; its underlying premise is that economic wellbeing is inextricably linked to the health of the environment and the success of the world's communities and citizens. Reviews from current research show that there is a critical need for a method to evaluate business sustainability performance and to incorporate it into the company's management and decision-making processes.

1.2 Problem formulation and purpose of study

When considering the importance of companies reporting their sustainable development as well as the growing pressures that companies face in today's competitive and fast changing markets, it becomes evident that communication is a strategic tool for success.

In recent years, scholars have argued that it is possible to achieve a win–win scenario under which a company can maximize returns while making some progress towards the implementation of sustainable business practices (Judge and Douglas, 1998; Florida, 1996; Klassen and McLaughlin, 1996; Porter and van der Linde, 1995). In addition Ocean Conservation (2009) has pointing out saying not enough research have been made about our use and treatment of the oceans. Therefore the purpose of this thesis is to find benchmarks as well as a way to communicate sustainability protocols for the open ocean aquaculture managers, in the hope to gain a win-win situation.

1.3 A Literature review

Business communication, it is in general a thoroughly investigated field of academic research. Business literature provides models and terminologies for communication from all thinkable angles, and thus provides a broad variety of sources to review. Researchers such as Mathis (2007), Porter and Kramer (2006) and van Marrewijk (2003) among others have explored business communication in reaching a more sustainable environment to some degree in their studies. Nevertheless, the secondary literatures on business communication, as well as business sustainability have increased in recent years.

With respect to specified research questions, existing research predominantly considers the importance of business communication at the stakeholder level. Effective stakeholder communication is essential to build trust, political goodwill and customer loyalty (Oxford Leadership Academy, 2008).

To determine environmental efficiency, methodical practice such as ecological footprint, life cycle as well as energy analysis all need to be regarded as important insights (Pittenger *et al*., 2007; Mattsson and Sonesson, 2003; Brown and Herendeen, 1996; Wackernagel and Rees, 1996). Some reports have also attempted to quantify the nutrient outputs from marine fish farming. Unfortunately the various reports do not use a common measure but the findings do show that the total amount of nutrients discharged is dramatically increasing because of the large expansion of the industry.

According to Pittenger *et al.* (2007), both the aquaculture industry and the society have the interest to minimize pollution from aquaculture facilities. Untainted marine waters are a requirement for future economic achievement.

1.4 Research objectives

While studying the literature, I have found many valid starting points for further research topics. The aim of this study is how to find legitimate and innovative sustainable protocols when farming the deep blue and further communicate these to the stakeholders. I regard this, as the most relevant question for managers as well as for researchers, since the way of communicate is critical to the company and the environment. I feel that this field is particularly representative as aquaculture is the fastest growing food producing sector on earth (www, FAO, 1, 2006). Aquaculture, now accounts for almost 50 percent of the world's food fish and is perceived as having the greatest potential to meet the growing demand for aquatic food. "Given the projected population growth over the next two decades, it is estimated that at least an additional 40 million ton of aquatic food will be required by 2030 to maintain the current per capita consumption" (www, FAO, 1, 2006). If the prediction comes true, environmental sustainability will become more pertinent than ever before. Therefore, I want to find if a fish farm can make fish feed more sustainable. Undoubted, implementing more soyprotein is a key. Implication such as sustainability measurements further needs to be studied. Lastly, I want to find how to effectively communicate these sustainable benchmarks to the company's stakeholders.

1.5 Motives for a theoretical and a methodological approach

The research analysis of this paper is embedded in a theoretical framework that provides an overview of *communication strategies in a stakeholder context*. It provides an *explanation of the area of strategic sustainable benchmarks* and offers insights into the various approaches within affinity communication. The theoretical information and the models presented are the basis of the analytical research within the case study. Moreover, a transfer from the stakeholder relationship theory to the area of communicating sustainable protocols and drawing conclusions for business-stakeholder relationships are made. This is important as it provides a typology for this field.

Finally, the terminology of the existing theory is organized according to a comparison between the secondary literature and the primary empirical data compiled from the interviews. In order to confirm assumptions and provide empirical evidence, a qualitative research analysis was conducted. I chose to create a case study and conducted interviews, believing these approaches were the most suitable research vehicles for this thesis. This particular approach offers the possibility to access qualitative and meaningful data, and thus, serves in gaining practical and theoretical contributions in a distinctive way.

1.6 Delimitations

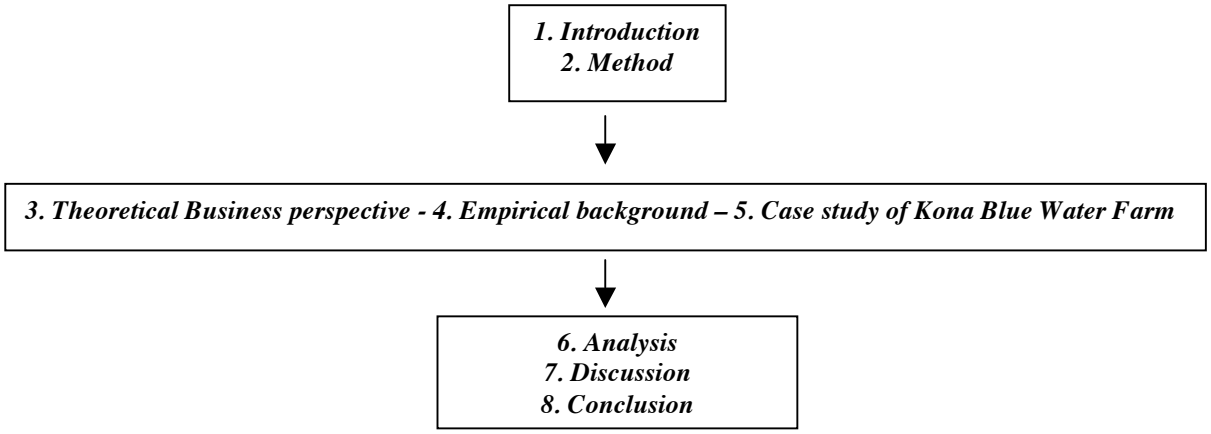
The theories cited in this project are simplified descriptions of many comprehensive studies. It is not the objective of this thesis to provide exhaustive accounts of these theories. Only those theoretical views, parts and concepts that support the objectives of this study are given consideration. It should be emphasized that the research focus is communication from a management perspective, focusing on one company, KBWF, Hawaii. It should further be noted that if other cases had been used, such as less successful aquaculture ventures, with different production, or interviewed experts with a different background, such as environmental managers, other conclusions might have been drawn. The conclusions

therefore are strongly connected to the case company and should be generalized to be able to adopt for similar companies. Furthermore, there are other elements of business communication, which are not covered in the scope of this paper, but which nevertheless should be considered as part of the process of detecting sustainable protocols. Possible elements, for instance, include politics or the cultural environment.

1.7 Outline of paper

The outline of the thesis, illustrated in Figure 1, gives the reader a picture of the structure. Chapter one gives the reader an introduction to the area of marine aquaculture and business communication as well as the topic's problem background. In chapter two, the chosen method is described for this study. Chapter three provides a theoretical perspective on business communication. Further, chapter four deals with the empirical background and perspective required for the analysis of the case study.

Figure 1. Outline of the thesis.



Chapter five, which is the empirical part, provides the reader with insight and a deeper understanding of the specific studied case company, Kona Blue Water Farm. Chapter six deals with the analysis of used theory and empirical material. Further, the seventh chapter discusses my analysis in relation to other research papers. In chapter eight, conclusions are drawn from the discussion and analysis.

2 Method

In this chapter, the methods and scientific approaches, which are applied during the process, are briefly presented. Furthermore, an introduction to the data collection is presented.

The purpose of this part is to introduce the reader to my research process of finding and formulating the problem statement. As a candidate for Master of Science in Agriculture and Business Administration, it seemed obvious to choose the fastest growing food industry; full of potentials yet underrepresented and controversial in media.

As a former exchange student at the University at Illinois at Urbana Champaign in the U.S. it was also evident to use and apply my basis of knowledge to a casestudy in the U.S. When to find and create the research topic I chose the only fish farm of its kind in the U.S., with a unique record of monitored production data.

2.1 Choice of method and data collection

Fundamentally, when writing a thesis, the intention and research strategy are crucial. A detected problem is the starting point when initiate the research (Ejvegard, 1996). The method should be seen as a tool and approach to solve the detected problem in a way of gaining new acquaintance (Holme and Solvang, 1991).

Even though more than two-dozen standards or certification programs for aquaculture exist (www, WWF, 2009) none of the programs are effective at making the aquaculture industry more sustainable nor have governance structures that are in compliance with International Social and Environmental Accreditation and Labeling (ISEAL) Alliance's guidelines for certification programs – the world's most reputable guidelines for addressing social and environmental issues. "Companies that wish to truly distinguish themselves on the basis of their environmental stewardship may push for more stringent production standards than a consensus-based certification program" (Pittenger *et al*., 2007, p. 110).

Owing to this, finding farms pushing for sustainability makes it difficult and less encouraging to explore quantitative data. Therefore a qualitative approach in data that further search to explore the meaning of this specific area has been used.

Criterias for unit of analysis:

Production field: the marine open ocean aquaculture industry.

Environmental awareness: the chosen company must pay understanding for the ecosystem's sustainability and impact for future generations. In this case this means focusing on finding an alternative feed to the current used within the industry. Further, specifically introduction of more soybean products in the fish diet.

Location: due to time and budget constraints, the farm needed to be located in the U.S.

Stakeholder approach: the Company's openness, transparency and communication abilities towards the stakeholders, as well as the importance of being considered to be a sustainability working company.

After the set up of criterias, the selection was based upon personally knowledge, meaning based on recommendations from experienced expertise in a certain area (Merriam, 1994). One expert within the aquaculture and soybean industry was Bridget Owen, NSRL, who gave suggestions, information and contact information about the potential farm to interview and participate in the water quality trial due to more use of soybean products. The case farm was eager and enthusiastic to participate in my study.

The progression of this thesis began with a literature review, reading scientific articles, publications and listening to experts within the chosen field.

The literature review provided an understanding of the aquaculture and more specifically the open ocean fish production as well as business communication. This knowledge was needed in order to be able to understand why benchmarks in sustainability within the industry are needed to gain a win-win situation. The empirical background gives a global overview of the importance to raise the question about sustainability within the industry. This is further applied to a one of a kind farm situated in the U.S. Questions used in performed interviews (Table 1) and during the farm visit were developed and based on the theory and the empirical background.

Table 1. Performed interviews throughout the paper.

Company	Role	Interview date *Validation date*
Kona Blue Water Farm, HI	Fish health manager, Jennica Lowell	Email: June 2008- February 2009 Personal meeting: 2008-08-19 - 2008-08-21 *Email: June 2008- February 2009*
Kona Blue Water Farm, HI	Co-founder and president, Neil Sims	Personal meeting, 2008-08-20 *Email: 2008-10-05*
National Soybean Research Center, IL	Associate Director, Bridget Owen	Email: June 2008-February 2009 Personal meeting: June 2008- September 2008 *Email: June 2008- June 2009*

After that, an explorative and quality single case study involving a feed trial at the chosen farm was conducted. In the analysis a comparison between theory and empirical findings were made, followed by a discussion and finally the conclusion.

2.2 Case study as a method

According to Yin (1994, p. 1) case study is a form of research for social science. It is a "preferred strategy when 'how' or 'why' questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some

real-life context" (Yin, 1994, p. 15). Case studies have an important place in evaluation research. The most important application is to explain the causal links in real-life interventions. A second application is to describe an intervention and the real-life context in which it occurred and third, case studies can illustrate topics within an evolution, again in a descriptive mode[1] *(Ibid)*.

To design a case study some crucial points, which are listed, have to be defined (Yin, 1994, p. 52-53)

- defining the boundaries of a case study
- defining the unit of analysis for a case study
- defining a case study research design
- establishing the rationale for single- and multiple-case studies
- defining the criteria for judging the quality of research design (validity and reliability)

The issue of single-case and multiple-case and the issue of units of analysis will be explained. Yin (1994) distinguishes between single-case and multiple-case designs, and holistic versus embedded case studies. The presented research is a single-case study.

2.2.1 Single case study

Single case-studies are used where the case represents a critical test of existing theory, where the case is a rare or unique event, or where the case serves for revelatory purpose (Yin, 1994, p. 44). Additionally, single case studies may be conducted as a prelude to further studies. The Kona Blue Water Farm, is the only fish farm of its kind in the USA, with a unique record of monitored production data.

Relative to other research methods like experiments or surveys, the skills required for data collection in a case study are much more demanding (Yin, 1994, p. 55). This is because the collection procedures are not routinized and because of the continuous interaction between the theoretical issues and the data. Yin (1994, p. 56-59) defines required skills for assessing case studies, such as the ability to ask good questions, to be a good "listener", adaptability and flexibility to new situations, to have a firm grasp of the issues being studied, and to be unbiased by preconceived notions. Evidence for case studies may come from different sources. Yin (1994) describes six different sources, such as: documents, archival records, interviews, direct observation, participant observation, and physical artifacts. Considering the data collection, Yin states three main principles. The first principle is to use multiple sources of evidence. Any finding and conclusions based on the use of multiple sources is much more convincing than conclusions drawn from a single source. The second principle is related to creating a case study database. This aids in the organization and documentation of the collected data. The last principle of data collection is to maintain a chain of evidence, as it increases the reliability of the information in the case study. The chain of evidence allows an external observer to follow the evidence from initial research questions to ultimate conclusions. Throughout, the process, continuous interaction between the theoretical issues and the collected data will be evident.

[1] Schramm 1971, cited in Yin (1994, p. 12) states that case study tries to illuminate a decision or set of decisions: why they were taken, how they were taken.

2.3 Data collection

The data in this case study is based upon:
(i) providing relevant information (ii) data that is reliable and measurable (iii) data that is based on available data (iv) providing information that can influence management choices and optimize production.

2.3.1 Interviews

One way of collecting data is to conduct interviews. An interview is characterized by a researcher collecting information by asking a respondent questions (Lundahl & Skärvad, 1999). An interview can be structured in different ways; one common way to distinguish forms of interviews is to refer to *standardized* or *non-standardized* interviews. In a standardized interview, the questions and the order of the questions asked are determined in advance. In a non-standardized interview the researcher can adjust the questions and the order during the interview. The researcher can also add resulting questions and lead the interview in a desired direction. The answers in a non-standardized interview are more complete and thorough compared to the answers in a standardized interview (Lundahl and Skärvad, 1999, p. 92).

Another way to distinguish different types of interviews is to refer to *structured* interviews, *semi-structured* interviews and *unstructured* interviews (Saunders *et al*., 1997). In a structured interview, it is common to standardize the interview with predetermined sets of questions, for example using a questionnaire. A semi-structured interview is a kind of non-standardized interview- the questions are not fixed in advance *(Ibid)*. Nevertheless, the researcher must have some kind of comprehension of the topic before conducting an interview. It is common to prepare a number of *themes* for the interview *(Ibid)*. An unstructured interview is closer to an informal discussion and is used to explore a general area in depth. To plan and prepare the interview, the researcher must consider a number of practical questions (Lundahl and Skärvad, 1999, p. 93). First of all, respondents must be identified. The interviewer needs to determine who is interesting and valuable for the aim of the research process. The interviewer also needs to determine how to contact the respondents and how she can get them to participate. When the preparations are finished, the researcher must arrange and carry out the interview. In a non-standardized interview it is important to establish a personal connection with the respondent (Kvale, 1997).

2.3.2 Performed interviews

The empirical base of this thesis is made up partly of non-standardized semi-structured interviews. The interviews were chosen to match the research question at the open ocean fish farm in Hawaii, USA. Before the interviews, studies of the theoretical frame were made in order to gain sound knowledge of the research area. The respondents had different areas of knowledge. The people interviewed was the President and co-founder of Kona Blue Water Farm (KBWF), Neil Sims as well as the farm's Fish Health Manager, Jennica Lowell. Further I also executed a three days visit and participation in a conducted fish feeding trial at KBWF.

2.3.3 Documents

Besides the interviews, studies of various documents were also part of the empirical base. A document is defined as information collected through other channels other than observations

and interviews (Merriam, 1994). Examples of channels for document-collection could be written sources, sources expressed by art or a TV-program. The Internet is also a common source for finding documents. In this thesis, carefully chosen written documents such as books, articles and reports have been used based on the relevance. Some internal documents were used but cannot be revealed in order not to expose the company for unnecessary risks. Nevertheless, these documents will not be of a vital essence to the research but only complementary in order to put things in context and thereby will not affect the result.

2.4 Avoidance and handling possible pitfalls

In research processes, it is crucial to produce and present compelling and settled information. The question about accuracy, to what extent the result is in accordance with the reality, was controlled by the people that were interviewed and as well as by expertise.

During the interview inaccuracy might occurred and the respondents may have been affected by the verbal and body language from the interviewer. Also mistakes may have occurred when formulating the questions (Kvale, 1997). One limitation could have been, having a solo interviewer. This could entail an inability to obtain all pertinent information, even though some of the interviews were recorded.

An additional imperative factor is reliability, to what extent there is a connection or logic in the result (Merriam, 1994). In order to attain this, the theoretical perspective is being auxiliary explained in detail. Further, the recital of the paper and its conclusion is later being elucidated in detail. According to Yin (2003), it is up to each reader to decide if they would generalize the information or accept and transform the result of the study. The transferability is less when making a case study but by using a theoretical framework it is likely to increase the possibility of generalization.

When performing the non-standardized interview, adjustment of the questions as well as its´ order might needed to change during the interviews. Also adding resulting questions and leading the interview in a desired direction might be a result of this technique. The answers in a non-standardized interview are more complete and thorough compared to the answers in a standardized interview, which is regarded to be an advantage (Lundahl and Skärvad, 1999, p. 92).

In a non-standardized interview it is important to establish a personal connection with the respondent. Since the interview sometimes tends to be more of a discussion or dialogue between the interviewer and the respondent a *validation* of the results of the interview must be done. A continuous validation process during the interview helps to understand the respondent (Kvale, 1997). This means that asking clarifying questions to assure the meaning of the answers. Another validation method is to let the respondents read and correct the minutes from the interview.

3 A theoretical perspective on business communication

This chapter aims to present the concepts and definitions relevant to the study and as well to make it possible and easier to understand the next coming chapters to all readers regardless to their previous knowledge. Further the main focuses are *corporate environment, benchmarking and communication processes.*

3.1 Corporate environment

A company has to acknowledge several different factors, in order to become a successful player on the market. The most important factor, which is presented in this thesis is the notion of sustainability.

3.1.1 What is sustainability?

Today, sustainability[2] is a highly valued issue for many business corporations (Gerbens-Leenes *et al.,* 2003). Addressing Corporate Responsibility (CR) and Sustainable Corporate Performance (SCP) is essential for their licensures to operate and form the basis for their business principles and practices.

The most celebrated formulation of sustainable development is that given by the World Commission on Environment and Development (the Brundtland Commission) (WCED, 1987). For the past decade, substantial progress has been made in clarifying the many controversial issues that have emerged since the early shaping of the sustainability problem in the Brundtland Report (Pearce & Atkinson, 1998). The concept of sustainable development itself has been explained in a number of ways. The Brundtland Report explains it as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (Atkinson, 2000; WCED, 1987, p. 43).

Another definition is the one given by the Food and Agriculture Organization of the United Nations (FAO). FAO acts as a neutral forum where all nations meet as equals to negotiate agreements and debate policy (www, FAO, 1, 2008) According to the FAO, the definition on sustainable ability is "Sustainable development is the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in agriculture, forestry, fisheries sectors) conserves land, water, plant, and animal. Resources should be environmentally non-degrading, technically appropriate, economically viable, and socially acceptable" (www, FAO, 2, 2008).

Sustainability issues increase environmental uncertainty since they bring additional topics to the agenda of companies (Hoffmann, 2008). This increases the need for outside orientation. The aspects that they have not yet been in the focus of relevant stakeholders so far (e.g. social

[2] Something that is sustainable, according to the Brundtland report, should meet the needs of the present generation without compromising the ability of future generations to meet their own needs.

and ecological impacts of the company in foreign countries) might jeopardize the legitimacy of companies (*Ibid*). The vagueness of the term sustainability supports different perceptions and thus necessitates a common interpretation process if a company is willing to meet the expectations of its stakeholders. Thus, the acquisition and processing of new external knowledge, addressing social and ecological aspects of products and processes, becomes crucial *(Ibid)*.

3.1.2 Sustainability and CSR in corporations

Literature states a firm is operating sustainably when it does not reduce the capacity of the environment to provide for future generations (Bebbington and Gray, 1997; Porter and Linde, 1995; Hawken, 1993). Similarly, literature also declares that at a minimum, a sustainable business is one that leaves the environment no worse off at the end of each accounting period than it was during the beginning of that period.

When using the term ”corporate social responsibility” (CSR), which is widely used with different interpretations of sustainability (Crowther, 2002b, p. 2-3; Gray *et al.,* 1995, p 78-101) it is important to point out that mainstream literature identifies four major themes for CSR:

- Natural environment
- Employees
- Community
- Customers

CSR is also defined as a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis (Gallego, 2005).

Describing the connection between the economy, environmental values and social values it is common to talk about the Triple Bottom Line (TBL). This concept stresses the balance between the three values, where the financial result of a corporation is equally important as the corporation’s environmental and social performances according to the TBL idea. The three different areas should not be regarded as separated issues. Historically, the relationship between the business community and the society, even in global terms, has been of interest historically. But the topic has never been of more immediate interest than today (Garriga and Melé, 2004; Hollender and Fenichell, 2004; Löhman and Steinholz, 2003). Corporations’ social responsibility has become a pressing issue of today and has gained attention and acceptance in the public and in business communities. Stakeholders demand that the issue be taken seriously. One reason for the increasing focus on CSR today is the demand for and possibility of *transparency* in the business community. Corporations cannot undertake activities without stakeholders being aware of it. But the increasing influence could also mean increasing responsibility, which is proven by the awareness and attendance of the consumers and other stakeholders.

3.1.3 Stakeholder management

Traditionally, companies have paid more attention to their shareholders (or stockholders) than to the rest of the stakeholders (Kotler, 2000). The expression ”shareholders” refers to the owners of the company and stresses the financial aspect of a company (Lazonick and O’Sullivan, 2000, p. 13). But stakeholders are all the different groups, outside and inside the

organization, that have some kind of interest in the company. Besides the shareholders, a traditional and brief list of stakeholders could be: consumers, workers, investors, suppliers, distributors, host communities, the general society and the world ecological community (Kotler, 2000, p. 40; Deetz, 1995, p. 50-51).

The acknowledgement of the company as an actor together with other actors has created different approaches to the company's role and the term *stakeholder management* (Kotler *et al.*, 1999). Companies that strive to satisfy the needs of the different groups of stakeholders will meet a difficult challenge since the expectations and demands of the stakeholders are vary greatly.

This case study has adopted what Mitchell, Agle and Wood (1997, p. 853-886) would classify as a "narrow" definition of stakeholders. This definition considers primary stakeholders as those stakeholders who "bear some form of risk as a result of having invested some form of capital, human or financial, something of value, in a firm" (Clarkson, 1994, p. 5). These stakeholders are those without whose participation the corporation cannot survive (Clarkson, 1995). Primary stakeholders include capital suppliers (shareholders), employees, other resource suppliers, customers, community residents, and the natural environment (Clarkson, 1995; Starik, 1995). Clarkson argues that "primary stakeholder groups typically are comprised of shareholders and investors, employees, customers, and suppliers, together with what is defined as the public stakeholder group- the governments and communities that provide infrastructures and markets, whose laws and regulations must be obeyed, and to whom taxes and other obligations may be due" (Clarkson, 1995, p. 106) (see Textbox 1). While not all community residents are employees, suppliers, customers or investors, they do provide various forms of important infrastructure for the firm and in turn are impacted directly by tax revenues and physical environmental protection (or degradation) (Hillman and Keim, 2001).

Primary stakeholders

Shareholders/investors Employees

Customers Governments Communities

Textbox 1. Clarkson's (1995, p. 106) definition of primary stakeholders, definition also applied in this thesis.

Clarkson (1995) asserts, "the survival and continuing profitability of the corporation depends upon its ability to fulfill its economic and social purpose, which is to create and distribute wealth or value sufficient to ensure that each primary stakeholder group (Textbox 1) continues as part of the corporation's stakeholder system" (Clarkson, 1995, p. 107). Thus, an organization can be viewed as a set of interdependent relationships among primary stakeholders (Greenley and Foxall, 1996; Donaldson and Preston, 1995; Jones, 1995; Harrison and St. John, 1994; Hill and Jones, 1992; Kotter and Heskett, 1992; Evan and Freeman, 1988; Chakravarthy, 1986). For example, purchasing a quality product at a reasonable price is a consumer objective. If desired value is not delivered, fewer products will

be purchased. This, in turn, affects present and future expectations resulting in lower stock prices, possibly leading to lay-offs, reductions in purchases of inputs from suppliers, and lower taxes being paid by the firm, etc. meaning negative consequences for all primary stakeholders. Managing relationships with primary stakeholders, however, can result in much more than just their continued participation in the firm.

Effective stakeholder management relations with primary stakeholders to include customers, employees, suppliers, community residents and the environment - can constitute intangible, socially complex resources that may enhance firms' ability to outperform competitors in terms of long-term value creation. The resource-based view of the firm (Barney, 1991; Wernerfelt, 1984; Penrose, 1959) contends that a firm's ability to perform better than the competition depends on the unique interplay of human, organizational, and physical resources over time (Amit and Schoemaker, 1993; Barney, 1991; Dierickx and Cool, 1989; Lippman and Rumelt, 1982). Many scholars now argue that intangible, difficult-to-replicate resources must undergird the business processes if a firm is to outperform its rivals and create value for shareholders (Teece, 1998; Atkinson *et al.,* 1997; Barney, 1991).

According to Barney (1991) resources that are most likely to lead to competitive advantage are those that meet following four criteria:

- Valuable
- Rare
- Inimitable
- The firm must be organized to deploy these resources effectively

Using these criteria, resources that may lead to competitive advantages include socially complex and causally ambiguous resources such as reputation, corporate culture, long-term relationships with suppliers and customers, and knowledge assets (Teece, 1998; Leonard, 1995; Barney, 1986). Some strategy researchers have explored the firm as an institutional setting that can facilitate learning and the creation and dissemination of value-producing knowledge (Nahapiet and Ghoshal, 1998; Grant, 1996; Moran and Ghoshal, 1996; Spender, 1996). This institutional context can include, for example, a history of repeat dealings with actors such as employees, customers, suppliers, and local communities that generate reputational capital and trust (Barney and Hansen, 1994; Ring and Van de Ven, 1992, 1994). By developing longer-term relationships with primary stakeholders like customers, suppliers, and communities, as well as present and future employees, firms expand the set of *value-creating exchanges* with these groups beyond that which would be possible with interactions limited to market transactions. The emphasis in this case study is in the value that can be created by interactions, between firms and primary stakeholders, which are *relational* rather than transactional since transactional interactions can be easily duplicated and thus offer little potential for competitive advantage.

Communicating with the stakeholders of a company is an important part of successful stakeholder management (*Ibid*). Corporate communication includes internal and external communication and can be expressed in annual reports, press releases, internal magazines, business cards and logotype- everything with the purpose of reaching different stakeholders using valid benchmarks. How to find these valid benchmarks and metrics among others related topics will be addressed in the next chapter.

3.2 A benchmarking approach

The use of metrics for benchmarking enables managers to determine where the greatest opportunities for improvement exist in their current operations (Schwarz *et al.*, 2002, p. 60).

The development of metrics that relate environmental and economic performance for production processes is an excellent way for many companies to begin to incorporate the goal of sustainability into managerial decision-making. Therefore, metrics will further be described and explained in the development of the possessed benchmarks in this case study.

3.2.1 The use of metrics in reporting to stakeholders

Companies that incorporate the views of external parties into how they manage sustainability issues, and how they incorporate stakeholder concern into their business processes, demonstrate an understanding of how their operations fit a larger society (Stratos, 2007).

The development of metrics that relate environmental and economic performance for production processes is an excellent way for many companies to begin to incorporate the goal of sustainability into management decision-making. Also linking the business concept of creating value with environmental performance is important. This is according to Schwarz *et al.,* (2002, p. 58) known as "eco-efficiency". A management strategy that incorporates eco-efficiency strives to create more value with less impact. It enables more efficient production processes and the creation of better products and services, while reducing resource use, waste and pollution along the entire value chain (*Ibid*).

A common temptation in designing metrics is to take into consideration too many factors (Schwarz *et al.,* 2002). Measurements that combine too many components are actually less versatile and less useful for making comparison across products and industries. Therefore, it is best to have a core set of simple, widely applicable metrics and to construct complementary metrics within each subgroup.

Metrics provide a cost-effective means for tracking how well a company is doing in the key impact areas and for communicating that information to a variety of audiences. While many companies originally engaged in CR to protect their reputations, they have increasingly begun to understand that responsible and sustainable practices enable companies to effectively manage risk and create new business opportunities (Edelman, 2008). A company's social and environmental impacts, as well as its treatment of employees across the supply chain, feed directly into stakeholder perceptions. It is a matter of trust. And over the past few years it has become increasingly clear that trust is critical to market performance and stakeholder value.

3.2.2 Policy and certification systems as benchmarks

To date, the major approaches taken by government authorities within the major aquaculture-producing countries for minimizing or reducing the potential negative feed related environmental impacts of farm effluents is to acknowledge there is no single solution (Tacon and Forster, 2003, p. 181-189). "A well recognized, widely accepted certification system does not yet exist for marine aquaculture products" (Pittenger *et al.,* 2007, p.7). The diversity of policy options reflects the wide variety of farming systems and species cultivated around the world and the different approaches used by government authorities and/or farming

associations to deal with the discharge of effluents and wastewaters from their aquaculture operations.
”This is a concern shared by both producers and environmentalists as aquaculture’s share of the market grows” (Pittenger *et al*., 2007, p. 108). Instead ”private sector initiatives increasingly provide a public relations advantage, which may create market advantage but is also related to “goodwill” - an intangible asset valued by business independent of financial rewards” (Pittenger *et al*., 2007, p. 104).

”Private sector initiatives, such as eco-labeling and certification have the potential to significantly improve the sustainability of aquaculture production practices” (Pittenger *et al*., 2007, p. 110). Sustainability can be promoted by controlling the vast power of the marketplace, compensate good action regarding the environment, and require that programs offers indulcements for environmental fortification that authorities cannot offer (*Ibid).* ”These methods are not a substitute for good environmental regulation and management, but they can complement and enhance the effectiveness of such measures. No one kind of demand-side program is a “silver bullet” for the marketplace” (Pittenger *et al*., 2007, p. 110).

Pittenger *et al.,* (2007, p. 110) further means that importance in accomplish these incentives may include ”high standards for sustainability achieved through practical and viable measures, strong verification procedures and compliance with standards, transparency and accessibility of the process to interested parties, and achieving and maintaining high consumer confidence in the label”. Further, the process for ”developing strong, credible certification programs, with requirements for transparency and broad agreement on standards, can be quite lengthy. Companies that profit by differentiating their brand and their products may wish to retain their own production standards. If developed collaboratively with conservation organizations, such standards often achieve considerable credibility” (*Ibid*). Product differentiation can be beneficial for the environment as well as the bottom line. ”Companies that wish to truly distinguish themselves on the basis of their environmental stewardship may push for more stringent production standards than a consensus-based certification program” (*Ibid*), e.g. LEED Certification[3]. ”Individual private sector programs are nimble and can be “laboratories” for innovation. In short, while the development of certification systems for aquaculture is highly desirable, other programs to differentiate environmentally preferable farmed seafood in the marketplace may prove valuable catalysts for better production practices. Different approaches can be bridged at least in part by encouraging representatives from individual private sector programs to bring their experiences to the development of broad certification programs” (*Ibid*).

Roheim (2003) has identified and said there are four major beneficiaries of successful eco-labeling programs. First, marine fisheries and surrounding ecosystems benefit from the establishment of sustainable management practices. Second, consumers benefit from receiving more information on the seafood products, which they consume, allowing them to make more informed purchasing decisions. Third, producers of eco-labeled seafood products benefit from potentially higher prices, due to the ability to differentiate their products. And finally, the fishing industry itself benefits from operating in a sustainable and well-managed framework designed to preserve both the resource and the industry.

[3] LEED (Leadership in Energy and Environmental Design) certification, a green building certification process developed by the U.S. Green Building Council (USGBC), can serve as a template for how a new food label should operate. LEED is a voluntary, consensus-based national rating system for developing high-performance, sustainable buildings (www, USGBC, 2008).

Pittenger *et al.* (2007, p. 103) means that ”the rationale for labeling is to connect products in the marketplace with production practices”, as an example of this is the community protest concerning the assassination of dolphins by some tuna fishing practices. This further developed in a dolphin-safe classification and label for canned tuna. This kind of labeling can then offer supplementary information to the end user about their preferences in the marketplace (Pittenger *et al.,* 2007).

When it comes to consumers' choice of purchase, they are gradually more looking to product labels to support them, making a purchases more based on environmental and social matter (Pittenger *et al.,* 2007; Wessells *et al.,* 1999).

3.2.3 Existing policies and guidelines aimed at reducing environment impacts in aquaculture

Even though more than two-dozen standards or certification programs for aquaculture exist (www, WWF, 2009) none of the programs are effective at making the aquaculture industry more sustainable. Governance structures that are in compliance with International Social and Environmental Accreditation and Labeling (ISEAL) Alliance's guidelines for certification programs – the world's most reputable guidelines for addressing social and environmental issues *(Ibid)* have also been unable to make the industry sustainable. Even fewer are useful and suitable for farming the KBWF's yellowtail fish, *Kona Kampachi*®, in Latin named *Seriola Rivoliana.* To this yellowtail family other fishes like Almaco Jack, Hamachi and Kahala should be named and where guidelines also are absent.

The few guidelines on the market that is useful for farming open ocean yellowtail currently comes from Blue Ocean Institute, WWF, FAO- Code of Conduct and the Clean Water Act. Below is a short presentation of each of them.

*Blue Ocean Institute (*www, Blueocean, 1, 2009) has a well-regarded “Guide to Ocean-Friendly Seafood” Blue Ocean Institute's seafood program helps *stakeholders* discover the connection between a healthy ocean, fishing, and seafood. BOI products and publications aim to increase consumer understanding to drive extensive demand for sustainable seafood. BOI also encourage seafood industry retailers and restaurateurs to implement sustainable seafood practices. In BOI's, *Guide to Ocean Friendly Seafood,* stakeholders can find the first comprehensive seafood analysis and ranking methodology. BOI uses a color-coded ranking of popular seafood. It focuses on evaluating species' life history, abundance in the wild, habitat concerns, and catch method or farming system. The analysis also includes health advisory information. All this information makes it transparent and easy for the stakeholders to understand and use the information.

The criteria for BOI's guidelines include (*Ibid*):

- ”Limiting the use of fishmeal and fish oil in feed”
- ”Implementing measures to prevent escapes”
- ”Minimizing or eliminating drug use”
- ”Reducing incidents of disease and parasites”
- ”Reducing water pollution”
- ”Monitoring and reducing the impacts on the sea floor”
- ”Prohibiting the killing or harassment of marine wildlife”

When the *World Wildlife Fund (WWF*) began an initiative in 2004 to develop a sustainable aquaculture certification program, they approached the problem by opening up dialogues with the multistakeholders. WWF anticipate this dialogue as a way to inform people of the development of the best management practices and the development of standards for a certification system. The standards created by the Aquaculture Dialogue will be credible because it will be:

- *Science-based:* The Dialogue standards are being developed with input from the world's leading aquaculture scientists and will be updated over time to reflect the newest scientific findings.
- *Performance-based:* The standards will not tell producers what practices to use to reduce or eliminate the impacts of aquaculture. Rather, the standards will provide targets to reach if producers want to address the impacts. How they do so will be their choice. This will encourage innovation and continual improvement by the farm.
- *Metrics-based:* By being measurable, the standards will be objective and therefore more credible.

This standard is created by a diverse and balanced group of stakeholders. It is also compliant with the International Social and Environmental Accreditation and Labeling Alliance.

The goal of the Dialogues is to create draft standards for 12 aquaculture species (salmon, shrimp, tilapia, trout, pangasius*, Seriola*, cobia, abalone, mussels, clams, oysters and scallops) by the beginning of 2010. When finalized, the standards will be given to a new organization, to be co-founded by WWF, which will be responsible for working with independent, third party entities to certify farms that are in compliance with the standards (WWF, 2009). With minor exceptions, the standards will focus on quantitative performance levels that farmers must reach to become certified. More than 2,000 aquaculture producers, conservationists, scientists and others are involved in the process, which is coordinated by World Wildlife Fund (WWF). The first sets of standards, for tilapia and pangasius, are to be completed in 2009 and the remainder will be finalized in 2010 *(Ibid)*.

FAO, Code of Conduct, is another trusted source of guidelines for the aquaculture. Following is to be found at the fisheries and aquaculture department (FAO) (www, FAO, 1, 2009): "Fisheries, including aquaculture, provide a vital source of food, employment, recreation, trade and economic well-being for people throughout the world, both for present and future generations and should therefore be conducted in a responsible manner. National and international fisheries policies and management practices that better reflect the principles of the Code of Conduct will lead to an improved and sustainable economic, social and environmental contribution of the fisheries sector. The optimization of the contribution of fisheries to achieving benefits in terms of food, employment, recreation and trade as well as ecosystem and socio-economic well- being will benefit populations throughout the world". The Code of Conduct also gives information (Appendix 3) for a responsible aquaculture production development.

By using the existing authority under *the Clean Water Act* (Appendix 2) the growth of marine aquaculture ought not to degrade the marine waterquality or the health of marine ecosystems (Pittenger *et al*., 2007). The Clean Water Act offers a selection of tools to make sure that marine environmental quality is not tainted by emission of pollutants, which may contain live organisms and their gametes, from marine aquaculture facilities (Pittenger *et al.,* 2007). Totaling, discharges to marine waters under both federal and state jurisdiction must obey

principles intended to preclude degradation of the environmental quality of marine waters (Appendix 2). Notably, these ocean emission's criteria have not been revised since 1980, regardless of the substantial development since that time. However, to efficiently communicate existing and useful benchmarks, guidelines, certification programs and other efforts that are made in the progress towards a sustainable aquaculture, will be presented in the next sub chapter.

3.3 The communication process

Communication is defined as the process by which information is transmitted and understood between two or more people (McShane and Von Glinow, 2003).

3.3.1 Importance of creating an image

The model of communication that is regarded as the classical communication model was developed in the 40s and has been modified and altered by later scholars (Larsson, 1997). The classical communication model describes five elements: the sender, message, channels, receiver and feedback. The communication is expected to result in some kind of effect and the notion of noise or disturbance was mentioned as a part of this early theory. A version of the model is shown in Figure 2 (Kotler, 2003, p. 565; McShane and Von Glinow, 2003, p. 324; Larsson, 1997, p. 45). Information flows through the channels from the sender to the receiver and there will be feedback from the receiver to the sender, which is a confirmation of the message being received.

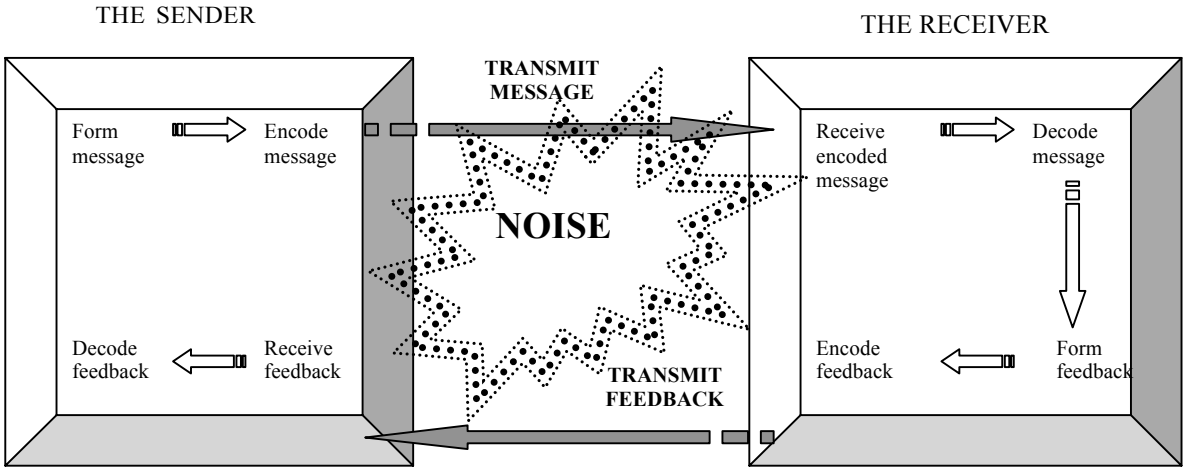


Figure 2. The developed communication model (Kotler, 2003, p. 565; McShane and Von Glinow, 2003, p. 324; Larsson, 1997, p. 45, with minor modifications). It shows the many steps in the communication process and how difficult it is have a common understanding of the intended message.

The model (Figure 2) shows that if any part of the communication process is distorted or broken, the sender and the receiver will not have a common understanding of the message. Despite the best intentions of the sender of the communication, the barriers might hinder the purpose and effect of the intended message. It is important for the sender of a message not to take for granted that the message has been successfully transmitted and perceived, just by sending the message. It is an illusion that a communication process is accomplished by the first step. There are many barriers in a communication process referred to as noise in the

model above (Figure 2). Differences in perceptions, filtering, languages and the phenomena of information overload are examples of communication barriers according to McShane & Von Glinow (2003). Information overload means a condition in which the volume of information received exceeds the person's capacity to process it.

To proceed with the information in different ways, according to Davidson (2005, p. 158-160), there are several different ways organizations communicate. Davidson divides these ways into eight groups:

- *Action*- this is what the organization does. There are hundreds or thousands of actions each day.
- *Behavior* – describes how things are done, how people treat others, especially colleagues and customers. It changes daily in every organization.
- *Face to face management*- covers talks, meetings, debate, one-to-one conversations and questions asked.
- *Signals*- are actions or objects, which convey information about an organization.
- *Products and services- quality and style* embody the organization's vision and values. Poor quality or service says people don't care.
- *Advertising*- covers the whole gamut of paid-for communication. While advertising output is planned and controlled, reaction to it, is not.
- *Word of mouth and word of web* (including e-mail)- next to action and behavior, this is the most important way organizations communicate. It is heavily influenced by the other seven ways.
- *Comments by other organizations*- such as the media, pressure groups, governments.

The way to communicate, also understood as the phenomenon of branding is not new in the business community, but the awareness of its strategic value has developed considerably (Kay, 2006; Riezebos, 2003; Keller, 2001; Arnold, 1993).

The concept of branding became highly discussed in the late 1980s and it has since been a strategic issue for companies with a market oriented approach (Arnold, 1993).

3.3.2 Company brand and reputation

The definition of a brand is according to Kotler (2000) and the American Marketing Association "a name, term, sign, symbol or design, or a combination of these, intended to identify the goods or services of one seller or a group of sellers and to differentiate them from those of competitors" (Keller, 1998, p. 37). The basic function of a brand is to help the customer identify the suppliers and simplify the selection among the multiple choices on a market. This way of explaining the function of a brand is regarded to be a mechanical aspect of product differentiation and a extended way of describing the function of a brand is to explain it as a personality of a product, making the customers emotionally attached and loyal to the company (Arnold, 1993).

Understanding the possibilities and managing the risks of communication a company can create a strong brand (Kotler, 2003; Keller, 2001). The main idea of branding is that everything a company does communicates and that successful brand management will secure the position of the company's products in the mind of the customer. Users and companies' do not only have different knowledge bases, but also different languages, values, and coding schemes (Hoffmann, 2008).

3.3.3 A Communication-Based Marketing Model for Managing Relationships

Because stakeholder relationships are influenced heavily by messages from and to a company, a brand relationship-building model should consider brand messages from all internal sources. Figure 3 illustrates this model and shows the corporate, marketing, and marketing communication levels (Duncan and Moriarty, 1998, p. 9). Figure 3 also illustrates the interactivity between the various message sources in an organization and the various stakeholders of the organization *(Ibid)*. Because most organizational communication dimensions (other than marketing communication) are ignored, not recognized, or taken for granted, brand messages that originate at the corporate and marketing levels often are not managed strategically. Even marketing communication messages, especially in larger companies that have separate departments and agencies for each of the marketing communication functions, are often a mixed assortment of messages and images. For example, advertising messages could promise quality, sales promotion messages could promise bargains, and product publicity releases could discuss product safety.

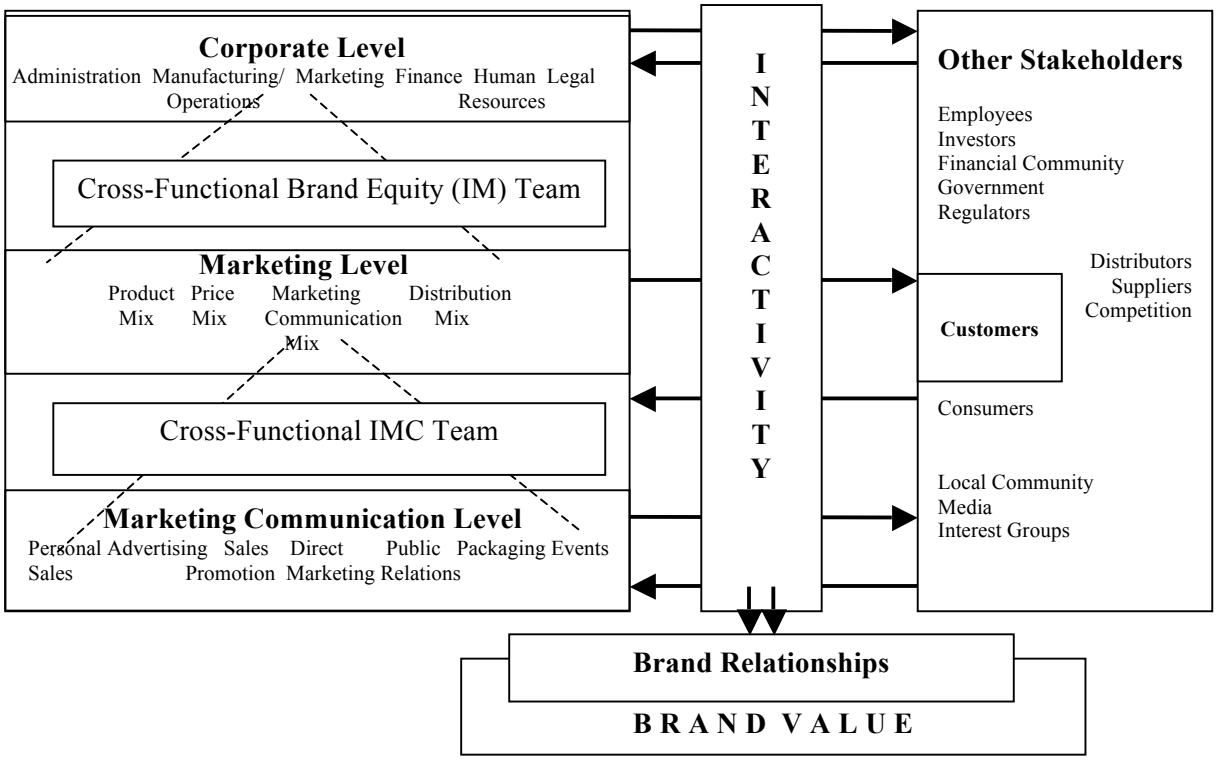


Figure 3. A communication-based marketing model for managing relationships (Duncan and Moriarty, 1998, p. 9) with minor modifications. The illustration shows the interactivity between the various message sources in an organization and the various stakeholders of the organization.

Even when a company does manage to achieve strategic consistency at the marketing communication level, these messages might have far less impact than brand messages coming from other marketing functions and corporate areas, not to mention brand messages originating outside the company (from customers, the media, and the competition).
The social and associational nature of marketing and business in general depends on relationships. Not only has communication always played a role in attracting and keeping

customers (and other stakeholders), but also with advances in new media and computer technologies, the benefits of understanding and applying communication theory and strategies to marketing have never been greater. A communication-based model of marketing recognizes that the management of communication that builds brand value involves more than traditional marketing communication. Planning tools such as brand message audits, contact point analysis, and stakeholder maps are needed to identify message fractures, ignored stakeholders, and points of message confusion. An appreciation of the complexities of brand communication makes it possible to understand the structural changes needed to facilitate cross-functional planning and monitoring of all brand messages. When this understanding exists, a company can apply this communication-based model of marketing more easily to deliver more effective relationship- building programs. The big challenge in communicating corporate values expressed in strategies and every day procedures to stakeholders is all the variety of interests and expectations (Mark-Herbert and von Schantz, 2007; Whitehouse, 2006). This implication will be expressed in the next subchapter.

3.3.4 Implications in the communication process

The communication process thus implies that what a company "says" (brand character, an image) is not always what is perceived by the receiver (consumer insights, a profile) or based in product characteristics (Figure 4) (Pringle and Thompson, 1999, p. 155). The desired image must be supported through active communication. Senders and receivers of information create a picture that is a labeled profile. Senders of information may include any stakeholder, sharing information (Mark- Herbert, 2007). But it is important to remember in positioning a brand, the ideal situation (Pringle and Thompson, 1999, p. 155) is a large territory (Figure 4), which from a consumer perspective refers to a brand that provides the anticipated values.

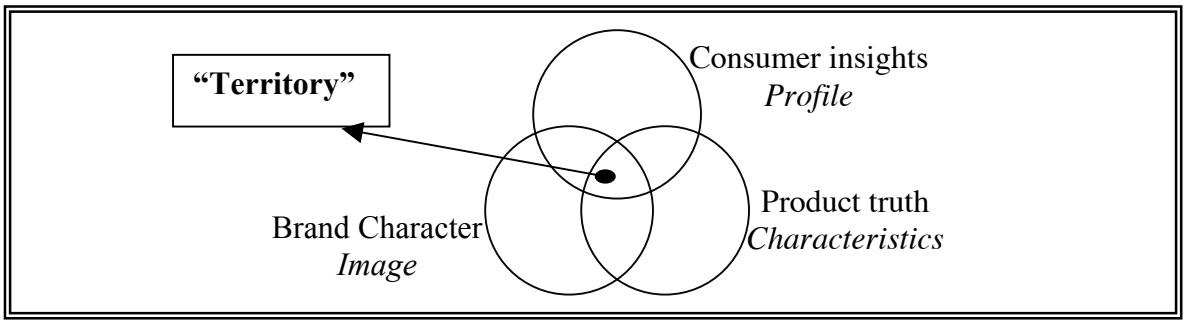


Figure 4. The term "territory" explains the common grounds for perceptions of a brand (Pringle and Thompson, 1999, p. 155). In positioning a brand, the ideal situation is a large territory, which from a consumer perspective refers to a brand that provides the anticipated values.

The key point is that the sender of a message must make active choices in communications and evaluate the outcome in a long-term perspective, above and beyond sales statistics to establish a solid, (preferably bigger) territory (Figure 4) for building a corporate image (Ibid).

How to implement sustainably benchmarks in the preferably bigger territory while communicating a company's environmental stewardship is a delicate but problematic question.

4 Empirical Background

This chapter explores the aquaculture industry and more specifically the open ocean aquaculture farming. Also the need and supply of fishmeal and fishoil is covered in a global perspective. Furthermore the idea of implementing a more sustainable replacement for fishmeal and fishoil such as soybean meal is discussed. The effect on waterbodies from cage farming in the open ocean is also explained.

It is announced by the U.N. Food and Agriculture Organization (FAO), most capture fisheries are exploited and have been over fished (FAO, 2004). Still the request for seafood is expected to increase in the future (Pittenger *et al.,* 2007; FAO, 2004). The aquaculture production worldwide is growing (Figure 5) and will likely continue to do so in the foreseeable future (www, FishStat, 2008). However, the production of many aquaculture species depends on the wild fisheries (captures). Some of the wild fish, from the wild fisheries (captures) are transformed and used as fishmeal and fishoil for the farmed fish. This poses a potential sustainability problem for the aquaculture industry.

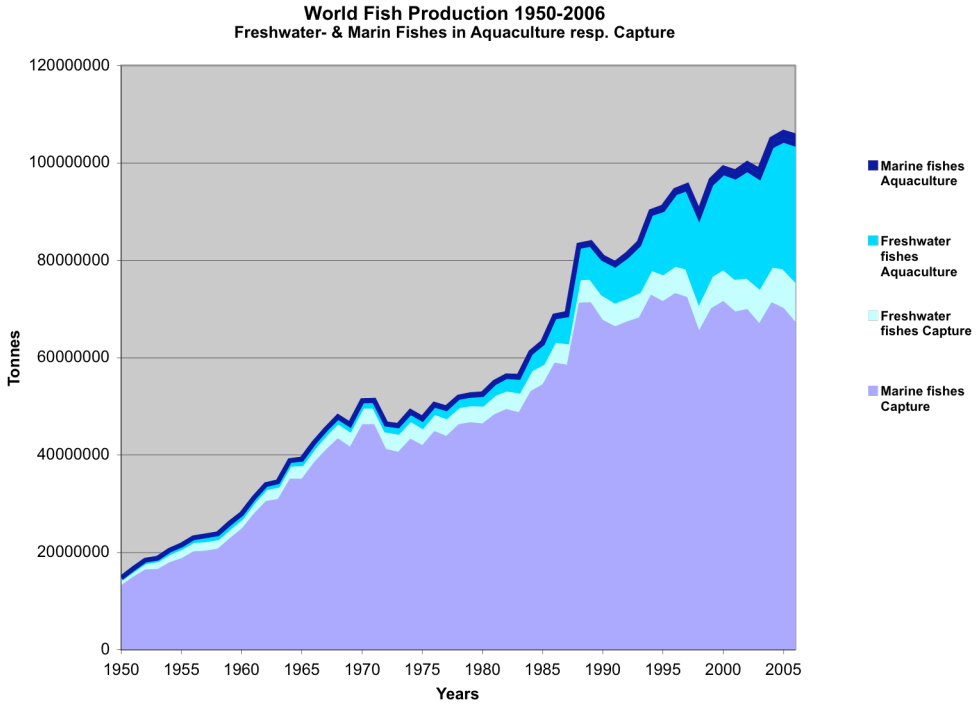


Figure 5. World Fish production 1950-2006. The world fish supply has steadily increased but if it hadn't been for the Aquaculture (both fresh and marine waters) the last twenty years- the supply increasement should only have been moderate. (Source: www, FishStat, 2008).

With the detected grows (Figure 5), the concern is that aquaculture has limited opportunity to substitute fishmeal[4] with vegetable protein sources and that the limited supply of fishmeal

[4] Fish meal: ingredients typically made from small pelagic fish, such as sardines and anchovies, further caught for this purpose

may restrict future development of the aquaculture industry and the result in over fishing of the small pelagics used in fishmeal (Kristofferson and Anderson, 2005).

Not only is the fishmeal and fishoil supply a greatly discussed question, as the marine finfish is growing. a range of measures - such as appropriate *siting*, devotion to *best management practices*, *enhanced feed formulations* and *integrated aquaculture*—will crucial become of major importance to ensure minimal impact on waterquality (Pittenger *et al.,* 2007).

In this thesis the sustainably growth in the open ocean aquaculture sector is with respect only to feed formulation and its impact on water. Currently there are no waterquality standards for federal marine waters. ”Most states in the U. S have marine waterquality standards, but it is not known whether these standards are sufficient to protect marine environmental health” (Pittenger *et al.,* 2007, p. 84). The ocean emission criteria (Appendix 2) developed by the Clean Water Act offer a correlated, but separate, tool for protecting the marine waterquality (Pittenger *et al.,* 2007).

4.1 What is marine aquaculture?

Jacques Cousteau (1973) may had said, “…we must turn to the sea with new understanding and new technology. We need to farm it as we farm the land…” (www, NOAA, 2008:1). Maybe he was right? Only the future can tell.

“The broad term “aquaculture” refers to the breeding, rearing, and harvesting of plants and animals in all types of water environments, including but not limited to ponds, rivers, lakes, and the ocean” (www, NOAA, 1, 2008). “Similar to agriculture, aquaculture can take place in the natural environment or in a manmade environment. Using aquaculture techniques and technologies, researchers and the aquaculture industry are growing, producing, culturing and farming all types of freshwater and marine species” (*Ibid*). Marine aquaculture production comprises clams, mussels, oysters, salmon and shrimp, while freshwater aquaculture operations produce catfish, tilapia and trout *(Ibid)*.

The most important Federal agency on marine aquaculture when it comes to regulatory and policy matters (the National Oceanic and Atmospheric Administration (NOAA) identify aquaculture as “the propagation and rearing of aquatic organisms in controlled or selected aquatic environments for any commercial, recreational, or public purpose” (www, NOAA, 1, 2008). This definition of aquaculture was established in 1998 in Policy Program *(Ibid)*.

4.2 The industry's need for fishmeal

The growth in the marine fish industry (Figure 6) has certainly created a bigger demand for fishmeal and fishoil as a feed source (www, FishStat, 2008; Tacon *et al.,* 2008, p. 150-153).

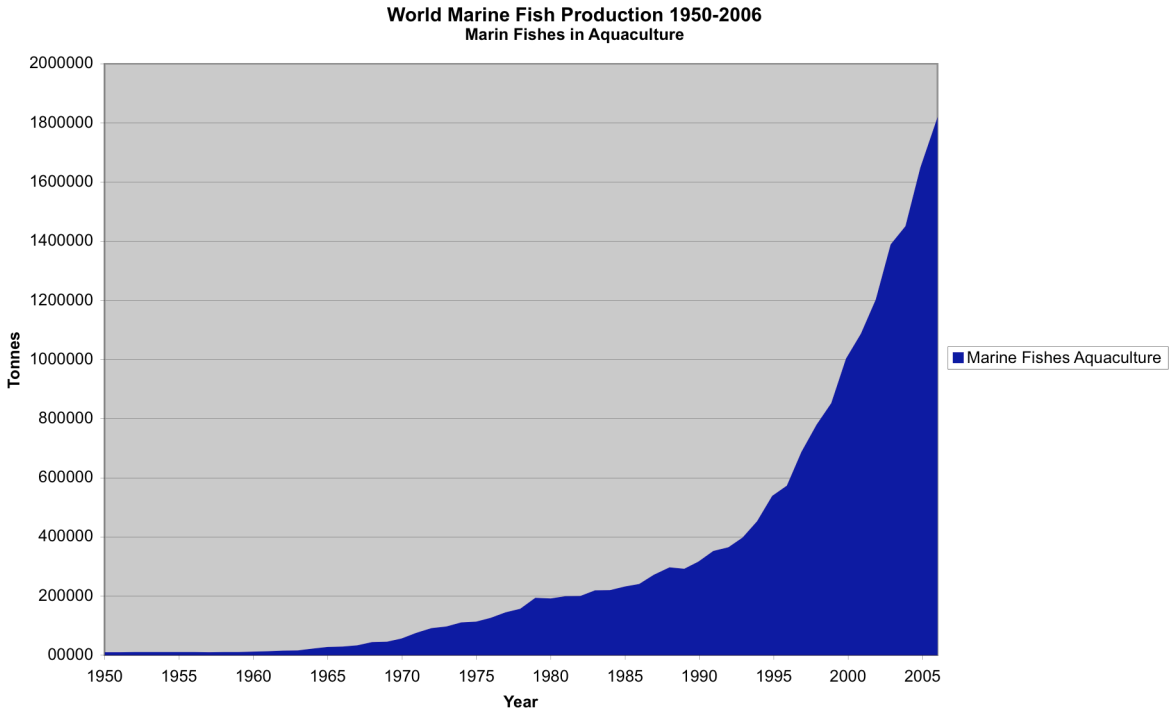


Figure 6. The growth in world marine fish production 1950-2006. The rapid growth in the marine fish production has not only made a higher supply possible but also increased the industries demand for fishmeal and fishoil as a feed source (www, FishStat, 2008). To continuing the fast growth, the industry therefore needs to find alternative feed sources that are suitable and environmentally sustainable.

Fishmeal has historically been considered as the most important protein source for use in aquaculture diets for both carnivorous and omnivorous species, and many aquaculture formulations still have fishmeal included at a level exceeding 50% in marine diets (Glencross *et al*., 2007, p. 18). By the exploding growth in the World Marine Fish Production (Figure 6)

"Despite being the smallest sector for major farmed animal feeds, aquaculture is the largest consumer of two common ingredients in many animal feeds: fishmeal and fish oil" (Pittenger *et al.,* 2007, p. 102). Hertrampf and Piedad-Pascual (2000), further means these ingredients provide an exceptional basis of animal protein, omega-3 fatty acids, essential amino acids, vitamins and minerals as well as energy.

It is know carnivorous species have precise dietary necessities for essential fatty acids, trace minerals and high levels of protein (Hardy *et al.,* 2001). These dietary necessities are obtainable in fishmeal and fish oil, further increasing the obvious high dependency of these ingredients for carnivorous species in the aquaculture production (*Ibid*). "Marine species represent about 25 percent of global aquaculture production yet they consume more than 75 percent of the fishmeal and fishoil used in aquaculture" (Pittenger *et al.,* 2007, p. 92).

Why do fish need fishmeal and fishoil? To answer this question it has to be understood that for wild Marine fish, the key source of protein and energy just comes from other kinds of fish in their surrounding environment. But when farming fish, this protein and energy source is limited and therefore the farmed fish need to be fed by other kind of wild fish, caught by reduction fisheries.

The usage of fishmeal and fish oil in the diets of animals is not a haphazard decision made by producers and feed manufacturers. "Fishmeal is an excellent source of high quality proteins and long chain omega-3 fatty acids, including EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid)" (www, NOAA, 1, 2008).

Also, both DHA and EPA offer necessary health benefits such as cardiovascular health, improved cellular function as well as overall brain and nervous system function. Fishmeal also offers the essential amino acids in a great digestible form (*Ibid*).

According to NOAA (*Ibid*), fishmeal usage in all types of farmed fish shows:

- growth rates
- enhancements in feed conversion ratios
- lower allergic reactions
- improvements in disease resistance

Further, according to Seierstad *et al*., (2005); Eliseo *et al*., (2002); Kris-Etherton *et al*., (2002); Connor, (2000) and Kromhout *et al*., (1985), the utilization of omega-3 fatty acids is also favorable to humans, particularly with respect to cardiovascular health.

4.2.1 Supply and demand for fishmeal and fishoil in a global perspective

"Global catches of wild fish have leveled off in recent years" (Pittenger *et al*., 2007, p.9). "The ability to catch fish has simply exceeded the capacity of marine ecosystems to produce them. Most of the reduction fisheries that produce fishmeal and fish oil have reached, or in some cases exceeded, sustainable harvest levels. To fill this gap, governments and the seafood industry are increasingly looking to aquaculture" (*Ibid*).

The annual global fishmeal production is in the range of 6 - 7 million tons of fishmeal and a little under 1 million tons of fish oil except during the periodic El Niño years (IFFO, 2005). This requires an annual catch of 25 - 30 million tons of feed-grade fish and unwanted fish processing waste; in other words 4 - 5 kilos of wet fish yield 1 kilo of fish oil and dry fishmeal *(Ibid)*.

Compared to the 1940's, global fishmeal production was about one million tons per year. Production increased after World War II, reaching 2 million tons per early 1960's year by the (www, IFFO, 1, 2008). It was in the 1960's and 1970's when the fishmeal industry expanded in Peru, Chile, Iceland, Denmark, Norway, South Africa and other countries. Fishmeal production increased until the mid-1980's, and has been relatively constant at 6-7 million tons since then[5]. The major producers of fishmeal nowadays are: Peru (28 % in 2003), Chile, China, Thailand, USA, Japan and Scandinavia. "In Peru, the major species harvested are anchovy (*Engraulis ringens*) and jack mackerel (*Trachurus symmetricus*)" (www, NOAA, 1, 2008; www, FIN, 2, 2008). "According to the Fishmeal Information Network 2005 (FIN),

[5] Harvest levels can fluctuate significantly during El Niño events

there are approximately 400 dedicated fishmeal plants that produce about 6.3 million tons of fishmeal and 1.1 million tons of oil annually from about 33 million tons of whole fish and trimmings" (www, NOAA, 1, 2008). Based upon estimations made by Pike (2005, p. 38-40), calculations show that "the aquaculture sector consumed 46 % of the fishmeal and 81 % of the fish oil produced in the global production 2002". By 2012, Pike (2005, p. 38-40) also "estimates that the percentage of fishmeal consumed by the aquaculture sector will be 50% and the percentage of fish oil comprising aquafeeds will be 88%". These approximations are a prediction of the global fishmeal (6.0 million tons) and fish oil (1.1 million tons) production in 2012 (*Ibid*).

On the basis of a survey and previous available estimates from Tacon *et al.* (2006) and IFFO (Jackson, 2006, 2007), Tacon *et al.* (2008, p. 150-153) constructed new calculations with help from data from FAO concerning the current global use and estimated demand for fishmeal and fishoil within compound aquafeeds from 1995 to 2020. Their findings and prediction are shown in the graph below (Figure 7 and 8).

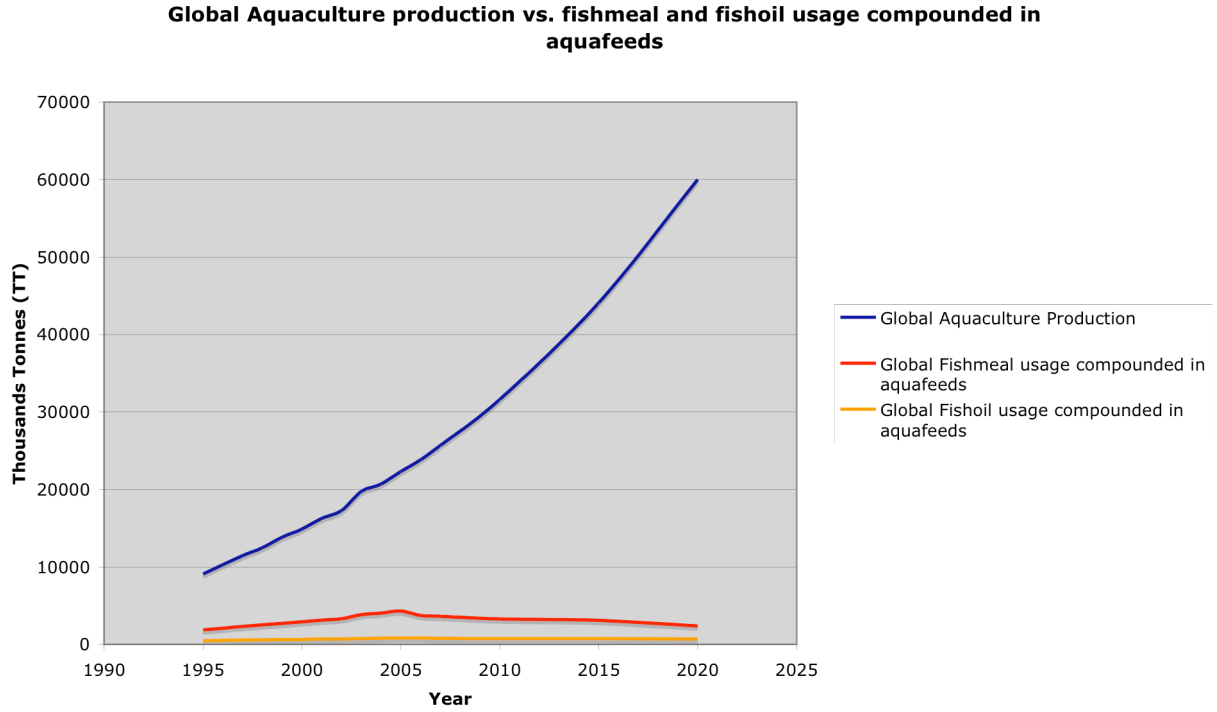


Figure 7. The global aquaculture production vs. the fishmeal and fishoil usage compounded in aquafeeds. Based on Tacon et al., (2008, p. 150-153) earlier calculations as well as other contributors[6], the prediction of global aquaculture production may increasing over the next 10 years by at least 200 percent but where the fishmeal and fishoil production slowly have been decreasing and cannot catch up with the fast growing aquaculture industry. This implies an interesting and great potential to find an alternative feed source for the future.

The prediction of global aquaculture production may increasing over the next 10 years by at least 200 percent but where the fishmeal and fishoil production slowly have been decreasing

6 . Tacon (1998), Tacon and Barg (2000), Tacon and Forster (2001), Tacon (2003), Tacon (2004), Tacon *et al.* (2006) and the International Fishmeal and Fish Oil Organization: IFOMA (2000) and Jackson (2006).

and cannot catch up with the fast growing aquaculture industry. This implies an interesting and great potential to find an alternative feed source for the future.

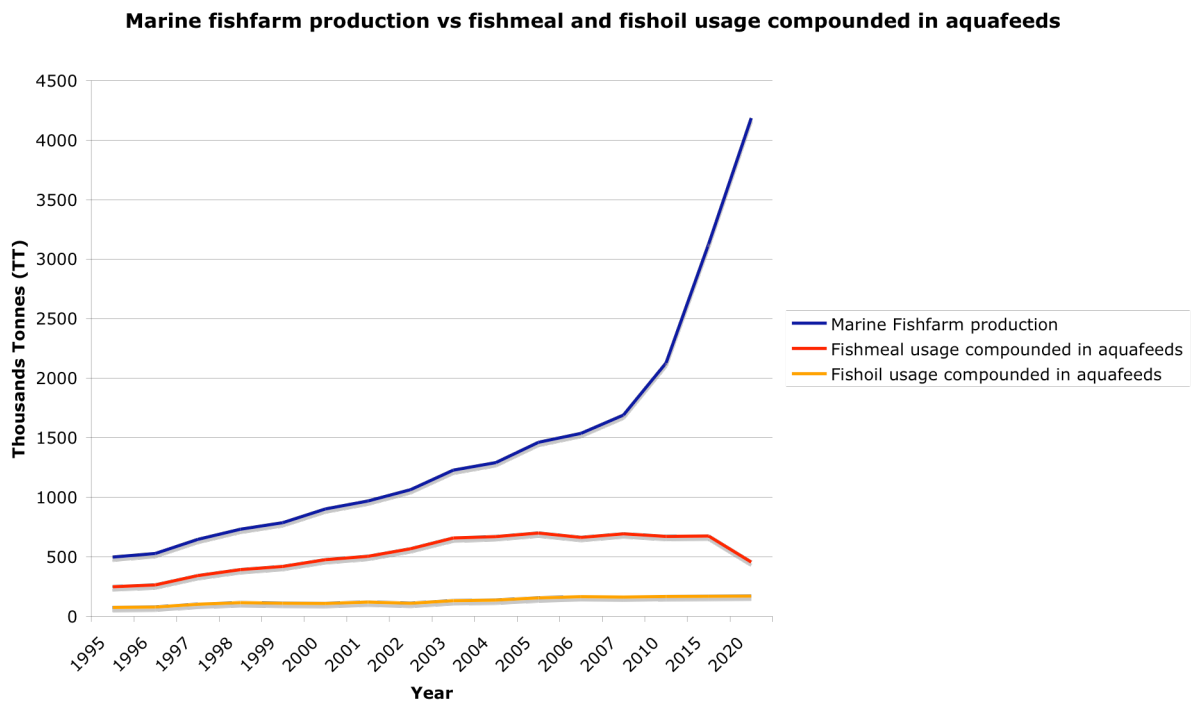


Figure 8. The marine fish farm production vs. fishmeal and fishoil usage compounded in aquafeeds. Based on Tacon's et al., (2008, p. 150-153) earlier calculations as well as other contributors[5]*, the marine fish farm industry is increasing and will continuing to do so the next 10 years and where the fishmeal product has started to decline. This emerging situation could greatly be dealt with by using more alternative fishfeed such as soybean products. Research needs to be paid attention so further results can contributes to find the most suitable percentage of this ingredience.*

This emerging situation could greatly be dealt with by using more alternative fishfeed such as soybean products. Research needs to be paid attention so further results can contributes to find the most suitable percentage of this ingredience.

The new reported data shows a significant increase in current fishmeal and fishoil use (compared with previous estimates by Tacon and IFFO) due to the increased global trends in aquaculture production (Figure 7 & 8). But the remaining question is how the gap between aquaculture's increased production and the supply of fishmeal and fishoil can been covered.

4.2.2 International market price for fish oil and fish meal

Tacon *et al.* (2008, p. 150-153) also signify the main reason for the global decrease in reported dietary fish meal and fish oil inclusion levels in compound aquafeeds has been due to the increasing global fish meal and fish oil prices since 2000; fish meal prices doubling from US $694 to US $1379 per ton between July 2005 and July 2006, and fish oil prices almost doubling from US $894 to US $1700 per ton between March 2007 and March 2008 (Figure 9).

Since 2000, an increase in price can be seen which further implies an alternative and more cost effective ingredience in the fish diet should be used (US $ per ton: Helga Josupeit, FAO Globefish Database, May 2008; Tacon et al., 2008, p. 150-153).

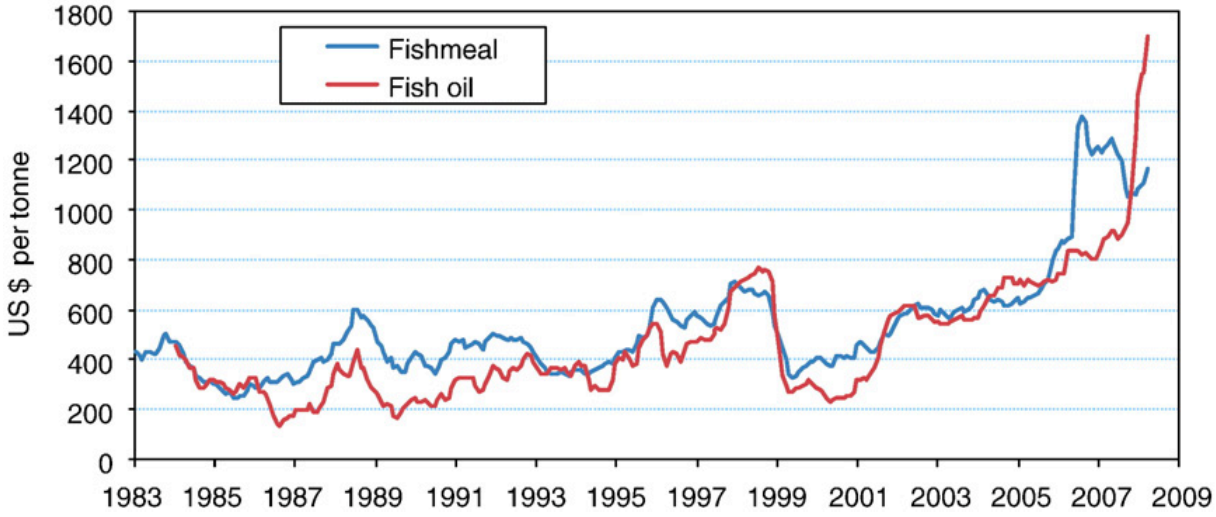


Figure 9. International market price for fish oil and fish meal (monthly average, 64/65 % crude protein), any origin, wholesale, CIF Hamburg. Since 2000, an increase in price can be seen which further implies an alternative and more cost effective ingredience in the fish diet should be used (US $ per ton: Helga Josupeit, FAO Globefish Database, May 2008; Tacon et al., 2008, p. 150-153).

The reason for these price increases (Figure 9) have been due to a combination of different factors, including static global supplies of fishmeal and fishoil, strong market demand for fishmeal and fishoil by the aquaculture and livestock sector in the major importing countries, and in particular China (FAO/Globefish, 2007; Gain, 2007; Hongjle, 2007; Tacon and Nates, 2007), and increasing key vegetable oil (rapeseed oil, soybean oil, palmoil) and global petroleum and energy prices (FAO, 2008; www, IFFO, 3, 2008).

”Although carnivorous fish have certain requirements for protein, energy, fatty acids, and micronutrients, as do all organisms, they are not physiologically dependent on fishmeal and oil in a farm situation” (Pittenger *et al.,* 2007, p. 92). Dietary necessities can be fulfilled by other sources *(Ibid).*

4.3 In the search for more sustainable fishfeed

In research made by Pittenger *et al*., (2007), it shows economics will drive the aquaculture industry in the direction of alternative feeds if low-cost and nutritionally alike substitutes for fishmeal and fish oil are established, ”Farmed fish have a dietary requirement for about 40 essential nutrients. Finding substitutes that meet the dietary requirements of farmed species will be critical in reducing aquaculture’s dependency on fishmeal and fish oil” (Pittenger *et al.,* 2007, p. 94).

Nutritional values of protein ingredients in fish feed are generally defined by their protein content and essential amino acid, (EAA). Ingredients to replace fishmeal and oil in aquafeeds are currently at various stages of research, but the development shows the following

ingredients may be used at a higher percentage in the future (Pittenger *et al.,* 2007): canola meal, pea protein concentrate, soybeanmeal, canola (rapeseed) oil, corn gluten meal, wheat gluten meal, soybean protein concentrate, poultry byproduct meal and poultry oil. ”A high degree of variation exists in the amount and types of materials that are substituted for fishmeal and oil, depending on the protein, energy, and nutrient requirements of the species. Successful substitution will require the resulting products contain essential nutrients, not including any “anti-nutrients” plus a good taste for the fish” (Pittenger *et al.,* 2007, p. 95).

In search for optional feed components, researchers must bear in mind the factors such as ”palatability”, ”quality”, ”digestibility”, ”availability” and ”cost” (Hardy, 1996). Researchers have successfully discovered substitutes that can totally alternate fishmeal in aquafeeds. ”However, there are currently no commercial alternatives to completely replace fish oil, which is a highly digestible source of energy for fish and an important factor in the nutritional value of the final product” (Tacon, 2005, p. 38). ”The main challenge in replacing fish oil is finding alternative sources of the long chain omega-3 fatty acids, DHA and EPA” (Pittenger *et al.,* 2007, p. 95).

”Possible land-based substitutes in the oil meal family include: rapeseed, soybean, corn gluten, wheat, gluten, and terrestrial byproduct meals that include meat meal, bone meal, feather meal and blood meal” (Tacon, 2004). Marine-based alternatives incorporate the use of small marine crustaceans, including krill, copepods, and algae (www, NOAA, 1, 2008). ”Other potential sources of fishmeal include the recycling of by-catch for use in production, as well as the use of fish processing byproducts, mainly the excess trimmings and wastes that result from processing fish for human consumption” (Shamshak and Anderson, 2005). In addition, bio-technological substitutes are in the early stages of development (www, NOAA, 1, 2008).

4.3.1 Using soybeanmeal as a substitute

Among the various protein sources available for fish feed today, defatted soybeanmeal is universally accepted, both qualitatively and quantitatively (Watanabe, 2002). Soybeanmeal is consistently available, cost-effective, and reported to be palatable for most fish species (Akiyama, 1988).

”Adding the vegetable-based soybeanmeal in the fish diet, its protein will provide the fish with important amino acids such as Omega 3[7] and essential nutrients, although not of the same caliber as fishmeal” (www, NOAA, 1, 2008). But among the various protein sources available for fish feed, defatted soybeanmeal is universally accepted for omnivores and herbivores – but not yet universally accepted for carnivores (either qualitatively nor quantitatively).

According to Akiyam (1988), soybeanmeal is consistently available, cost effective and reported to be palatable to most fish species. Upon considering these benefits, several attempts have been made to partially or totally replace fishmeal with soybeanmeal as a protein source and many results have shown that it is one of the most promising replacements (Watanabe, 2002).
Since fish feed generally include fishmeal and fish oil around 50 to 75 percent, any increases in the price of these commodities will increased the cost of the fishfeeds for the farm and further diminish the profitability (Pittenger *et al.,* 2007; Tacon, 2005).

[7] Omega 3 is necessary for brain functioning and also for development and progress of the fish body

As fishmeal and fish oil are commodities traded on international market, the cost of this product vary with the quality and quantity of the product as well as the cost and accessibility of comparable products, such as soybeanmeal and plant-based oils (Pittenger *et al.,* 2007; Tacon, 2005). ”If low-cost and nutritionally equivalent substitutes for fishmeal and fish oil are found, economics will drive the aquaculture industry toward alternative feeds” (Pittenger *et al.,* 2007, p. 97). ”Feed costs represent 40-70 % of total production costs, depending on the species; producers are sensitive to rising fishmeal and fish oil prices” (www, NOAA, 1, 2008); Tacon, 2005, p 19; Anderson, 2003, p. 153; Guttormsen, 2002, p. 91-102). ”On the other hand, reducing aquaculture’s demand for fishmeal and fish oil would not necessarily result in a reduction in forage fish catch. As a globally traded commodity, the fishmeal and fish oil prices might drop and/or the products would go to other uses. However, if the goal is to improve the sustainability of aquaculture itself, then reducing fishmeal and fish oil use is still desirable” *(*Pittenger *et al.,* 2007, p. 97).

Historically, fishmeal has commanded a higher price than soybeanmeal; the next chapter deals with this comparison.

4.3.2 Price comparison between soybeanmeal and fishmeal

The two commodities, fishmeal and soybeanmeal are close substitutes. Fishmeal has always been relatively expensive compared to soybeanmeal, its closest vegetable substitute (Owen, 2008). The price difference between the two commodities (Figure 10) reflects a difference in composition, where fishmeal has about 70 % protein and dehulled soybeanmeal has 48% protein and contains smaller amounts of methione and lysine in comparison to the amino acid profile compared in fishmeal (www, Globefish, 2009:1).

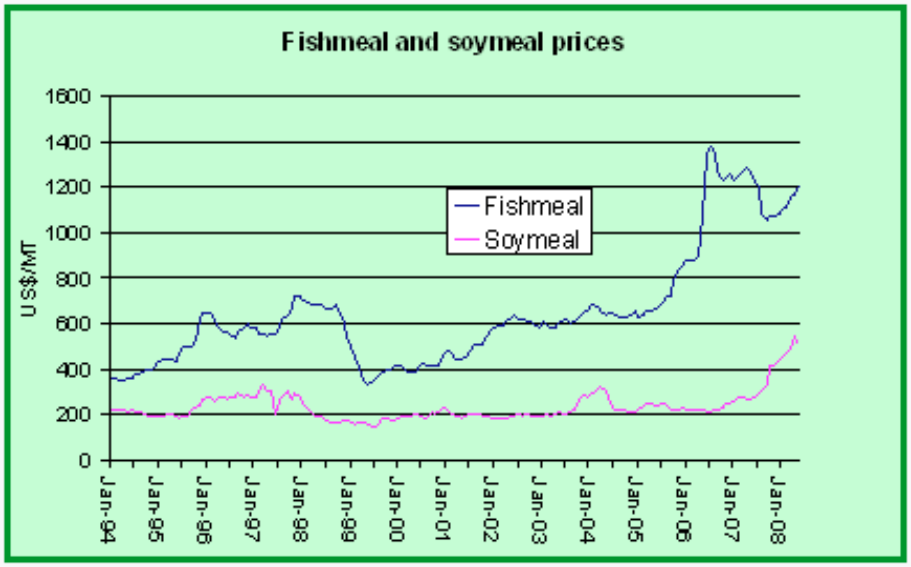


Figure 10. Fishmeal has historical always been relatively more expensive than soybeanmeal. The large price shocks in the fishmeal markets during 1988-89 and 1998 coincide with temperature anomalies in the Pacific, the 1988 La Niña and the 1998 El Niño. Even though both commodities have been increasing in price, a higher use of soybean meal may be seen as a more cost effective fish diet (Source: www, Globefish, 2009).

The illustration (Figure 10) clearly demonstrates price difference is another great incentive for introducing additional soybeanmeal. But to launch more soybeanmeal in the fishdiet, as when aquaculture is growing, auxiliary research also needs to be directed towards the effects in waterquality it may cause. This paper has narrowed this issue and implication by studying cage farming in the marine waters.

4.4 Cage farming's effect on waterquality

Up to date feed use in marine cage culture where the waste is released directly into the environment, concerns have been raised about the waste management challenges for marine cage farms, and the impact on waterquality and sediments due to the release of organic waste have been demonstrated (Huiwen and Yinglan, 2007).

For the sustainable development of marine cage aquaculture, it is an effective management measure to keep the stocking density and pollution loadings below the environmental carrying capacity (Huiwen and Yinglan, 2007). With the reference concept of water environmental capacity and from the point of environmental protection, the aquaculture environmental carrying capacity can be expressed as: the permitted maximum waste discharge amount in a certain sea area (based on the cage aquaculture distribution status and the waste discharge amount), on the condition that the waterquality satisfies the prescribed marine environmental quality objectives (*Ibid).*

"Clearly, discharges from aquaculture can harm marine waterquality" (Pittenger *et al.,* 2007, p. 83). "A substantial body of research shows that conventional fed aquaculture - culture operations, such as for finfish, that require external inputs of food - introduces tons of kilograms of dissolved nitrogen, and several times that amount of particulate organic matter, for every ton of fish produced. Relying on dilution to address nutrient discharges from aquaculture operations only works for small, widely dispersed culture operations" *(Ibid).* "Marine aquaculture operations tend to cluster geographically, raising the potential for cumulative impacts. Wastes from marine aquaculture generally include dissolved (inorganic) nutrients, particulate (organic) wastes (feces, uneaten food and animal carcasses), and chemicals" (Pittenger *et al.,* 2007, p. 69).

Looking at the overall fate of feed figure applied to an aquaculture farm (Figure 11) fish usually consume 90 to 95 % of feed (Boyd *et al.,* 2007, p. 347). About 80 to 90 % of feed consumed is absorbed across the intestine while the rest is excreted as feces *(Ibid).* Usually about 10 to 20 % of nutrients *(Ibid)* absorbed across the gut become biomass.

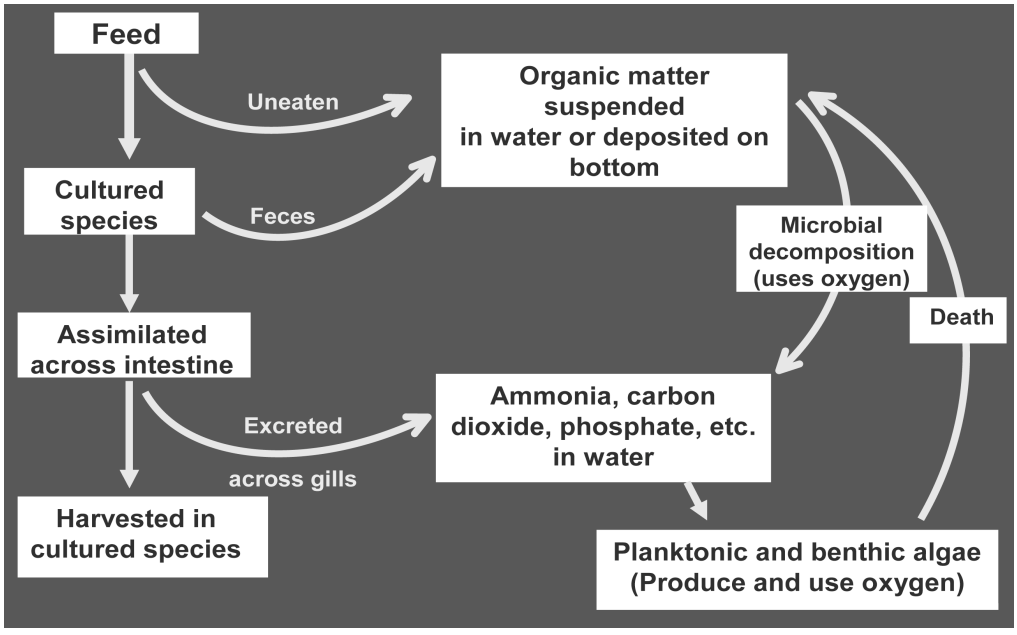


Figure 11. Fate of feed applied to an aquaculture farm (modified from Boyd and Tucker, 1995; Boyd el al., 2007).

The remainder is excreted primarily as carbon dioxide, ammonia, phosphate, and other inorganic substances by bacteria (Figure 11). A portion settles to the bottom of the oceans floor and to accumulate as organic matter.

Inorganic nutrients from fish and microbial metabolism stimulate phytoplankton growth. Phytoplankton removes nutrients from the water, and bacteria decompose organic matter. Ammonia from animal excretions and bacteria degradation is lost by diffusion, converted to organic nitrogen in microbial biomass, and transformed to nitrate by nitrifying bacteria. Nitrate is converted to nitrogen gas through denitrification and lost to the air. Phosphorus is removed from water by microorganisms. Nutrients and organic matter from feed that are not converted to fish biomass pass directly from cages into surrounding waters.

Thus, considering all types of aquaculture, cage culture has the greatest potential for causing pollution *(*Boyd *et al.,* 2007, p. 348). The most important variables in consideration of effluent quality are ammonia, total suspended solids (TSS), total nitrogen (TN), total phosphorus (TP) and total oxygen carbon (TOC) (Figure 11) *(Ibid)*.

The extent to which the environment is affected varies quickly, depending upon the species cultured and farming system and aquatic environment employed (Boyd and Queiroz, 2001; National Aquaculture Association (NAA), 1998). Unconsumed feed has been identified as the most important origin of pollutants in the cage culturing system (Huiwen and Yinglan, 2007). This suggests the importance in increasing the feed utilization and improving the feed composition on the basis of nutrient requirements. Aquaculture producers are motivated to operate at a highly efficient feed conversion rate for economic as well as environmental reasons. The carrying capacity information can give scientific suggestions for the sustainable management of aquaculture environments (GESAMP, 2001; Wu, 1995; Beveridge, 1984). Therefore the importance in location or "siting" of a marine aquaculture facility really can make the difference- economically, environmentally and socially.

The Clean Water Act requires the Environmental Protection Agency to develop technology-based restraint guidelines (Appendix 2) for diverse pollution sources, such as industrial, commercial and public sources (Pittenger *et al*., 2007). "Such guidelines provide minimum pollution control technology to be deployed by dischargers, and may also include numeric and narrative limitations on discharges, required best management practices, and monitoring and reporting requirements (EPA 2004)" (Pittenger *et al.,* 2007, p. 79).

5 Case study Kona Blue Water Farm, HI, USA

This chapter presents the case farm, an open ocean cage fish farm within the aquaculture sector. Readers will find an introduction to the case company as well as findings from a conducted feed trial at the case company known as Kona Blue Water Farm (KBWF). The farm is situated in Hawaii (Appendix 1) and is the only commercial, open ocean cage farm with its own hatchery in the United States.

The open ocean cage farm KBWF and it's stewardship towards sustainability, is progressing by a feeding set up trial. Further the findings in the conducted feed trial, will be paid attention as useful and possible metrics and protocols in the communication towards the stakeholders.

5.1 The story of the revolutionary water farm

Kona Blue Water Farms, LLC, began with a dream, to revolutionize the aquaculture industry by pioneering sustainable production of marine fish (Kona Blue, 2008).

Dr. Dale Sarver and Neil Anthony Sims, marine biologists and longtime Kona residents, founded Kona Blue Water Farm (KBWF) in 2001. They believed there was an opportunity for sustainably managed, open ocean aquaculture of high-value, sushi-quality fish (Figure 12). After three years of research and development, KBWF received an investment infusion in 2004 from Thomas McCloskey, President and CEO of Cornerstone Holdings, in Aspen, Colorado, and other investors from the Mainland and Hawaii (www, Kona Blue, 2008) to make their dream come true.

Figure 12. Picture of KBWF's sushi grade fish, the Kona Kampachi®

The two marine biologists' great advantage was "their understanding of the delicate balance of ocean ecosystems. They have refined the technology behind raising fish through sustainable aquaculture" (www, Kona Blue, 2008). Their fish (Figure 12) the Kona Kampachi® is a sushi-grade Hawaiian yellowtail that is an open ocean fish grown in the pristine waters off the Kona Coast of the Big Island (Appendix 1) —hatched, reared, and

harvested using state-of-the-art aquaculture technology. The company is furthering the ancient Hawaiian tradition of aquaculture by leveraging innovative, state-of-the-art hatchery and open ocean grow-out technology (*Ibid*). KBWF's hatchery is located at the Natural Energy Lab of Hawaii (NELHA) in Kona, on the very lava rock created by the flow that covered Pa'aiea more than 200 years ago. The company's open ocean grow-out site is directly half a mile offshore from this lava rock coast (*Ibid*).

In the wild, Kona Kampachi® or *Seriola rivoliana (Latin)* would be known as Almaco Jack or Kahala. But Kona Kampachi® is substantially different[8] from its wild counterpart (Kona Blue, 2008). Kona Blue is now the first integrated hatchery and commercial offshore fish farm in the United States of America, an advantage the company will strengthen as it expands in Hawaii and beyond. KBWF nurtures its Kona Kampachi® through its entire life cycle from hatch-to-harvest. "This hatch-to-harvest approach separates Kona Blue from most other marine fish farms engaged in other yellowtail farming, which rely on the capture of wild fingerlings to stock their cages" (www, Kona Blue, 2008).

KBWF is committed not only to excellence in fish culturing and to producing a high-quality product, but also to environmental stewardship. Sustainability and minimum ecological impact have always been priorities for the company. KBWF's' dedicated staff includes many experts in their respective fields—people from many different origins and walks of life. Despite this diversity, all Kona Blue employees share an abiding belief in the company's mission of environmental integrity and consumer health.

5.1.1 Kona Blue's open ocean fish production

"The process of farming Kona Kampachi® begins with brood stock from KBWF's' land-based hatchery" (Kona Blue, 2008). "The fish spawn naturally, without stress or hormone inducement. Eggs are gently collected from brood stock tanks and are then placed into separate tanks where they hatch within 24 hours. These extremely small, newly hatched fish need very specific types of live feed to grow. To overcome this challenge, KBWF cultures specific strains of microscopic algae to feed to selected zooplankton, which in turn becomes the feed for the newly-hatched Kona Kampachi®. Within 6 to 10 weeks of hatching in KBWF's land-based hatchery, the Kona Kampachi® are transferred to 3,000-cubic-meter submersible pens (Figure 13) half a mile off the Kona Coast" *(Ibid)*. "Depth ranges from 200-220 feet and the currents are brisk. The 30,000 fish per cage are nurtured in these deep-water cages for another 8 to 10 months, where they are regularly fed once a day to minimize the feed use. This keeps them ravenous enough that at meal time the food released into the cages is devoured quickly, which helps prevent pellets from drifting into the ocean" *(Ibid)*.

Kona Blue, which grows Kona Kampachi in Sea Stations submerged off the shore of Kona, Hawaii, has collaborated with Oceanspar to create a cage (Figure 13) that can be flipped under water so that the bottom half can be raised above the surface for cleaning or harvest. Harvesting occur twice weekly, when the fish weight about 6 to 8 pounds. The total weekly harvest is about 5,000 pounds (www, Seattle Pi, 2006).

[8] The difference is the cultivating. The Kona Kampachi is hatched in KWBF own hatchery.

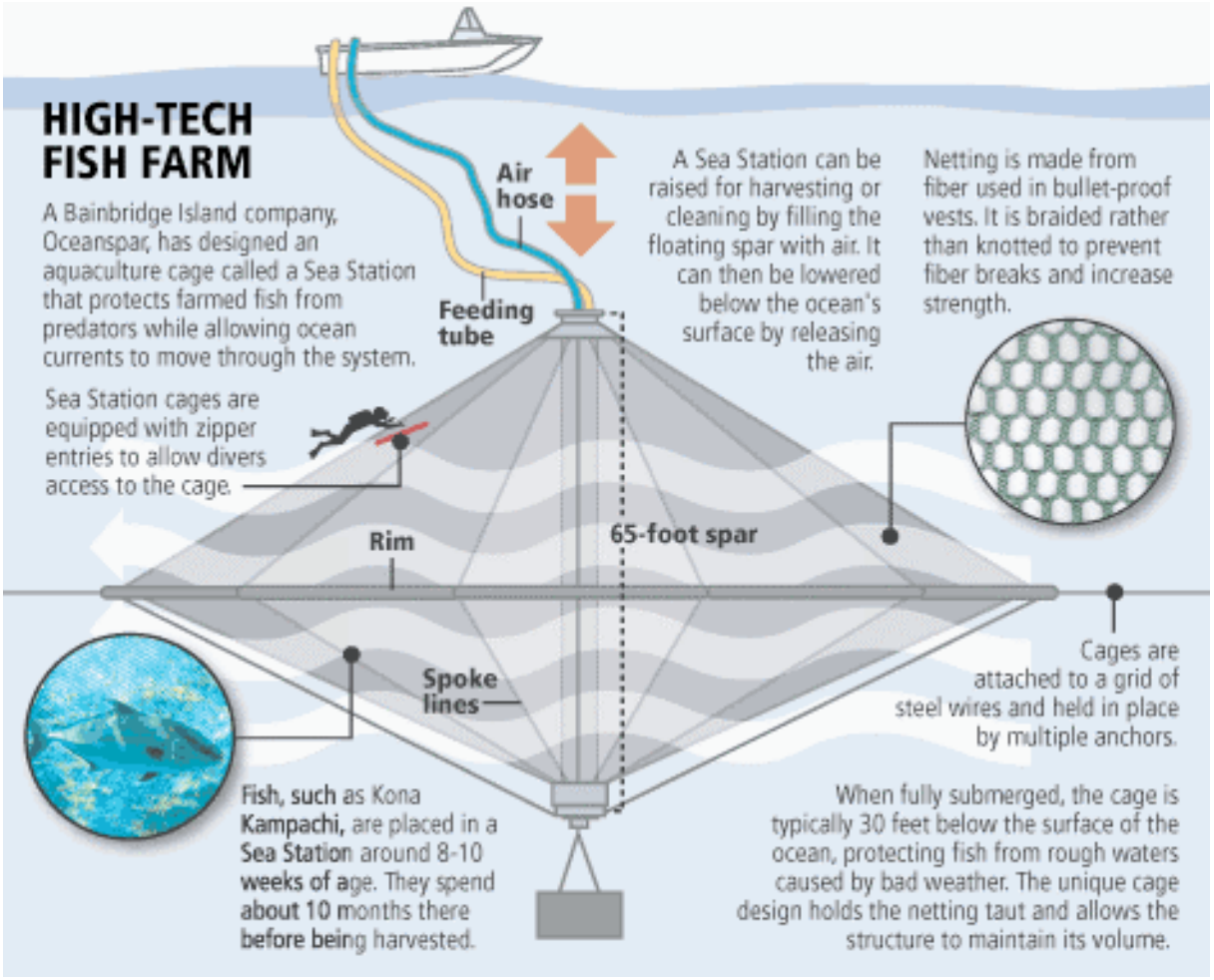


Figure 13. The underwater fish cage. According to Oceanspar, Kona Blue uses Bainbridge firm's underwater fish cages like suspension bridges (www, Seattle Pi, 2006).

According to Hsiao-Ching Choup (www, Seattle Pi, 2006) Sea Stations (Figure 13), of which there are 30 scattered around the world, are made of triangular pieces of Dyneema net that are cut and hung (or attached) by hand. Each cage costs from $110,000 to $170,000, depending on the model. It takes several months to build Sea Station pieces at the workshop and then, the parts are shipped and assembled on site.

5.1.2 Effort in preserving it's own ocean ecosystem

”The seabed off the Kona coast is sandy, and strong currents move through the offshore site” (Kona Blue, 2008). ”This deep ocean aquaculture is dedicated to environmentally friendly production, ensuring the operation does not impact ocean waterquality, and that it doesn't damage delicate coral reefs or the surrounding marine ecosystem” *(Ibid)*.

”Prior to commencing operations, KBWF went through an exhaustive three-year permitting process to satisfy all relevant federal and state regulatory agencies, providing extensive opportunities for public comment” (Kona Blue, 2008). ”The State Division of Aquatic Resources, the State Department of Health under a National Pollutant Discharge Elimination System, and the Hawaii Island Humpback Whale National Marine Sanctuary monitor the company’s operations on an ongoing basis” *(Ibid)*. ”Kona Blue currently monitors the

waterquality at seven sampling locations around its cages, measuring everything from ammonia to turbidity to many other parameters: (NO2, NO3, Sal, Temp, pH, DO, and total P)" *(Ibid). "*The company adheres precisely to the EPA guidelines for all sampling and analyses methods, contracting this out to an independent company *(Ibid).* The results of this monitoring show (February 2009) no measurable impact on waterquality from Kona Blue's open ocean cages *(Ibid).*

5.1.3 Guidelines and information available to stakeholders regarding KBWF and the Kona Kampachi®

BOI (2009) inform that American Yellowtail is farmed in net cages. Pollution concerns are generally low because cages are situated in areas of deeper water and strong currents, promoting the dispersal of waste. The majority of fishmeal and oil is from targeted reduction fisheries, while a small amount is trimmings from the British Columbia hake fishery (pers. com., Sims, 2008).

Government policy promotes research, development and commercialization of carnivorous or other highly fishmeal-dependent species. NOAA, through the National Marine Aquaculture Initiative, encourages farming of carnivorous marine finfish in near shore, open water and terrestrial environments (NOAA, 2007). Effluent[9] is not treated before discharge (www, KBWF, 3, 2008). Nutrient levels, measured using total organic carbon, around the farm vary seasonally, being slightly higher in fall when ocean currents are weaker (Sarver, 2008). By winter, nutrient levels are low and similar to sites away from the farm. Benthic surveys around the farm show no to very little impact to the benthic community (Sarver, 2008).

Currently farming operations for Yellowtail in the U.S. do not use feed sensors or floating feeds, however most feedings are observed by divers and cameras to avoid overfeeding. Excess feed is said to be consumed by wild fish around the cages (www, KBWF, 2, 2008). Current the U.S. Yellowtail farming operations use no prophylactic antibiotics. Florfenicol has been used several times to treat a specific bacterial infection under the supervisions of the US Fish and Wildlife Serve and veterinarians from the University of California, Davis (pers. com., Sims, 2008).

U.S. Yellowtail farmers must conduct regular waterquality monitoring to fulfill the EPA's National Pollutant Discharge Elimination System (NPDES) Permit (www, KBWF, 3, 2008). Additionally, benthic flora and fauna is sampled quarterly to monitor impacts (Sarver, 2008).

Escapes do occur, but Yellowtail is native to Hawaii (www, KBWF, 3, 2008). At the beginning of farming operations tens of thousands of fish escaped (pers. com., Sims, 2008). Many small fish floated to the surface and were consumed by predators. Larger fish (3-4 kg), however, likely mixed with wild populations (Sims, 2008). However, escapes in farms have decreased with the use of Sea Station net pens. One mistake that was made was in December 2007, when 1,500 fish escaped from Kona Blue's farm into surrounding waters when a diver failed to lock the bottom of the cage. Kona Blue is implementing procedures to ensure that this does not happen in the future (Honolulu Observer, 2008). While there is high predation of escapees by trevally, seals, dolphins and sharks, the species is native to the area (www, KBWF, 3, 2008). While the impacts and survival rates of escapees are unknown, it is likely that escapees, if not predated, would survive in the wild (pers. com., Sims, 2008). Current farming operations use either wild, first or second-generation broodstock, so farmed fish are

[9] Effluent is an out flowing of wastewater

at most three generations removed from wild populations (www, KBWF, 3, 2008). Current farming operations, therefore, are unlikely to compromise the genetic integrity of wild populations. Existing farming operations do not employ any predator deterrents (pers. com., Sims, 2008). About 50 wild Yellowtail are harvested annually from healthy wild populations and used as broodstock. Seed comes from these wild broodstock and does not deplete the wild population (www, KBWF, 3, 2008).

5.2 Determination and objectives on the waterquality data during the conducted feed trial

Determination and objectives on water quality in a ten week feed trial – testing replacement of fishmeal and fishoil with soy-based protein and novel high omega-3 oil (Appendix 4) has been conducted.

This study and analysis was to determine following waterquality parameters; total nitrogen (TN), total phosphorous (TP), total suspended solids (TSS), ammonia (NH_3) and total organic carbon (TOC). During the feed trial 540 jars of water samples were collected and shipped from Hawaii to Waterquality laboratories at the University of Illinois for analysis. Following was to be found:

- ***Total Organic Carbon-*** TOC values can increase before feed (14 %) and decrease after feed (6 %) when implementing the suggested 10 % SPC replacement (Appendix 5). No significant difference in TOC can be measured introducing more soy product in the fish feed.

- ***Total Nitrogen-*** TN can decrease by using 10 % SPC in the fish diet (Appendix 5). Before feed an improvement of 12 % can be made and after feed 25 % *(Ibid)*.

- ***Total Phosphorus-*** TP can decrease using 10 % SPC with as much as 38 % before feed and 25 % after feed (Appendix 5).

- ***Ammonia***- The suggested SPC replacement of 10 % will increase the ammonia value (164 %) before feed but slightly decrease (9 %) the value after feed (Appendix 5). Even though the TP levels are decreasing with the 10 % SPC replacement, still the ammonia must be considered to not have been improved by the replacement which Gatlin and Hardy (2002, p. 155-165) imply should be the case when reducing total dietary phosphorus and using feedstuffs and supplements with high phosphorus availability. This has not been detected in this trial.

- ***Total Suspendid Solids***- Limits of total suspendid solids as a potential pollutant are typically 20 to 30 mg/L (Boyd, 2000) indicating that introducing more soybeanmeal in the diet will decrease this chance as being a water pollutant. Introducing too much soybeanmeal in the diet- it is shown that the fish leave more uneaten feed and therefore increase the TSS. The suggested replacement at 10 % more SPC, the TSS value can improve 18 % (before feed) but after feed increase the TSS value by 9.7 % (Appendix 5).

With respect to *water quality,* the findings shows that the level of detection in the parameters is in most cases are better in soy products. Only in the case of ammonia there is a slightly raise in values compared to the current used commercial feed. The result shows that the

waterquality in many cases actually is better or less affected introducing a higher level of soy products. The recommendation according to the result is that these results indicate that protein inclusion from SPC could effectively replace fishmeal protein at 10% in diets of *Seriola rivoliana* (Kona Kampachi®). Further experiments and more research are required in the use of blends of soybean oils to obtain the best growth results in order to substitute higher percentages of fish oil.

To further connect the water data into stringent environmental stewardship will be analyzed in the next chapter.

6 Analysis

This chapter includes the analysis of the empirical results for accomplishing the purpose of the research. Critical analysis of the results, and comparison and contrast of them with the theories taking place in the theoretical framework is included in this section. Specifically, the analysis intends to show the importance of communication to stakeholders within open ocean cage farming and a farm's stewardship towards sustainability and search for metrics in its branding process.

6.1 KBWF's corporate environment

6.1.1 Sustainability and its importance for KBWF

For KBWF sustainability means development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs (pers. com., Sims, 2008*)*, this is the same and most celebrated formulation the Brundtland Report presented in 1987.

Also similar to Bebbington and Gray (1997), Porter and Linde (1995) and Hawken (1993), KBWF declare their work praxis is to have a sustainable business that leaves the environment no worse off at the end of each accounting period than it was in the beginning of that period.

KBWF has incorporated the notion of sustainability into its business for three key reasons: environmental management, strengthening the open ocean fish farming industry and strengthening the own brand (*Ibid*). Further, it is important to approach the Triple Bottom Line (TBL), though KBWF consider the economic value should go hand in hand with environmental and social values, if not their own future will be endangered.

6.1.2 Could it be interesting for KBWF to use stakeholder management as a strategic tool?

KBWF consider similar to Clarkson (1994, p. 5), their primary stakeholders as those stakeholders who "bear some form of risk as a result of having invested some form of capital, human or financial, something of value, in a firm". Further KBWF agree with Hillman and Keim (2001) that this could be community residents, employees, suppliers, customers investors and governments: groups that provide various forms of important infrastructure for the firm and in turn are impacted directly by tax revenues and physical environmental protection (or degradation).

As Clarkson (1995) asserts, "the survival and continuing profitability of the corporation depends upon its ability to fulfill its economic and social purpose, which is to create and distribute wealth or value sufficient to ensure that each primary stakeholder group continues as part of the corporation's stakeholder system". Thus, an organization can be viewed as a set of mutually dependent relationships among primary stakeholders (Greenley and Foxall, 1996; Donaldson and Preston, 1995; Jones, 1995; Harrison and St. John, 1994; Hill and Jones, 1992; Kotter and Heskett, 1992; Evan and Freeman, 1988; Chakravarthy, 1986) this is also true for KBWF.

KBWF's consumers are high-end customers and the survival and continuing profitability of the corporation depends upon its ability to fulfill its purpose to each primary stakeholder group, therefore the stakeholder management is a strategic tool for the company.

In addition KBWF has a resource-based view of the firm. A resource-based firm (Barney, 1991; Wernerfelt, 1984; Penrose, 1959) argues that a firm's ability to perform better than the competition depends on the unique interplay of human, organizational, and physical resources over time (Amit and Schoemaker, 1993; Barney, 1991; Dierickx and Cool, 1989; Lippman and Rumelt, 1982). By developing longer-term relationships with primary stakeholders like customers, suppliers, and communities, as well as present and future employees, firms expand the set of *value-creating exchanges* with these groups beyond which would be possible with interactions limited to market transactions. The emphasis in this case study is in the value that can be created by interactions, between KBWF and its primary stakeholders, which are *relational* rather than transactional since transactional interactions can be easily duplicated and thus offer little potential for competitive advantage.

Communicating with the primary stakeholders of a company is an important part of successful stakeholder management (Hillman and Keim, 2001). Stakeholder management with respect to KBWF includes internal and external communication and are expressed in annual reports (only for the executives and investors since KBWF is a privately held company), press releases, informative videos, business cards and logotype- everything with the purpose of reaching different stakeholders using valid *benchmarks*.

6.2 KBWF's benchmarking approach

A common temptation in designing metrics is to take into consideration too many factors (Schwarz *et al.,* 2002). Measurements that combine too many components are actually less adaptable and less constructive for making comparison across products and industries. Therefore, it is best to have a core set of simple, widely applicable metrics. The approach used in this thesis is the use of water data as metrics. These metrics provide cost-effective means for tracking how well a company is doing in the key impact areas and for communicating that information to a variety of audiences.

6.2.1 Reporting sustainability and environmental progress in KBWF

The open ocean fish farm has been monitored since the start, and has been a great transparency for the stakeholders to prove their responsibility *(*pers. com., Sims, 2008*)*. Since KBWF is a private company with no public annual reports or sustainable development reports, demonstrating the monitored water data on Internet has been a successful tool for all stakeholders. By having a high awareness approach to responsibility questions the farm will avoid finding itself in troublesome situations.

Currently when there are no perfect reporting systems and certifications for sustainability. WWF and BOI, NOAA and FAO develop the best guidelines on the market for farming the Kona Kampachi®. The company have a high degree of transparency of the progress and work towards sustainability and environmental issues. Also by using the existing authority under the Clean Water Act and Environmental Protection Agency, it should ensure that "the development of marine aquaculture does not degrade marine waterquality or the health of marine ecosystems" (Pittenger *et al.,* 2007, p. 86) by discharges of pollutants.

6.2.2 Metrics in reporting to KBWF's stakeholders

The monitored watermetrics in the open ocean cages are frequently updated and communicated to stakeholders. KBWF has a big amount of water data, directly available to inform the populace. KBWF's social and environmental impacts, as well as its treatment of employees across the supply chain, feed directly into stakeholder perceptions. It is a matter of trust. And over the past few years it has become increasingly clear that trust is critical to market performance and stakeholder value for KBWF. To win trust KBWF communicates through different channels, such as action, behavior, face-to-face management, market signals, products and services, word of mouth and finally comments by other organizations.

Product publicity releases could discuss product safety. Even when a company does manage to achieve strategic consistency at the marketing communication level, these messages might have far less impact than brand messages coming from other marketing functions and corporate areas, not to mention brand messages originating outside the company (from customers, the media, and the competition). Earlier, KBWF tried to send out their message through an advertising bureau, unfortunately this did not work out as planned.

The development of metrics that relates to environmental and economic performance for production processes is an excellent way for many companies to begin to incorporate the goal of sustainability into management decision-making. Also linking the business concept of creating value with environmental performance is termed "eco-efficiency" (Schwarz *et al.,* 2002). Using a management strategy that incorporates eco-efficiency strives to create more value with less impact. It enables more efficient production processes and the creation of better products and services, while reducing resource use, waste and pollution along the entire value chain *(Ibid)*.

"A well recognized, widely accepted certification system does not yet exist for marine aquaculture products. This is a concern shared by both producers and environmentalists as aquaculture's share of the market grows" (Pittenger *et al.,* 2007, p. 108). "Instead private sector initiatives increasingly provide a public relations advantage, which may create market advantage but is also related to "goodwill"—an intangible asset valued by business independent of financial rewards" (Pittenger *et al.,* 2007, p. 104).

KBWF's keys to success include high standards for sustainability achieved through practical and viable measures, strong verification procedures and compliance with standards, transparency and accessibility of the process to interested parties, and achieving and maintaining high consumer confidence in the label. "The rationale for labeling is to connect products in the marketplace with production practices. Public outcry about the killing of dolphins by some tuna fishing practices led to the development of a dolphin-safe definition and label for canned tuna. The label provides additional information to consumers about their choices in the marketplace" (Pittenger *et al.,* 2007, p. 103).

6.2.3 Policy and certification systems as benchmarks in KBWF

"Companies that wish to truly distinguish themselves on the basis of their environmental stewardship may push for more stringent production standards than a consensus-based certifications" (Pittenger *et al.,* 2007, p. 110). Feed related environmental impacts of farm effluents have a high diversity and no single solution (Tacon and Forster, 2003, p. 181-189).

”A well recognized, widely accepted certification system does not yet exist for marine aquaculture products” (Pittenger *et al.,* 2007, p. 7) neither for KBWF.

Pittenger *et al.,* (2007, p. 110) further means that ”keys to success include high standards for sustainability achieved through practical and viable measures, strong verification procedures and compliance with standards, transparency and accessibility of the process to interested parties, and achieving and maintaining high consumer confidence in the label”.

”First, marine fisheries and surrounding ecosystems benefit from the establishment of sustainable management practices. Second, consumers benefit from receiving more information on the seafood products, which they consume, allowing them to make more informed purchasing decisions. Third, producers of eco-labeled seafood products benefit from potentially higher prices, due to the ability to differentiate their products. And finally, the fishing industry itself benefits from operating in a sustainable and well-managed framework designed to preserve both the resource and the industry” (www, NOAA, 1, 2008).

When it comes to the development of certification systems for aquaculture, this is shown to be highly desirable (Pittenger *et al.,* 2007). ”Other programs to differentiate environmentally preferable farmed seafood in the marketplace may prove valuable catalysts for better production practices” (Pittenger *et al.,* 2007, p. 110). Further ”companies that profit by differentiating their brand and their products may wish to retain their own production standards” (*Ibid*). ”If developed collaboratively with conservation organizations, such standards often achieve considerable credibility” *(Ibid)*. KBWF clearly wants to take part in the progress in developing high standards of sustainability in a widely accepted certification system. Today KBWF participate in policies and certification systems like WWF, BOI, The Clean Water Act, Code of Conduct and NOAA.

Importance when developing high standards are the communication of the sustainable work and efforts being made and the incentives why a change should be made and how this effect the stakeholders.

6.3 The communication process in KBWF

The communication process at KBWF is “*pretty organic*” (pers. com., Sims, 2008). Sims sees some implications in communication with the stakeholders. Since farming the blue is a highly political question, he sees that the populace needs to be informed about what is occurring in the ocean as well as informing the public that fish farming for instance is a much more environmentally friendly practice than beef production (*Ibid*). KBWF also believes the higher the involvement with the product; the more people will be motivated to take part in developing activities. Their knowledge about the product and related problems will also increase.

Understanding the possibilities and managing the risks of communication a company can create a strong brand, luckily there have not been many risky events that needed serious risk management.

6.3.1 KBWF creating an image

The desired image KBWF strives for must be supported through active communication. Important when communicating and positioning a brand according to Pringle and Thompson

(1999) is to find the ideal situation also referred to as a large territory. It is from this territory that the consumer perspective refers to as a brand and that also provides the anticipated values. Here KBWF has made a great lot of work as a leading producer of Hamachi or Seriola Rivoliana from the USA (BOI, 2009).
KBWF has made the key point, that the sender of a message must make active choices in communications and evaluate the outcome in a long-term perspective, above and beyond sales statistics to establish a solid, (preferably bigger) territory for building a corporate image. This is happening when they promote their product by sales and dialogue with stakeholders.

The many barriers in a communication process referred to as noise could be difference in perceptions, filtering, languages and the phenomena of information overload are examples of communication barriers according to McShane & Von Glinow (2003).

Attractive opportunities within the marketplace and image making are to change the social pattern: like consuming more fish, is the most crucial impact the fish farm face today. Also, easier arrangements to set up cage farms would improve the possibilities in growth opportunities.

The non-growing fishmeal and fishoil production in the world is encouraging more use of sustainable feed when the aquaculture industry grows, like soybean- meal and oil. This is a major deal and can come to totally change the current open ocean fish production and the acceptance among the population. The importance for farms in the future is to find more environmental friendly as well as economically sustainable fish diets.

6.3.2 Company brand and reputation

The basic function of a brand is to help the customer identify the suppliers and simplify the selection among the multiple choices on a market Understanding the possibilities and managing the risks of communication a company can create a strong brand. Users and companies do not only have different knowledge bases, but also different languages, values, and coding schemes (Hoffmann, 2008) to perceive the message.

”Certification programs provide another form of value-added product differentiation to consumers by providing information on the production and harvest practices, and also the overall environmental and social impacts of a given fishery. Consumers are becoming increasingly interested in where and how their seafood is produced or harvested, and the value of this information has not been lost on retailers and restaurants” (www, NOAA, 1, 2008).

Roheim (2003) distinguish ”four major beneficiaries of successful eco-labeling programs. First, marine fisheries and surrounding ecosystems benefit from the establishment of sustainable management practices. Second, consumers benefit from receiving more information on the seafood products, which they consume, allowing them to make more informed purchasing decisions. Third, producers of eco-labeled seafood products benefit from potentially higher prices, due to the ability to differentiate their products. And finally, the fishing industry itself benefits from operating in a sustainable and well-managed framework designed to preserve both the resource and the industry” (www, NOAA, 1, 2008). All this said, introducing and marketing with more SPC in the fish diet, will be a positive outcome of sustainability.

6.3.3 A Communication-Based Marketing Model for Managing Relationships

Building better relations with primary stakeholders like employees, customers, suppliers, and communities could lead to increased shareholder wealth by helping firms develop intangible, valuable assets which can be sources of competitive advantage. On the other hand, using corporate resources for social issues not related to primary stakeholders may not create value for shareholders (Hillman and Keim, 2001) A brand relationship-building model should consider brand messages from all internal sources such as corporate, marketing, and marketing communication levels.

Brand value involves more than traditional marketing communication. Planning tools such as brand message audits, contact point analysis, and stakeholder maps are needed to identify message fractures, ignored stakeholders, and points of message confusion. An appreciation of the complexities of brand communication makes it possible to understand the structural changes needed to facilitate cross-functional planning and monitoring of all brand messages. When this understanding exists, a company can apply this communication-based model of marketing more easily to deliver more effective relationship- building programs.

6.3.4 Implications in the communication process of corporation's sustainable progress

It is vital to be prepared and face threats even during turbulent situations, like external factors that are out of our control. Always it is important to remember in positioning a brand, the ideal situation (Pringle and Thompson, 1999) is a large territory, which from a consumer perspective refers to a brand that provides the anticipated values. The territory is preferably bigger for building a corporate image *(Ibid)*. Further active communication where senders and receivers of information create a picture that is a labeled profile is important (Mark- Herbert, 2007).

To improve the production site and to always be able to sell a great premium product, a company must have an outlined risk management plan. The market segment is fairly certain, but always in premium food production the customer is aware of the product and reputation. Therefore it is important to update the customers and to have a transparency in the communication.

The environment and social impact from the worldwide aquaculture industry has importance in KBWF's existence. It is also important for the reputation of the industry that every farm is trying its best to fulfill the Code of Conduct and guidelines for its license to operate.

Weakness in the stakeholder communication could be the argument about the current location of the fish farm. There are always possibilities to find a more efficient distribution line. Having a production far away from the U.S mainland, given the circumstances, the distribution is more expensive, though one of the selling arguments is to sell the fish fresh. This means that the fish has to be flown to the mainland. KBWF has recently started to look into also selling frozen fish. This means that a cheaper way of distribution can be fulfilled. Further will there always be different kinds of products that can be farmed, meaning different kinds of farm set-ups. Farms that have introduced a better-formulated and sustainable diet and that can compete with lower prices will be more competitive. Companies that have a broader production line will also be more competitive. Therefore KBWF is looking into the possibility of also producing from mainland Mexico.

To be able to change the consumer demand is needed to communicate the importance of farmed fish as a protein resource for the world's population. To be known should also be the lower feed conversion rate compared to for instance the beef industry. Also promoting that eating more fish is healthy though it contains many healthy nutrients and Omega 3 oil. If consumers only accept eating caught fish, there will also be a problem in the aquaculture's existence.

6.3.5 How can KBWF reach stakeholders with the case related watermetrics

With respect to *waterquality,* the findings shows that the level of detection in the parameters is in most cases better in soy products. Only in the case of ammonia there is a slightly raise in values compared to the commercial feed. The result shows that the waterquality in many cases actually is better or less affected introducing a higher level of soybean products. The recommendation according to the result is that these results indicate that protein inclusion from SPC could effectively replace fishmeal protein at 10 % (pers. com., Lowell, 2009) in diets of *Seriola rivoliana* (Kona Kampachi®). Further experiments and more research are required in the use of blends of soybean oils to obtain the best growth results in order to substitute higher percentages of fish oil.

Therefore, these positive research findings hold a great advantage in the industry and being able to show this progress as a transparency in the sustainable work and branding to stakeholders should hold great value. Even better and stronger would be to have a certification to the product when reaching goals. Using the suggested method in approaching and defining the stakeholders should help the corporation in their search of communication of sustainable benchmarks.

Further research about a greener feed's impact on water bodies to improve sustainability is needed to continuously gain trust, truth and knowledge- making the "territory"[10] for the stakeholders bigger.

[10] Please see page 6, Figure 4 for further details

7 Discussion

This chapter includes a discussion based on the theoretical framework, the empirical material, and the information from previous chapters and studies that further aims to address the research questions stated in chapter one.

Aquaculture as well as agriculture has an impact on the ecosystems in which it takes place. The conception is what are the character and magnitude of these impacts and can they be managed to an adequate level so that society can get the benefit of farmed seafood without substantial damage to marine resources and other uses of the oceans.

The fact that the oceans are space available to everyone enhance another aspect and makes the issue even more controversial. Constant growth in the aquaculture sector is forecasted (Tacon *et al.,* 2008; Anderson, 2003) and this growth will in sequence increased demand for fishmeal and fishoil. Within the next 10 to 20 years, the global aquaculture sector is forecasted to surpass wild production, with estimates ranging between the years 2015 to 2030 (Tacon, 2004; FAO, 2000; www, NOAA, 1, 2008). These findings in previous studies is also detected by KBWF, that have seen a stronger demand of fish products and therefore also a higher use of fishmeal since this is one of the main components in the used fishfeed.

7.1 The corporate environment

WCED's formulation (1987) for sustainability, as well as Atkinson's (2000) and FAO's (2008) further explanations can be well fitted into KBWF's approach when it comes to the topic. Also Hoffmann's (2008) discussion about the problematic issues about bringing the sustainability notion to the agenda of Companies is a well-regarded problem within KBWF. Of course KBWF see the problematic questions as an jeopardization of their own production and legitimacy, therefore also want to have an intense communication with their stakeholders. Further, the vagueness of the term sustainability supports different perceptions for KBWF and thus necessitates a common interpretation process if the company is willing to meet the expectations of its stakeholders. Thus, the acquisition and processing of new external knowledge, addressing social and ecological aspects of products and processes, becomes crucial.

KBWF is well aware that is cannot undertake activities without stakeholders being aware of it. But the increasing influence could also mean increasing responsibility, which is proven by the awareness and attendance of the consumers and other stakeholders. KWBF share the same understanding as Garriga & Melé, 2004; Hollender & Fenichell, 2004; Löhman & Steinholz, 2003, when it comes to the topic's importance and has never been of more immediate interest than today. As Kotler *et al.* (1999) are describing the acknowledgement of the company as an actor *together* with other actors has created different approaches to the company's role and the term *stakeholder management* is of high importance within the organization. KBWF further consider their primary stakeholders and most important infrastructure, similar to what Mitchell, Agle and Wood (1997, p. 853-886); Clarkson (1994, p. 5); Hillman & Keim (2001) are saying, see Textbox 1. Corporations' social responsibility has become a pressing issue of today and has gained attention and acceptance in the public and in business communities. Stakeholders demand that the issue be taken seriously. One reason for the increasing focus is

the demand for and possibility of *transparency* in the business community. Even if KBWF doesn't use the exact term Corporate social responsibility in their branding, there is a general undertone and understanding for the work towards the same kind of goals within the KBWF organization. As Crowther, 2002b, p. 2-3; Gray *et al.,* 1995, p 78-101) has pointed out, four major themes (Natural environment, Employees, Community and Customers) for CSR or similarities in the business approach has been detected also within the KBWF organization.

The KBWF's organization can be viewed as a resource-based firm, similar to the point of view as Barney, 1991; Wernerfelt, 1984; Penrose, 1959. They all further contend that a firm's ability to perform better than the competition depends on the unique interplay of human, organizational, and physical resources over time (Amit and Schoemaker, 1993; Barney, 1991; Dierickx and Cool, 1989; Lippman and Rumelt, 1982). The KBWF also argue similar to Teece (1998); Atkinson *et al.,* (1997) and Barney (1991), that intangible, difficult-to-replicate resources must undergird the business processes if a firm is to outperform its rivals and create value for shareholders as well as stakeholder. The four criteria Barney (1991) is suggestion as leading to competitive advantage are well integrated into KBWF's business strategy. Advantages include socially complex and causally ambiguous resources like reputation, corporate culture, long-term relationships with suppliers and customers, and knowledge assets, this is also detected by Teece (1998); Leonard (1995) and Barney (1986).

By developing longer-term relationships with primary stakeholders like customers, suppliers, and communities, as well as present and future employees, firms expand the set of *value-creating exchanges*- value that can be created by interactions, between firms and primary stakeholders, which are *relational* rather than transactional since transactional interactions can be easily duplicated and thus offer little potential for competitive advantage. KBWF's corporate communication includes internal and external communication and are expressed in annual reports (only for shareholders), press releases, business cards and logotype- everything with the purpose of reaching different stakeholders using valid benchmarks. But yet they are not using internal magazines. Further KBWF's management strategy is an example of Schwarz's *et al.* (2002) strategy that incorporates eco-efficiency, which strives to create more value with less impact. It enables more efficient production processes and the creation of better products and services, while reducing resource use, waste and pollution along the entire value chain.

KBWF incorporate the belief of sustainability into its business for three key reasons: environmental management, strengthening the open ocean fish farming industry, strengthening the own brand as well as risk management. Further, the company approach the Triple Bottom Line (TBL) by considering the economic value with environmental and social values, otherwise their own future would be jeopardize. This company also clearly shows that they desire to really differentiate themselves based on their environmental stewardship and can drive for more rigorous production standards than an agreement-based certification program.

7.2 The benchmarking approach

When finding valid benchmarks, KBWF continuously try to make great effort in improving the fish diet with respect of diminishing the use of fishmeal and fishoil, cutting it down from approximately 80 % to 30 % in the commercial fishfeeds (pers. com., Sims, 2008). Trial of bringing it down shows that possibilities of another cut of 10 % is possible without loss in growth and health. This trial also shows that the waterquality can be improved in most case

with more use of Soy Protein Concentrate (SPC). This also shows that ”as the price of fishmeal and fishoil rises relative to other protein sources, such as soybeanmeal, aquaculture users will attempt to substitute across protein sources to reduce production costs while maintaining nutritional and quality standards for their products” (www, NOAA, 1, 2008).

Watermetrics, as numbers are simple to compare but difficult to observe. The inducement for a company when setting or improving a standard is to talk about their effort in this high potential branding issue. KBWF are doing a great work in finding both a more economical production as well as sustainable.

KBWF agrees that there is several existing guidelines and certifications systems but these also shows a great diversity. But why should sustainability be different- we are all living on the same plane, equal responsible for the future. This incentive is just one for encouraging the progress in a worldwide standard. Therefore the existing guidelines and certifications systems are extremely important in the industry’s progress towards the sustainability goal. Unfortunately, to date there is a lack of numbers of indicators measuring sustainability within the fish farming of the specific fish studied in this case study; the Kona Kampachi®. KBWF sees great possibilities of growth when developing an industry such as the marine open ocean industry and carefulness needs to be paid as well as clear and communicative indicators are important when branding and expanding a company within the aquaculture industry.

The existing diversity of policy options reflects the wide variety of farming systems and species cultivated around the world and the different approaches used by government authorities and/or farming associations to deal with the discharge of effluents and wastewaters from their aquaculture operations. KBWF take part of private sector initiatives for ”increasingly provide a public relations advantage, which may create market advantage but is also related to “goodwill” - an intangible asset valued by business independent of financial rewards” (Pittenger *et al.,* 2007, p. 104). Further KBWF is a company that profit by differentiating their brand and their products and may wish to retain their own production standards. ”If developed collaboratively with conservation organization such standards can often achieve considerable credibility though (*Ibid*). ”Product differentiation can be beneficial for the environment as well as the bottom line pushing for more stringent production standards. The rationale for eco-labeling though is to connect products in the marketplace with production practices” (Pittenger *et al.,* 2007, p. 110).

KBWF take part in BOI’s, *Guide to Ocean Friendly Seafood,* where stakeholders can find the first comprehensive seafood analysis and ranking methodology online. It focuses on evaluating species’ life history, abundance in the wild, habitat concerns, and catch method or farming system. The analysis also includes health advisory information. All this information makes it transparent and easy for the stakeholders to understand and use the information. Further KBWF also see positively and give support to WWF where they hope this dialogue can inform people of the development of the best management practices and the development of standards for a certification system. *FAO, Code of Conduct,* is another trusted source of guidelines for KBWF’s execution of aquaculture practice. They are also following The Clean Water Act, using several tools to guarantee the marine environmental excellence is not tainted by emissions of contaminants.

7.3 The communication process

As Kotler 2003, p. 565; McShane & Von Glinow, 2003, p. 324; Larsson, 1997, p. 45 describes, information flows through the channels from the sender to the receiver and there will be feedback from the receiver to the sender, which is a confirmation of the message being received. This is a difficult set up since the ”noise” which could be considerate as the media in the case of KBWF makes it hard to transmit the message. And as the Figure 2, page 3 is showing, if any part of the communication process is distorted or broken, the sender and the receiver will not have a common understanding of the message. This is mainly what KBWF is struggling with, likewise as McShane and Von Glinow (2003) are saying differences in perceptions, filtering, languages and the phenomena of information overload are examples of communication barriers.

The ways a firm communicate according to Davidson (2005, p. 158-160), which are applicable to KBWF are:

- *Action* - this is what the organization does. There are hundreds or thousands of actions each day.
- *Behavior* – describes how things are done, how people treat others, especially colleagues and customers. It changes daily in every organization.
- *Face to face managemen t*- covers talks, meetings, debate, one-to-one conversations and questions asked.
- *Signals* - are actions or objects, which convey information about an organization.
- *Products and services - quality and style* embody the organization’s vision and values. Poor quality or service says people don’t care.
- *Word of mouth and word of web* (including e-mail) - next to action and behavior, this is the most important way organizations communicate. It is heavily influenced by the other seven ways.
- *Comments by other organizations* - such as the media, pressure groups, governments.
- They might not agree on the *Advertising* - which covers the whole gamut of paid-for communication. While advertising output is planned and controlled, reaction to it, is not.

KBWF’s approach are to understanding the possibilities and managing the risks of communication a company can create a strong brand similar to the ideas presented by Kotler, 2003; Keller, 2001). The main idea of branding is that everything a company does communicates and that successful brand management will secure the position of the company’s products in the mind of the customer. As Hoffmann (2008) expresses it and further also are applicable in KBWF’s case, users and companies do not only have different knowledge bases, but also different languages, values, and coding schemes

The communication process at KBWF is “*pretty organic*” (pers. com., Sims, 2008). Sims sees some implications in communication with the stakeholders. Since farming the blue is a highly political question, he sees that the populace needs to be informed about what is occurring in the ocean as well as informing the public that fish farming for instance is a much more environmentally friendly practice than beef production (*Ibid*). KBWF also believes the higher the involvement with the product; the more people will be motivated to take part in developing activities. Their knowledge about the product and related problems will also increase.

A communication-based model of marketing recognizes that the management of communication that builds brand value involves more than traditional marketing communication. Planning tools such as *brand message audits*, *contact point analysis*, and *stakeholder maps* are needed to identify message fractures, ignored stakeholders, and points of message confusion. An appreciation of the complexities of brand communication makes it possible to understand the structural changes needed to facilitate cross-functional planning and monitoring of all brand messages. When this understanding exists, a company can apply this communication-based model of marketing more easily to deliver more effective relationship- building programs. Since KBWF is a smaller company and marketing communication messages do not have separate departments and agencies for each of the marketing communication functions.

The big challenge for KBWF is to communicating the firms corporate values expressed in strategies and every day procedures to stakeholders is all the variety of interests and expectations, similar that Mark-Herbert and von Schantz, 2007; Whitehouse, 2006, has expressed in this paper's theory chapter. When doing so KBWF needs to remember the ideal situation in positioning a brand is a large territory (Pringle and Thompson, 1999, p. 155; Figure 4), which from a consumer perspective refers to a brand that provides the anticipated values. The key point in KBWF's case is that as a sender of a message, the company must make active choices in communications and evaluate the outcome in a long-term perspective, above and beyond sales statistics to establish a solid, (preferably bigger) territory (Figure 4) for building a corporate image.

To detect the stakeholders that hold the greatest value to transform the appreciation of farmed fish is a big concern. To make them listen, to find a way in approaching them about all the work is a strategically question about a company's growth. Who can do it? Who will do it? When something goes bad the news are quick. When something is good – the news tends to go slower. The message of the better use of feed formulation when farming fish holds a great potential.

Further several studies have observed marine aquaculture and found incredibly alike conclusions. "While marine aquaculture can contribute to the supply of seafood and plays a role in stocking and restoration efforts, careful management is required to ensure that it is done in a way that does not harm marine life or the ecosystems on which it depends. Key features of such a governance regime, such as a precautionary approach, careful siting and high standards for environmental performance implemented through flexible, adaptive mechanisms, have been repeatedly articulated after careful examination of the issues" (Pittenger *et al.,* 2007, p. 38). In KBWF's case it was a long process to permit the site set-up and establish a well functioning working production due to the hard state regulations. Continuously testing and reporting in the name of transparency for the environmental stewardship has been done for the continuously production allowance and profitability.

Water standards when farming the deep blue are a controversial issue though ocean water belongs to everyone, like air- we cannot live without it. A growing aquaculture industry will effect the environment, like every other industry. But the incentives are to make the production as environmental friendly and sustainable as possible- today and for the generations to come. Here KBWF has clearly shown that would to be a part of the development as well as acting as a role model for other aquaculture businesses.

As literature states, a firm is operation sustainably when it does not reduce the capacity of the environment to provide for future generations (Bebbington and Gray, 1997; Porter and Linde, 1995; Hawken, 1993). This is also true when it comes to KBWF's way of business approach. This papers finding in the watermetrics is kind of groundbreaking and has not been shown in earlier studies. The finding in this study shows lower transmission into water when introducing more soybean protein concentrate (SPC) in the fish feed. The KBWF brand today is strong and the worth of mouth is of course of great value. But one problem in communicating KBWF efforts is the general production of farmed fish in the ocean.

8 Conclusions

This chapter addresses and answers the importance of sustainability, not only to the environment and stakeholders, but also how it is an important issue for the company's survival:

Communicating sustainable protocols holds great potential as a strategic tool; the purpose of this thesis is to find benchmarks for aquaculture managers as well as a way to communicate sustainability protocols when farming the deep blue.

8.1 Sustainable development in the marine fish industry

The environmental impact of marine fish farming depends very much on species, culture method, stocking density, feed type and hydrograph of the site and husbandry practices. Feed may be lost into the environment through feed wastage, fish excretion, faeces production and respiration (Pittenger *et al.,* 2007). Cleaning of fouled cages may also add an organic loading to the water, albeit periodically (Wuu, 1995). Problems caused by high organic and nutrient loadings conflict with other uses of the coastal zone. The use of chemicals (therapeutants, vitamins and antifoulants) and the introduction of pathogens and new genetic strains have also raised environmental concerns (*Ibid*).

Marine fish culture can be a sustainable development, provided pollution loadings generated by fish farms are kept well below the carrying capacity of the water body. Effects can be significantly reduced by careful site selection, control of stock density, improved feed formulation and integrated culture (with macro algae, filter-feeders and deposit-feeders). An example of the application of an improved and *greener* feed formulation and its impact on marine water is demonstrated in this thesis. Environmental impact assessment and monitoring should be carried out to ensure culture activities are environmentally sustainable.

Effluent standards for land-based fish farms have been well established (e.g. Alabaster, 1982). It would, however, be much more difficult to set effluent standards and control effluent quality in open-water cage farming systems to prevent conflict between coastal users and protects sensitive habitats but it is important for sustainable development of the mariculture industry since nitrogen and organic wastes are major concerns. The susceptibility of the site to dissolved oxygen changes and nitrogen pollution should be given special attention.

Regular monitoring of water and sediment quality at fish culture sites could be required. In summary, marine fish farming can be a sustainable development, and may serve as an environmental probe to detect coastal pollution and protect marine life and non-culture species, if the industry is properly managed.

8.2 Sustainable management in the marine fish industry

Many of the difficulties that aquaculture activities face today with regard to impact on wildlife, can be avoided through a proactive stance (Frankic and Hershner, 2003). This includes opening communication channels with anti-aquaculture activists; continuing research into rectifying the negative impacts of aquaculture on other wildlife; building environmental awareness addressing positive value of sustainable aquaculture and the numerous ways in which it can benefit social communities as well as natural wildlife. Although, the level of uncertainty regarding certain issues remains substantial (water impact, GMOs, transgenics, etc), today's knowledge and available technology generally provide an adequate basis for action to remedy present situation (GESAMP, 2001; FAO, 2002).

Further importance to evaluate and report on the environmental and social performance of indicators face a major challenge in determining whether standards based on sustainability are being translated into sustainable performance on the ground. To determine whether decisions based on existing indicators are producing environmental and social benefits, data from the producer unit can effectively evaluate how indicators translate into performance due to their experience in consultation and standard setting, respectively. The data could be used to create a rigorous annual report on the company's success, both providing metrics for evaluation of success and identifying areas where the effectiveness of indicators could be improved through revision of the indicators or guidelines.

When finding valid benchmarks, KBWF continuously try to make great effort in improving the fish diet with respect of diminishing the use of fishmeal and fishoil, cutting it down from approximately 80 % to 30 % (pers. com., Neil, 2008) in the commercial fishfeeds. A trial of bringing fishmeal and fishoil further down shows that possibilities of another cut of 10 % is possible without loss in growth and health (pers. com., Lowell, 2009). This trial also shows that the waterquality can be improved in most case with more use of SPC. This also shows that "as the price of fishmeal and fishoil rises relative to other protein sources, such as soybeanmeal, aquaculture users will attempt to substitute across protein sources to reduce production costs while maintaining nutritional and quality standards for their products" (www, NOAA, 1, 2008).

The guidelines provide general information o the issue of sustainable development of open ocean aquaculture in order to clarify why indicators is needed to monitor the contribution of open ocean aquaculture to sustainable development. The indicators or watermetrics used in this thesis should be seen as complementary to the guidelines for the sector. The watermetrics highlight in graphics may be of use when conveying the information to stakeholders.

There is an urgent need for more comprehensive assessments and multidisciplinary research to generate data on the positive and negative roles of marine aquaculture in the habitats and ecosystems of oceans. In addition, globally collected data on aquaculture should be integrated, analyzed and generated as useful information. In addition, indicators can and should guide policy and help direct scientific research (Frankic and Hershner, 2001). International, regional and national regulations related to environmental quality standards and indicators are well developed for the control of waterquality and chemicals, although further development is required for sediment and ecosystem quality (e.g., FAO, 1999; ICES/NASCO).

To further improve the sustainability in the open ocean aquaculture industry, these are the recommendations of key regulations and policies that should continue to be addressed, developed and implemented:

- Emphasize use of processed feeds and not fresh feeds such as low valued marine fish (WB, 1998; Naylor *et al.*, 2000).
- Setting suitability standards and indicators for aquaculture (e.g., benthic fauna as bio-indicators).
- Setting monitoring and evaluation mechanisms (M & E).
- Establishing quality standards (certifications) for environmentally friendly practice, processing and sale in the aquaculture industry.
- Developing integrated farming systems – integrated aquaculture–agriculture (ICLARM, 1999; FAO, 2000).
- Eliminating government subsidies for ecologically unsound practices, and establish enforced regulatory measure for protection of coastal and ocean ecosystems (the same should apply to agriculture and fisheries).

Often, comprehensive policies and associated legal frameworks have been overlooked because development has been seen mainly in technical terms and support has been largely focused on technical aspects of production. Also, policymakers have often treated aquaculture in isolation from other sectors and other uses, thus ignoring important linkages and integrated system approach. The need to incorporate political, economic, social, environmental and legal aspects has been neglected, usually with negative consequences for this particular use. The recent emergence of industrial aquaculture and growing competition for resources has focused attention on the need for policy measures and regulatory frameworks (Cicin-Sain, 2000; EC, 2002).

It is essential for appropriate operational conditions to be established at all levels (local, national, regional, and international) to make development of aquaculture in a sustainable and environmentally sound manner attractive to farmers, fishers, local communities and other entrepreneurs and stakeholders. Often, the public's lack of interest in the issue leads to misconceptions and misinformation that later need to be readdressed by a government agency and industry. In order to develop consensus in an area like aquaculture that requires access to unbiased scientific knowledge, it is critical that all the stakeholders have confidence in their background information. Therefore, a framework of common policy elements required for effective aquaculture management includes (based on GESAMP, 2001):

- Cross-sectoral and holistic management
- Rational, equitable and sustainable allocation of resources (includes siting suitability areas for different types of aquaculture)
- Clear commitment by both government and public
- Regional and global international cooperation

The health and sustainable use of coastal and ocean products are of critical importance given their role in food production, economic activity, genetic biodiversity and recreation. In creating a 'sustainable aquaculture', it is essential to strike a balance between the need for aquaculture development and the need for natural resources conservation. In this context it is necessary to recognize and deal with the increasing competition for resources (use conflicts). The diminishing role of the public sector as a promoter of development and the globalization of markets must also be taken into consideration. However, free trade and globalization

ignores the fact that we cannot trade ecosystems and community services (Hawken *et al*., 2000). Therefore, inevitable process of globalization might become more sustainable if the local level development becomes more self-sustainable, considering the capacities of natural resources that are necessary for a long-term sustainable environmental, social and economic development.

In the United States, where this paper's feed trial was undertaken waterquality determination shows great potential for establishment of protocols and models for a sustainable managed open ocean aquaculture sector.

Collecting data needed for the indicator selected, further developing a strategy for dissemination of indicator information to stakeholders (e.g., via annual reporting, headline indicators, news letters or bulletins) involves a great strategic tool and brand activation.

The main conclusion is that an active communication approach that is based on values and implemented from top level management will contribute to strengthening the message and brand of sustainability in a company when it is communicated in a trustworthy way. The open ocean aquaculture sector can gain improved reputation and image if working with environmental and sustainable issues in a successful way.

Bibliography

Literature and publications

Alverson, D.L., Freeberg, M.H., Murawaski, S.A., Pope, J.G, 1994. A global assessment of fisheries by-catch and discards. *FAO Fisheries Technical Paper No. 339*. Rome, FAO.

Avnimelech, Y., 1999. Carbon/nitrogen ratio as a control element in aquaculture systems. *Aquaculture 176*, 227–235.

Akiyama, D. M., 1988. Soybean utilization in fish feeds. *Korean Feed Association Conference*; August 1988, Seoul, Korea.

Anderson, J.L., 2003. International Seafood Trade. *Woodhead Publishing Ltd.*, Cambridge, England.

APHA, AWWA, WEF, 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition. American Public Health Association, American Water Works Association and Water Environment Federation, Washington D.C.

Arnold, D., 1993. The handbook of brand management, *Pitman Publishing*, London.

Asche, F., Tveteras S., 2000. On the relationship between aquaculture and reduction fisheries. Paper presented at the biennial meetings of the *International Institute of Fisheries Economics and Trade*, held in Corvallis, Oregon, 10–14 July, 2000.

Åsgård, T., Austreng, E., 1995. Optimal utilization of marine protein and lipids for human interests. In: Reinertsen, E., Haaland, H., (eds). Sustainable Fish Farming. *Proceedings from First International Symposium on Sustainable Fish Farming,* Oslo, Norway. pp 79-87.

Åsgård, T., Austreng, E., Holmefjord, I., Hillestad, M., 1999. Resource efficiency in the production of various species. In Svennevig, N., Reinertsen, H., New, M. (eds), Sustainable aquaculture: food for the future? *Rotterdam, Netherlands, A.A. Balkema,* p. 171-183.

Atkinson, G., 1999. Measuring Corporate Sustainability. *Journal of Environmental planning and Management*, 2000:43:2, p.235-252.

Barlow, S. M., 2002. The World Market Overview of Fish Meal and Fish Oil. Paper presented to the Second *Seafood By-Products Conference* in Alaska, November 2002.

Beveridge, M., 1984. Cage and pen fish farming. Carrying capacity models and environmental impacts. *FAO Fisheries Technical Paper* 1984:255, 131 p.

Beveridge, M. C. M., Phillips M. J., Macintosh, D.J., 1997. Aquaculture and the Environment: Supply of and Demand for environmental goods and services by Asian aquaculture and the implications for sustainability. *Aquaculture Research*, 1997:28, p.797-807.

Björklund, M., Paulsson, U. 2003. Seminarieboken: att skriva presentera och opponera. Lund: *Studentlitteratur*.

Boyd, C. E., Tucker, C. S., 1995. Sustainability of channel catfish farming. *World Aquaculture,* 26, p. 45–53

Boyd, C. E., Tucker, C.S., 1998. Pond Aquaculture Waterquality Management*, Kluwer Academic Publishers*, Boston, MA.

Boyd, C. E., Schmittou H.R., 1999. Achievement of Sustainable Aquaculture through Environmental Management. *Aquaculture Economics and Management,* 1999:3:1, p. 59-69.

Boyd, C.E., 2000. Waterquality, an Introduction. *Kluwer Academic Publisher*, Boston, MA, 2000.

Boyd, C.E., Queiroz, J.F., 2001. Nitrogen, phosphorus loads vary by-USEPA should consider system variables in setting new effluent rules. *The Global Aquaculture advocate*, 2001:4:6, p. 84-86.

Boyd, C. E., Tucker, C., McNevin, A., Bostick K., Clay J., 2007. Indicators of Resource Use Efficiency and Environmental Performance in Fish and Crustacean Aquaculture. *Reviews in Fisheries Science*, 2007:15:4, p.327-360.

Brown, Becky J., Mark E. Hanson, Diana M. Liverman, and Robert W. Merideth, Jr., 1987. Global Sustainability: Toward Definition. *Environmental Management* 11 (6): 713-719.

Caddy, J. F., Griffiths, R. C., 1995. Living marine resources and their sustainable development. *FAO Fisheries Technical Paper 353*, p. 167.

Cai, H., Sun Y., 2007. Management of Marine Cage Aquaculture- Environmental Carrying Capacity Method on Dry Feed Conversion Rate. *Environmental Science Pollution Research*, 2007:14:7, p. 463-469.

Cao, L., Wang, W., Yang, Y., Yang, C., Yuan, Z., Xiong, S., Diana, J., 2007. Environmental Impact of Aquaculture and Countermeasures to Aquaculture Pollution in China. *Environmental Science Pollution Research* 2007:14 (7), p.452- 462.

Cho, C. Y., Bureau, D. P., 2001. A Review of Diet Formulation Strategies and Feeding Systems to Reduce Excretory and Feed Wastes in Aquaculture. *Aquaculture research*, 2001:32 (suppl.1), p.340-360.

Clarkson, M. B. E., 1995. A Stakeholder Framework for Analyzing and Evaluating Corporate Social Performance. *Academy of Management Review* 30:1, p. 92-117

Connor, W. E., 2000. Importance of n-3 fatty acids in health and disease. *American Journal of Clinical Nutrition* 71:171S-175S.

Crowther, D., 2002. A Social Critique of Corporate Reporting. *Aldershot: Ashgate, UK.*

Crowther, D., 2002b. Perspectives on corporate social responsibility. *Aldershot: Ashgate, UK.*

Delgado, C. L., Wada, N., Rosegrant, M.V., Meijer, S., Ahmed, M., 2003. Fish to 2020, Supply and Demand in Changing Global Markets. *International Food Policy Research Institute*, Washington, D.C., 226 p.

De Schryver, P., Crab, R., Defoirdt, T., Boon, N., Verstraete, W., 2008. The basics of bio-flocs technology: The added value for aquaculture. *Aquaculture* 277: 3-4, p.125-137.

Dowling, D., 2001. Creating Corporate Reputation. Identity, Image and Performance. *Oxford Univ. Press*, Oxford.

Duncan, T., Moriarty, S.E., 1998. A Communication-Based Marketing Model for Managing Relationships. *Journal of Marketing* Vol. 62, p. 1-13.

Enell, M., 1982. Changes in sediment dynamics caused by cage culture activities. In *Proc. 10th Nordic Syrup. Sediments,* p. 72-78.

Engle, C.R., Killian, H.S., 1997. Costs of producing catfish on commercial farms in levee ponds in Arkansas. ETB 252. Cooperative Extension Program, *University of Arkansas at Pine Bluff.*

European Parliament (EP), 2004. The Fishmeal and Fishoil Industry - Its role in the Common Fisheries Policy. *FISH 113 EN*, Feb 2004.

European Union (EU), 2001. Fact Sheet on Dioxin in Feed and Food. *Brussels.*

Food and Agriculture Organization of the United Nations (FAO), 2000. The State of World Fisheries and Aquaculture 2000. *FAO*, Rome.

Food and Agriculture Organization of the United Nations (FAO), 2001. Aquaculture development- Good aquaculture feed manufacturing practice. *FAO*, Rome.

Food and Agriculture Organization of the United Nations (FAO), 2004. The State of World Fisheries and Aquaculture 2004. *FAO*, Rome.

Food and Agriculture Organization of the United Nations (FAO), 2005. The State of the World Fisheries and Aquaculture. PART 1: World review of fisheries and aquaculture, Overview. *FAO*, Rome.

Food and Agriculture Organization of the United Nations (FAO), 2006. State of world aquaculture 2006. *FAO Fisheries Technical Paper,* vol. 500. *FAO*, Rome, p. 134.

Food and Agriculture Organization of the United Nations ((FAO)/GLOBEFISH), 2007. Fishmeal: higher fishmeal prices result in good business. *GLOBEFISH Seafood Highlights*, p. 19–20

Food and Agriculture Organization of the United Nations (FAO), 2008. *FishStat Plus*: Universal Software for Fishery Statistical Time Series.

Food and Agriculture Organization of the United Nations FAO, 2008. Food Outlook — Global Market Analysis. *FAO*, Rome, p. 95.

Forster, J., 1999. Aquaculture Chickens: Salmon - A Case Study. *World Aquaculture* 30(3): 33- 40.

Fowler, S.J., Hope, C., 2006. Incorporating Sustainable Business Practices into Company Strategy. *Judge Institute of Management, Cambridge University,* U.K.

Franic, A., Hershner C., 2003. Sustainable Aquaculture: Developing the promise of Aquaculture. *Aquaculture International*, 2003:11, p. 517-530.

Gallego, I., 2007. The use of Economic, Social and Environmental Indicators as a Measure of Sustainable Development in Spain. *Corporate Social Responsibility and Environmental Management*, 2006:13, p. 78-97.

Gatlin, D. M., Barrows F. T., Brown P., Dabrowski K., Gaylord G. T., Hardy R. W, Herman E., Hu G., Krogdahl Å., Nelson R., Overturf K., Rust M., Sealey W., Skonberg D., Souza E. J, Stone D., Wilson R, Wurtele E., 2007. Expanding the Utilization of Sustainable Plant Products in Aquafeeds: A Review. *Aquaculture Research*, 2007:38, p. 551-579.

Gatlin, D.M., Hardy R.W, 2002. Manipulations of diets and feeding to reduce losses of nutrients in intensive aquaculture, *Aquaculture and the Environments in the United States*, United States Aquaculture, p. 155–165.

GESAMP, (IMO/FAO/UNESCO_IOC/WMO/WHL/IAEAI/UN/UNEP), 1991. Global Strategies for Marine Environmental Protection *IMO Reports and Studies*: 45.

GESAMP, (IMO/FAO/UNESCO_IOC/WMO/WHL/IAEAI/UN/UNEP) Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection, 2001. Planning and Management for sustainable coastal aquaculture development. *Rep Stud GESAMP* 2001:68, p. 90.

Glencross, B. D., Booth, M., Allan, G. L., 2007. A feed is only as good as its ingredients- A review of ingredient evaluation strategies for aquaculture feeds. *Aquaculture Nutrition*, 2007:13, p. 17-34

Goldburg, R., Triplett, T., 1997. Murky Waters: Environmental Effects of Aquaculture in the US. *The Environmental Defense Fund Report.*

Goldburg, R. J., M.S. Elliott, R.L., Naylor, 2001. Marine Aquaculture in the United States: Environmental Impacts and Policy Options. *Pew Oceans Commission*, Arlington, Virginia.

Gray, R., Kouhy, R., Lavers, S., 1995. Methodological themes: constructing a research database of socials and environmental reporting by UK companies. *Accounting, Auditing, Accountability Journal* 1995:2, p. 78-101.

Guttormsen, A.G., 2002. Input Substitutability in Salmon Aquaculture. *Marine Resource Economics* 17: 91-102.

Hall, P., Holby, O., 1986. Environmental impact of a marine fish cage culture. *Int. Counc. Explor. Sea CM* 1986/F:46.

Hardy, R., 2005. Fish Meal Myths Concerning Omnivorous Farmed Fish. *Aquaculture Magazine* 31(3):53-58.
Hasan, M. R. (ed.) FAO, 2007. "Economics of Aquaculture feeding practices in selected Asian countries", *FAO Fisheries Technical Paper*, 2007:505.
Henriques, A., Richardson, J. (Eds). (2004), The Triple Bottom Line - does it all add up? Assessing the Sustainability of Business and CSR. *Erthscan*, London.
Hillman, A. J., Keim, G. D., 2001. Shareholder value, Stakeholder Management, and Social Issues: What's the Bottom Line? *Strategic Management Journal,* 22: 125–139.
Hoffmann, E., 2008. The Consumer Integration in Sustainable Product Development, *Strategic Direction*, 2008: 24: 1.
Holme, I. M., Solvang, B. K., 1991. Forskningsmetodik. Om kvalitativa och kvantitativa metoder. *Studentlitteratur*, Lund.
Huiwen, Yinglan, 2007. Management of marine cage aquaculture, Environmental carrying capacity method based on dry feed conversion rate. *Environmental Science and Pollution Research* Volume 14, Number 7 / November, 2007.
Johnson, H., 2003. U.S. Seafood Market in 2020: strong demand likely boon to aquaculture. *Global Aquaculture Advocate*, November 2003.
Jorgensen, H., Sauer, W.C., Thacker, P.A., 1984. Amino Acid Availabilities in Soybean-Meal, Sunflower Meal, Fishmeal and Meat and Bone Meal Fed to Growing Pigs. *Journal of Animal Sciences* 58(4): 926-934.
Jystad, P.T. 2001. Fishmeal and oil or vegetable alternatives: will high volume production spoil premium fish products? An *IntraFish Industry Report*.
Kay, M., 2006. Strong brands and corporate brands. *European Journal of Marketing*. Vol. 40 No. 7/8, p. 742-760.
Kelleher, K. 2005. Discards in the world's marine fisheries. An update. *FAO Fisheries Technical Paper*. No. 470. Rome, FAO.
Keller, K. L., 1998. Strategic Brand Management, *Prentice Hall,* New Jersey.
Keller, K. L., 2001. Mastering the Marketing Communication Mix: Micro and Macro Perspectives on Integrated Marketing Communication Programs, *Journal of Marketing Management*, No.17, p. 819-847.
Klasing, K.C., 1998. Nutritional Modulation of Resistance to Infectious Diseases. *Poultry Science* 77(8):1119-1125.
Kotler, P., 2003. Marketing Management, *Prentice Hall*, New Jersey.
Kotler, P., Armstrong, G., Saunders, J., Wong, V., 1999. Principles of Marketing. *Prentice Hall Europe*, London.
Kris-Etherton, P. M. Harris, W. S. Appel, L. J. 2002. Fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease. *Circulation* 106(21):2747-57.
Kristofferson, D., Anderson, J. L., 2006. Is there a relationship between fisheries and farming? Interdependence of fisheries, animal production and aquaculture. *Marine Policy* 30:721-725.
Kromhout, D., Bosschieter, E. B., de Lezenne Coulander, C., 1985. The inverse relation between fish consumption and 20-year mortality from coronary heart disease. *New England Journal of Medicine* 312:1205-1209.
Kvale, S., 1997. Den kvalitativa forsknings intervjun. *Studentlitteratur,* Lund.
Lem, A., Shehadeh, Z. H., 1997. International trade in aquaculture products. *FAO Aquaculture Newsletter 17,* p. 3–6.
Langan, R., 2007. Seafood-Exploring Benefits and Risks. *University of New Hampshire*
Larraín, C., Leyton, P., Almendras, F., 2005. Aquafeed country profile – Chile and salmon farming. *International Aquafeed,* 8(1):22-27.
Larsson, L., 1997. Tillämpad kommunikationsvetenskap, *Studentlitteratur,* Lund.

Larsson, L-O. 2002. Transparency! Det genomsynliga företaget, *Gecco information,* Malmö.
Lee, S. F., Sai On Ko, A., 2000. Building balanced scorecard with SWOT analysis, and implementing "Sun Tzu's The Art of Business Management Strategies" on QFD methodology. *Managerial Auditing Journal*, 2000. Vol. 15, Iss. 1/2; p. 68.
Loudon, K., Lowell, J., Sims, N., McComas, I., 2009. Testing replacement of fishmeal and fish oil in the *Seriola rivoliana* (Kona Kampachi®) diet with soy-based protein and novel high omega-3 oil (research paper, unpublished). *Kona Blue Water Farm*, Kailua-Kona, Hawaii.
Makkink, C.A., Negulescu, G.Q., Qin, G.X., Verstegen M.W.A., 1994. Effect of Dietary Protein Source on Feed Intake, Growth, Pancreatic-Enzyme Activities and Jejunal Morphology in Newly-Weaned Piglets. *British Journal of Nutrition* 72(3): 353-368.
Marshall, S. R., Brown D., 2003. Corporate Environmental Reporting: What's in a metric? *Business Strategy and the Environment*, 2003:12, p.87-106.
McPhaden, M. J., Soreide, N. N., undated. Frequently Asked Questions about El Nino and La Nina, Department of Commerce, National Oceanic and Atmospheric Administration, *Pacific Marine Environmental Laboratory*, (Tropical Atmosphere Ocean Project).
McShane, S. L., Von Glinow, M. A., 2003. Organizational Behavior. *McGraw-Hill*, New York.
Merriam, S., 1994. Fallstudien som forskningsmetod. *Studentlitteratur*, Lund.
Mitchell, Agle, Wood, 1997. Toward a theory of stakeholder identification and salience: Defining the principle of whom and what really counts. *Academy of Management Review* [AMR]22, p. 853 – 886.
Montero, D., Robaina, L., Caballero, M. J., Ginés, R., Izquierdo, M. S., 2005. Growth, feed utilization and flesh quality of European sea bass (Dicentrarchus labrax) fed diets containing vegetable oils: A time-course study on the effect of a re-feeding period with a 100% fish oil diet. *Aquaculture* 248 p. 121– 134.
Morhardt, E. J., Baird, S., Freeman, K., 2002. Scoring Corporate Environmental and Sustainability Reports Using GRI 2000, ISO 14031 and other Criteria, *Corporate Social Responsibility and Environmental Management,* 2002:9, p. 215-233.
National Aquaculture Association, NAA, 1998. Offshore Aquaculture in the United States: Economic Considerations, Implications & Opportunities, July 2008 (Pre-Publication Copy). *NOAA Aquaculture Program.*
Naylor, R., Goldburg, R., Primavera, J., Kautsky, N., Beveridge, M., Clay, J., Folke, C., Lubchenco, R., Mooney H., Troell, M., 2000. Effect of aquaculture on world fish supplies. *Nature* 405:June 29.
New, M. B., Wijkstrom, U. N., 2002. Use of Fishmeal and Fish oil in Aquafeeds: Further Thoughts on the Fishmeal Trap. *FAO Fisheries Circular* No 975. Rome.
Pensack, J. M., Bethke, R. M., Kennard, D. C.,1949. The Effect of Fish Meal and Extracts of Fish Meal on Hatchability of Hens Eggs and Growth of Progeny. *Poultry Science.* 28(3):398-405.
Perera, O., 2008. How material is ISO 26000 Social Responsibility to small and medium-sized enterprises (SMES)? *International Institute for Sustainable Development (IISD).*
Pike, I.H., 2005. Eco-efficiency in aquaculture: global catch of wild fish used in aquaculture. *International Aquafeed* 8(1): 38-40.
Pike, I.H., Barlow, S. M., 2002. Impact of Fish Farming on Fish Stocks. Paper presented at *Bordeaux Aquaculture and Environment Symposium.* September 2002.

Pike, I.H., Curran, M.K., Edge, M., Harvey, A., 1984. Effect of Nutrient Density, Presence of Fish-Meal and Method of Feeding of Unmedicated Diets on Early Weaned Pigs. *Animal Production* 39:291-299.

Pittenger, R., Anderson, B., Benetti, D., Dayton, D., Dewey, B., Goldberg, R., Rieser, A., Sher, B., Sturgulewski A., 2007. Sustainable Marine Aquaculture: Fulfilling The Promise; Managing The Risks.

Porter, M. E., Van der Linde C., 1995. Green and Competitive. *Harvard Business Review,* September-October 1995.

Porter, M. E., Van der Linde C., 1995. Toward a New Conception of the Environment-Competitiveness Relationship. *The Journal of Economic Perspectives (1986-1998);* 1995; 9, 4.

Pringle, H., Thompson, M., 1999. Brand spirit - how cause related marketing builds brands. *John Wiley & Sons,* Chichester.

Read, P., Fernandes, T., 2003. Management of environmental impacts of marine aquaculture in Europe. *Aquaculture* 2006:226, p. 139-163.

Riezebos, R., 2003. Brand Management. A theoretical and practical approach. *Prentice Hall*, Pearson Education Ltd., Harlow, the UK.

Roheim, C., Anderson, J.L., 2003. International Seafood Trade. *Woodhead Publishing Ltd.*, Cambridge, England.

Schipp, G., 2008. Is the Use of Fishmeal and Fish Oil in Aquaculture Diets Sustainable? *Darwin Aquaculture Center*

Schwarz, J., Beloff, B., Beaver, E., 2002. Use sustainability metrics to guide decision-making. *Chemical Engineering Progress*, July 2002.

Seierstad, S.L., Seljeflot, L., Johansen, O., Hansen, R., Haugen, M., Rosenlund, G., Froyland, L., Arnesen, H., 2005. Dietary Intake of Differently Fed Salmon: The Influence on Markers of Human Atherosclerosis. *European Journal of Clinical Investigation* 35(1): 52-59.

Shamshak, Anderson, 2008. Future Aquaculture Feeds and Feed Costs: The Role of Fish Meal and Fish Oil. *NOAA Aquaculture Program.*

Steinholtz, D., Löhman, O., 2003. Det ansvarsfulla företaget: Corporate Social Responsibility i praktiken. *Ekerlids Förlag*, Falun.

Sugiura, S. H., Hardy, R.W., 2000. Environmental friendly feeds. *Encyclopedia of Aquaculture* (Stickney, Ed R.R.), John Wiley & Sons, New York, 2000, p.299-310.

Tacon, A. G. J., Phillips, M. J., Barg, U.C., 1995. Aquaculture Feeds and the Environment: The Asian Experience. *Water Sciences Technology*, 1995:31:10, p.41-59

Tacon, A. G. J., Forster, I. P., 2003. Aquafeeds and the Environment: Policy Implications. *Aquaculture,* 2003:226, p.181-189

Tacon, A.G. J., 2004. Use of Fish Meal and Fish Oil in Aquaculture: A Global Perspective. *Aquatic Resources, Culture and Development* 1(1):3-14.

Tacon, A.G. J., 2005. State of Information on Salmon Aquaculture Feed and the Environment. http://www.westcoastaquatic.ca/Aquaculture_feed_environment.pdf

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. *Elsevier,* Aquaculture 285 (2008) p.146-158.

Thorstensson, G., 2006. Människor påverkar människor. *Springtime,* Stockholm.

Vukina, T., Anderson, J. L., 1993. A State-Space Forecasting Approach to Optimal Intertemporal Cross-Hedging. *American Journal of Agricultural Economics* 75:416-424.

Wåhlstedt, H., 2001. Resultatredovisning för hållbar utveckling: Naturekonomiska principer för kommunal tillämpning, *Akademitryck AB*, Edsbruk.

Wantanabe, T., 2002. Strategies for further development of aquatic feed. *Fisheries Science,* 2002: 68, p. 242-252.
Weber, M., 2003. What Price Farmed Fish: A review of the environmental and social costs of farming carnivorous fish. *SeaWeb Aquaculture Clearinghouse*.
Wetzel, R. G, 2001. Limnology, *Academic Press*, San Diego CA 3rd ed.
Whitehouse, L., 2006. Corporate Social Responsibility – Views from the Frontline. *Journal of Business Ethics*, No.63, p. 279-296.
Wu, R. S. S., Lam, K. S., MacKey, D. W., Lau, T. C., Yam, V., 1994. Impact of marine fish farming on waterquality and bottom sediment: a case study of the sub-tropical environment. *Marine Environmental Research 38*, p. 115-145.
WHO/FAO, 2003. Diet, Nutrition and the prevention of chronic diseases. *WHO technical report series 916*, Report on a joint WHO/FAO expert consultant, Geneva, 2003.
Woodman, H.E., Evans, R. E., 1951. The Determination of the Relative Supplemental Values of Vegetable Proteins (Extracted, Decorticated Ground Nut Meal) and Animal Protein (White Fish Meal). *Journal of Agricultural Science* 41(1-2):102-140.
Wray, T., 2001. Making the most of jack mackerel. *Seafood International,* July 2001, p.39-43.
Wu, R. S. S, 1995. The environmental impact of marine fish culture: Towards a sustainable future. *Mar Poll Bull 1995:31*, p. 159-166.
Wu, R. S. S., Shin P.K.S., Mackay D.W., Mollowney M., Johnson D, 1999. "Management of Marine Fish Farming in the Sub-Tropical Environment: A Modeling Approach", *Aquaculture*, 1999:174, p.279-298.
Yamagata, H., Saino, H., Suzuki, H., Kobayashi, M., Minamiyama, M., Fujita, K., Sakai, K., Takahashi, M., 2008. Management of chemical substances in a water environment communicating among stakeholders, *Water Science and Technology,* 57.1, 2008.
Zaldivar, M.J., 2004. Review of the commercial situation of fishmeal and fish oil and the new requirements imposed on them. Paper presented at *Tecnica Aqua Sur 2004* (Chile).
Zaryabova, V., Israel, M., 2007. Needs of communication with general public about the potential risk of electromagnetic fields and methods for achieving this goal, *Environmentalist,* 2007:27, p. 557-561.

Internet

BOI, Blue Ocean Institute, www.blueocean.org
1. *Guide to ocean friendly seafood,* 2009-02-10
http://www.blueocean.org/seafood/seafood-guide

Edelman, www.edelman.com
1. *Corporate Responsibility and Sustainability Communication,* 2008-08-20
http://www.edelman.com/image/insights/content/EdelmanCSR020508Final.pdf

FAO, Food and Agriculture Organization of the United Nations, http://www.fao.org

1. *About FAO,* 2008-06-15
http://www.fao.org/about/about-fao/en/

2. *Introduction to the Sustainable Development Concept in Fisheries*, 2008-06-15
http://www.fao.org/docrep/005/Y4260E/y4260e0r.htm

3. *The State of the World Fisheries and Aquaculture. PART 1: World review of fisheries and aquaculture, Overview*. 2008-06-16
www.fao.org/docrep/007/y5600e/y5600e04.htm

4. *Environmental impacts of aquaculture*, 2008-06-16
http://www.fao.org/fishery/topic/14894/en#container

FIN, Fishmeal Information Network, http://www.gafta.com/fin/fin.html
1. *Fishmeal Information network,* 2008-09-10
http://www.gafta.com/fin/fin.html

2. *Fin Dossier 2005: Annual review of the feed grade fish stocks used to produce fish meal and fish oil for the UK market,* 2008-09-10
http://www.gafta.com/fin/FINsustain.pdf

3. *Fish meal Facts and Figures*, 2008-09-10
http://www.gafta.com/fin/finfacts1.html

4. *Contaminants in Fish and Fish Meal,* 2008-09-10,
http://www.gafta.com/fin/findioxin.html

Globefish FAO, http://www.globefish.org/
1. Fishmeal market report – June 2008, 2009-06-20
http://www.globefish.org/dynamisk.php4?id=4535

GRI, Global Reporting Initiative, http://www.globalreporting.org
1. *Sustainability Reporting Guidelines*, 2008-08-20
http://www.globalreporting.org/ReportingFramework/ReportingFrameworkOverview/

GSMFC, Gulf States Marine Fisheries Commission,
http://www.gsmfc.org/menhaden/2002%20About%20Us.shtm
1. *Menhaden links,* 2008-08-30
http://www.gsmfc.org/menhaden/2002%20Links.shm

IFFO, International Fishmeal & Fish Oil Organization Ltd, www.iffo.com
1. *Fishmeal and Fishoil Outlook for 2007*, 2008-10-01
http://www.aquaculture.ugent.be/liter/BibMail/ioi/2007/jun/7.pdf

2. *Advantages of Using Fish Meal in Animal Feeds*, 2008-07-01
http://www.iffo.org.uk/tech/FM-Anim.pdf

3. Industry Overview, 2008-07-01
http://www.iffo.net/default.asp?fname=1&sWebIdiomas=1&url=253

KBWF, Kona Blue Water Farm, http://www.kona-blue-com
1. *Who is Kona Blue?* 06/10/2008
http://kona-blue.com/aboutus.php

2. *Kona Kampachi® is open ocean grown, sustainable from hatch to harvest*, 06/10/2008
http://kona-blue.com/sustainability.php

3. *Hawaiian Fish Farming & Kona Blue*, 06/10/2008
http://kona-blue.com/hawaiianaquaculture.php

NAA, National Aquaculture Association, http://www.natlaquaculture.org
1.*U.S aquaculture and environmental stewardship,* 07/1998,
http://www.natlaquaculture.org/EnvirPaper.htm

NOAA, National Oceanic and Atmospheric Administration, www.noaa.gov
1. *What is Aquaculture?* 2008-10-20
http://aquaculture.noaa.gov/what/welcome.html

2. *10-Year Plan for Marine Aquaculture (2007).* 2008-10-22,
http://aquaculture.noaa.gov/pdf/finalnoaa10yrrweb.pdf

NEFMC, New England Fishery Management Council, www.nefmc.org
1. *Atlantic Herring Fishery Management Plan*, 2008-11-21
http://www.nefmc.org/herring/summary/herring.pdf

OJEC, Official Journal of the European Communities, www.europa.eu.int
1. *Commission Regulation (EC)* (No 1292/2005. L 205/3. 6.8.2005), 2008-11-21
http://europa.eu.int/eurlex/lex/LexUriServ/site/en/oj/2005/l_205/l_20520050806en00030011.pdf

2.*Commission Regulation (EC)* (No 999/2001. L 147/1. 31.5.2001), 2008-11-21
http://europa.eu.int/eurlex/pri/en/oj/dat/2001/l_147/l_14720010531en00010040.pdf

Schneiderman, A.M., www.schneiderman.com
1. *How to build a Balanced Scorecard©*, 2009-04-01
http://www.schneiderman.com/Concepts/Scorecard/How_to_Build_a_Balanced_Scorecard/1_The_Business_Process/the_business_process.htm

Seattle Pi, www.seattlepi.com
1. *Bainbridge firm's underwater fish cages like suspension bridges*, 2009-07-20
http://www.seattlepi.com/local/260390_nets22.html

UN, www.un.org
1. *Report of the United Nations conference on Environment and Development, Rio Declaration on Environment and Development,* 2008-07-30
http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm

USDA, U.S. Department of Agriculture, www.nal.usda.gov
1. *Agricultural Research Service, USDA Nutrient Database for Standard Reference, Release 18*. 2008-08-19
http://www.nal.usda.gov/fnic/foodcomp

USDOC, U.S. Department of Commerce, www.nmfs.gov
1. Aquaculture Policy (1999). 2008-08-22
http://www.nmfs.noaa.gov/trade/DOCAQpolicy.htm

2. Imports and exports of fishery products: annual summary 2005. Current Fisheries Statistics No. 2005- 2008-08-22, http://www.st.nmfs.gov/st1/trade/documents/TRADE2005.pdf

USGBC, U.S Green Building Council, http://www.usgbc.org/

1. About USGBC, 2008-09-16 http://www.usgbc.org/DisplayPage.aspx?CMSPageID=124

WWF, World Wild Life, www.worldwildlife.org

1. *State of information on salmon aquaculture feed and the environment (prepared for the WWF Salmon Aquaculture Dialogue by Tacon,* A.G.J. 2005). 2008-11-15 http://www.worldwildlife.org/cci/dialogues/salmon.cfm

Personal messages

Lowell, J., Fish Heath Manager, Kona Blue Water Farm (HI), E-mails and telephone June 2008- February 2009.

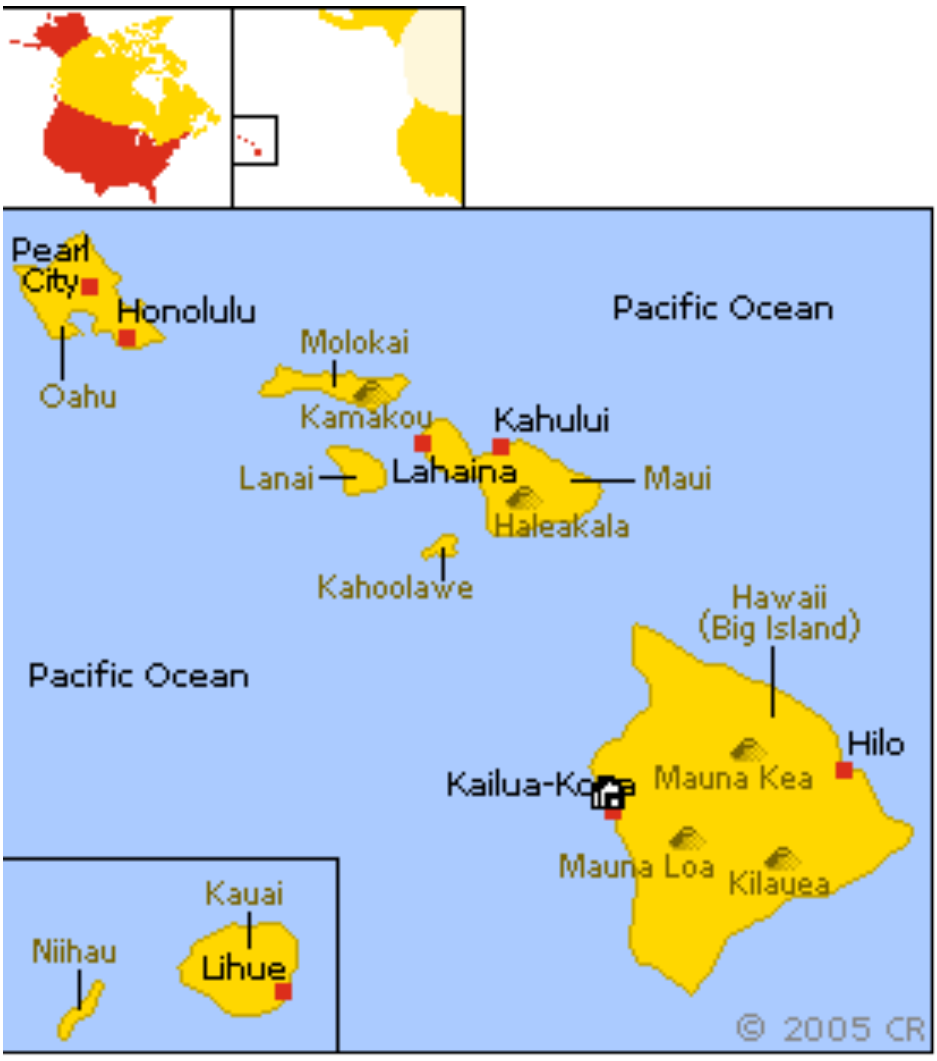
Owen, O., Vice Director, National Soybean Research Center (IL), Personal meetings and e-mails June 2008- April 2009.

Sims, N., President and co-founder, Kona Blue Water Farm (HI), Personal meeting August 2008.

Sims, N., President and co-founder, Kona Blue Water Farm (HI). Personal Communication on July 13, 2008, through BOI.

APPENDIX 1

Map over Hawaii and the location of the studied case company



APPENDIX 2

Environmental Protection Agency

”To ensure that waterquality and the health of marine ecosystems are not degraded by marine aquaculture, the Environmental Protection Agency should:
• Review effluent limitations guidelines (ELGs) for concentrated aquatic animal production facilities (CAAPFs) to ensure they address concerns related to aquaculture in marine waters under federal jurisdiction;
• Ensure waterquality standards are in place for marine waters under state jurisdiction; and
• Promulgate waterquality standards for marine waters under federal jurisdiction or revise guidelines for determining degradation of ocean waters required by section 403(c) of the Clean Water Act (Pittenger *et al.,* 2007, p. 86).

”EPA and the states should include enforceable conditions in new and revised NPDES permits for CAAPFs to ensure compliance with ELGs, waterquality standards and/or ocean discharge guidelines” (Pittenger *et al.,* 2007, p. 86).

”Regulations implementing waterquality standards and guidelines for determining degradation of ocean waters should specifically: Authorize NPDES permit writers to limit discharges of uneaten feed, animal wastes, drugs and chemicals) by CAAPFs if required to achieve waterquality standards and/or comply with ocean discharge criteria;
• Establish size thresholds for large CAAPFs above, which the inclusion in permits of such controls, would be mandatory” (Pittenger *et al.,* 2007, p. 86).

Require CAAPFs, as a condition of their NPDES permits, to:
• ”Periodically report the number and species of aquatic animals held in the permitted facility, and the amount and type of feeds, drugs and other chemicals used at a CAAPF:
• Promptly report failures of nets, cages or other containment structures; and
• Submit plans detailing best management practices (BMPs) for approval by the NPDES permitting authority and comply with those plans ”. (Pittenger *et al.,* 2007, p. 87).

”If legislation is enacted authorizing NOAA to issue site and operating permits for offshore aquaculture, BMP plans required under the Clean Water Act could be integrated into the broader operating plans we recommend NOAA require as a condition of operating permits issued by that agency” *(Ibid).*

APPENDIX 3

Guidelines for responsible aquaculture (production level).

- ”States should promote responsible aquaculture practices in support of rural communities, producer organizations and fish farmers”.
- ”States should promote active participation of fish farmers and their communities in the development of responsible aquaculture management practices”.
- ”States should promote efforts, which improve selection and use of appropriate feeds, feed additives and fertilizers, including manures”.
- ”States should promote effective farm and fish health management practices favoring hygienic measures and vaccines. Safe, effective and minimal use of therapeutants, hormones and drugs, antibiotics and other disease control chemicals should be ensured”.
- ”States should regulate the use of chemical inputs in aquaculture which are hazardous to human health and the environment”.
- ”States should require that the disposal of wastes such as offal, sludge, dead or diseased fish, excess veterinary drugs and other hazardous chemical inputs does not constitute a hazard to human health and the environment”.
- ”States should ensure the food safety of aquaculture products and promote efforts which maintain product quality and improve their value through particular care before and during harvesting and on-site processing and in storage and transport of the products”.

(FAO Fisheries Department, Code of Conduct for Responsible Fisheries, 1999)

APPENDIX 4

The conducted feed trial- an attempt to find metrics to report to stakeholders

”The commercial produced fish are fed a sustainable feed comprising approximately 30 % fishmeal and fishoil from Peruvian anchovies and trimmings from fish processed for human consumption, and 70 % sustainable agricultural proteins and oils” (pers. com., Lowell, 2008). ”As part of KBWF’s commitment to sustainability, the proportion of fishmeal and fishoil in the feed has been reduced from around 80 %, three years ago, to the current level of around 30%” (pers. com., Sims, 2008).

The replacement feed trial

A feeding trial involving water sampling starting on August 13th (2008) to October 22nd (2008) to investigate the water’s effect of partially replacing fishmeal (FM) with soy protein concentrate (SPC).

Five different diets were formulated, in which FM protein was replaced by SPC at 0%, 10%, 20%, 30% and 40%. These diets were tested against a commercially available control diet; crude protein 84 %, crude fat 24%, crude fiber 3%, crude phosphorus 1.3% (pers. com., Lowell, 2009). Each of the six diets was randomly assigned to triplicate groups of 40 fish per aquarium (initial weight 10.61±0.47 g), all the 726 fish were taken from KBWF production facility for use in this soy protein concentrate inclusion study *(Ibid)*. Fish were maintained in flow-through aquaria (18, 4MT HDPE, 4000 L/tank) at water temperature ranging from 24.0 to 26.0 °C and were fed three times daily *(Ibid*). Small containers of water were collected once a week for the first ten weeks.

The diets were further randomly assigned to each tank using a random number generator. Fish were allowed to acclimate and grow in these 18, 4MT HDPE tanks for 3 weeks, such that they would be large enough to begin feeding on the “small” pellet diet. All of the tanks contained 40 fish with the exception of one that was stocked with 46 fish. These fish were small and having this increased number ensured similar stocking densities *(Ibid*). Fish were fed to satiation three times daily and the amount of feed consumed each day was recorded (total amount consumed minus any uneaten pellets). The initial weight per fish for each diet was calculated by weighing the entire population of a tank and dividing the total by the number of fish the first morning of the feed trial (prior to feeding).

Fish receiving the diet containing 40 % SPC fed well initially, but as time progressed the fish showed less interest in the feed. By August 25 chronic mortalities were seen in all three replicates with increasing mortalities in these tanks as time progressed. This portion of the study was terminated on September 3 and the results shown later on must take this into consideration. All other fish continued to do well and were switched onto the “large” pellet in early September.

Observations made on the feed trial (pers. com., Lowell, 2009):

- When the feed trial ended there was a trend towards higher weight gain with lower percentage soy diets.
- There was no significant difference in total weight gain among fish fed the commercial diet, the 0% Soy diet, the 10% Soy diet and the 20% Soy diet.
- There was a trend towards higher mortality with higher percentage soy diets.
- There was no significant difference in mortality among fish fed the commercial diet, the 0% Soy diet, the 10% Soy diet and the 20% Soy diet.
- Fish fed the commercial diet and the 0% Soy diet showed significantly less mortality than fish fed the 30% Soy diet.
- There was no significant difference in mortality between fish fed the 10% soy diet, the 20% Soy diet and the 30% Soy diet.
- Fish fed the commercial diet, the 0% Soy diet and the 10% Soy diet grew significantly more than fish fed the 30% Soy diet.
- Although significant differences were observed in growth, there was no significant difference in feed conversion among the different diet types.

Results indicate that protein inclusion from SPC could effectively replace FM protein at 10 % in diets of *Seriola rivoliana* (Kona Kampachi®) (pers. com., Lowell, 2009), but Lowell further indicates that more research is required to investigate higher levels of FM replacement with different soybean protein blends.

The study made by KBWF has shown that it is possible to replace up to 10 % of FM by SPC without affecting *Seriola rivoliana* (Kona Kampachi®) growth. However, the use of soybean oil has been found to alter the nutritional quality of fish fillets by decreasing the levels of n-3 HUFA and increasing levels of C18 fatty acids, particularly Linoleic acid (LA) (Montero, 2005). Further experiments are required in the use of blends of soybean oils to obtain the best growth results in order to substitute higher percentages of fish oil (pers. com., Lowell, 2009).

Further to be detected is the waterquality determination of introducing more SPC into the fishdiet.

APPENDIX 5

Nutrients and organic matter from feed that are not converted to fish biomass pass directly from cages into surrounding waters. Thus, considering all types of aquaculture, cage culture has the greatest potential for causing pollution. The most important variables in consideration of effluent quality are: total oxygen carbon (TOC), total nitrogen (TN), total phosphorus (TP), ammonia and total suspended solids (TSS).

Limits for concentration of some potential pollutants typically are 2 to 5mg/L for total nitrogen (TN), 0.2 to 0.3 mg/L for total phosphorus (TP), and 20 to 30 mg/L total suspended solids (TSS) (Boyd, 2000). Also, reducing total dietary phosphorus and using feedstuffs and supplements with high phosphorus availability can reduce urinary losses of phosphorus by more than 70 % and reduce fecal losses by more than 50 % (Gatlin and Hardy, 2002, p. 155-165).

In several fish experiments, pH has been shown to be an environmental stressor resulting in aberrant physiological functioning, of course depending on the species. In general, next to the fact that it is not an easy parameter to control in the ocean, possible changes in pH are limited to the optimal range for the cultured animals to avoid mortality and disfunctioning (De Schryver *et al*., 2008).

The influence of temperature is another complex factor. The temperature is of major importance for the microbial metabolism. The temperature is closely linked to the amount of dissolved oxygen in the water (Boyd, 1998). The culture species will thus not only be influenced by the temperature (changes in growth rates, food conversion efficiencies and even mortality), but also by the associated dissolved oxygen level (De Schryver *et al.,* 2008).

Total Organic Carbon

The dosing of an organic carbon source to the culture water in bioflocs induces a decrease in dissolved oxygen levels due to aerobic microbial metabolism. This may induce (sub) lethal effects on sensitive culture species (Landman *et al*., 2005). The organic carbon can be supplied either as an additional organic carbon source (e.g. glucose, acetate, glycerol) or by changing the feed composition thus increasing its organic carbon content (Avnimelech, 1999).

As seen in Figure 14, the TOC values will increase before feed (14 %) and decrease after feed (6%) when implementing the suggested 10% SPC replacement.

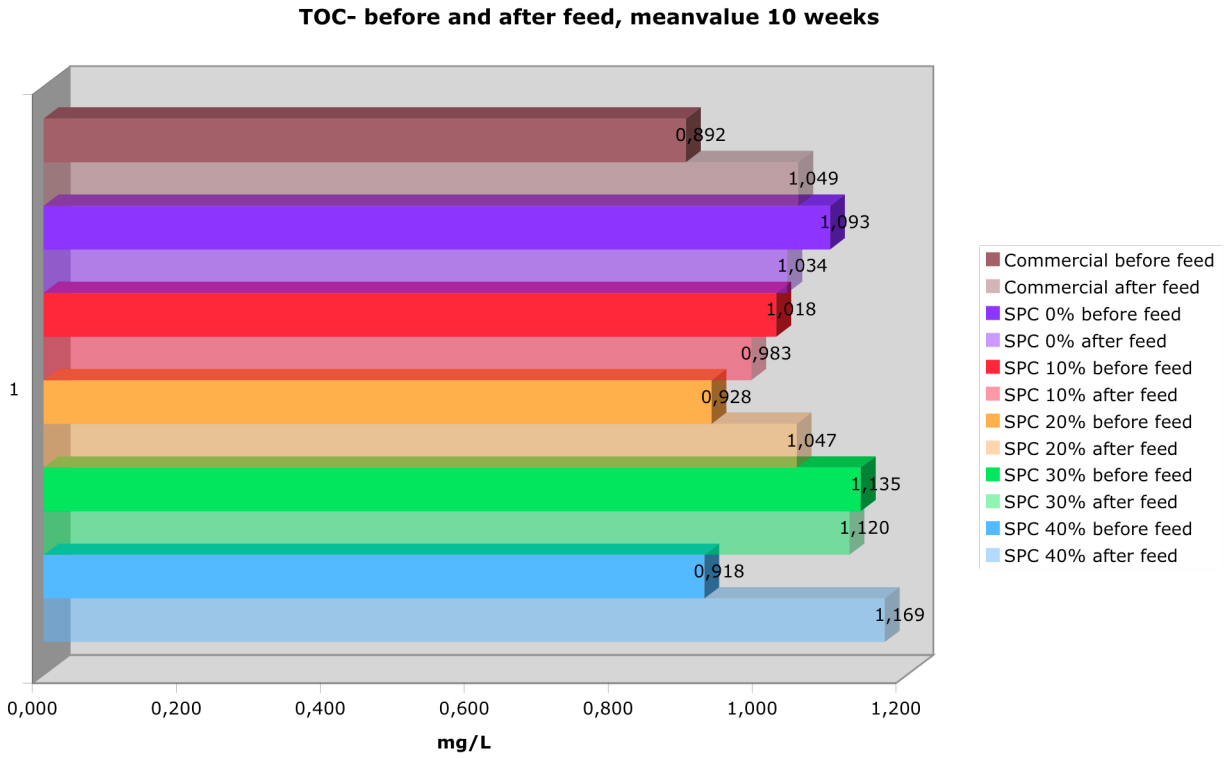


Figure 14. The TOC mean values–before and after feed, in the above graph shows that the replacement of SPC at an 10 % level (pers. com., Lowell, 2009) which is the optimum level of replacing fishmeal gives before feed (+12 %) and after feed (- 6 %) water quality change. The 10 % percentage allows optimum fish growth while the mortality rate is still low. All percentages are taken from the fishmeal portion of the commercial feed which is made up approximately 30 % fishmeal.

No significant difference in TOC can be measured introducing more soy product in the fish feed.

Total Nitrogen

The samples were oxidized in an autoclave at 120° C and 15 psi with an alkaline persulfate mixture. The oxidation process converts all nitrogen-containing compounds to nitrate. The nitrate is subsequently determined colorimetrically by continuous-flow autoanalysis using the hydrazine sulfate – sulfanilamide reduction method (Standard Methods 4500-NH_3 G, 20th Edition, 1998). *NB; This method may give poor recoveries for organic compounds that contain nitrogen to nitrogen double bonds as well as terminal nitrogen groups.*

Total nitrogen includes inorganic nitrogen compounds (nitrate, nitrite, ammonia) as well as organically fixed nitrogen (proteins, etc). Limits for concentration of total nitrogen as a potential pollutants according to Boyd (2000), is 2 to 5mg/L.

Figure 15 shows that the TN can decrease by using 10 % SPC in the fish diet. Before feed an improvement of 12 % can be made and after feed 25 %.

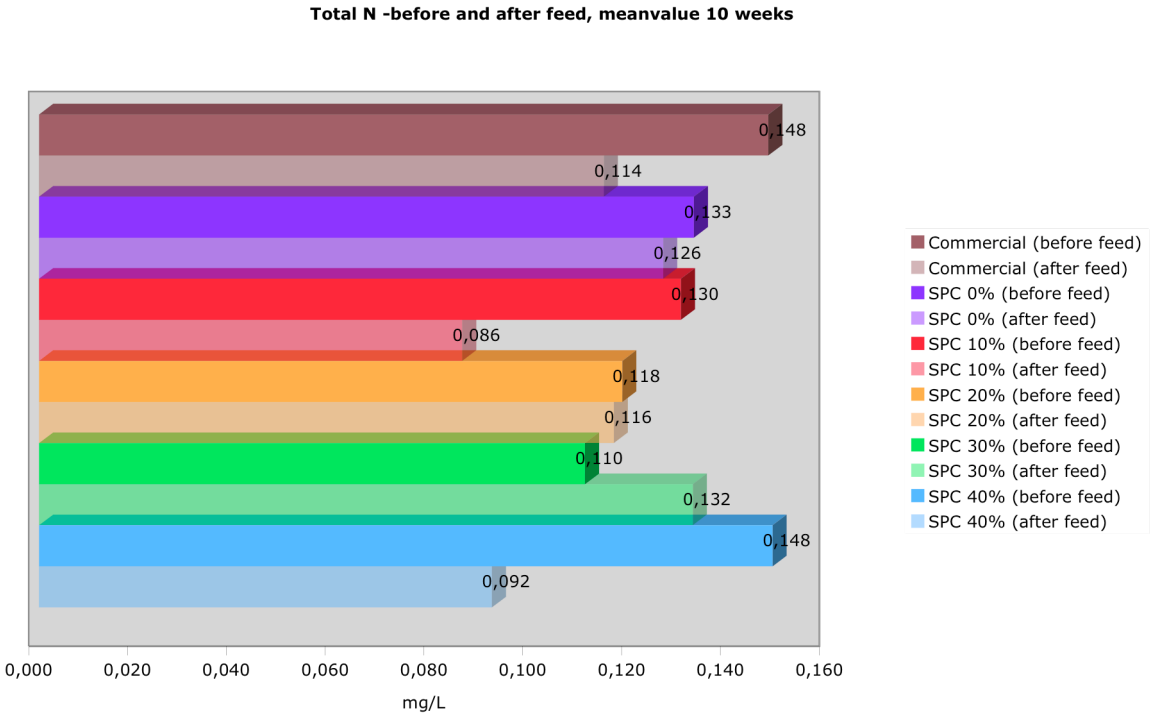


Figure 15. The TN mean values–before and after feed, in the above graph shows that the replacement of SPC at an 10 % level which is the optimum level of replacing fishmeal, gives before feed (-12 %) and after feed (- 25 %) water quality change. The 10 % percentage allows optimum fish growth while the mortality rate is still low. All percentages are taken from the fishmeal portion of the commercial feed which is made up approximately 30 % fishmeal.

The figure shows that the values as in whole are very low and cannot be seen as pollutants according to Boyd (2000).

Total Phosphorus

This is an automated procedure using a continuous flow Technicon Autoanalyzer II for the determination of ortho phosphate. The procedure is based on the colorimetric method in which a blue color is formed by the reaction of ortho phosphate, molybdate ion, and antimony ion followed by a reduction with ascorbic acid at an acidic pH. The reduced blue phosphomolybdenum complex is read at 660nm. (Standard methods 4500-NH_3 G, 20th Edition, 1998).

Figure 16 clearly shows that the TP will decrease using 10 % SPC, with as much as 38% before feed and 25% after feed.

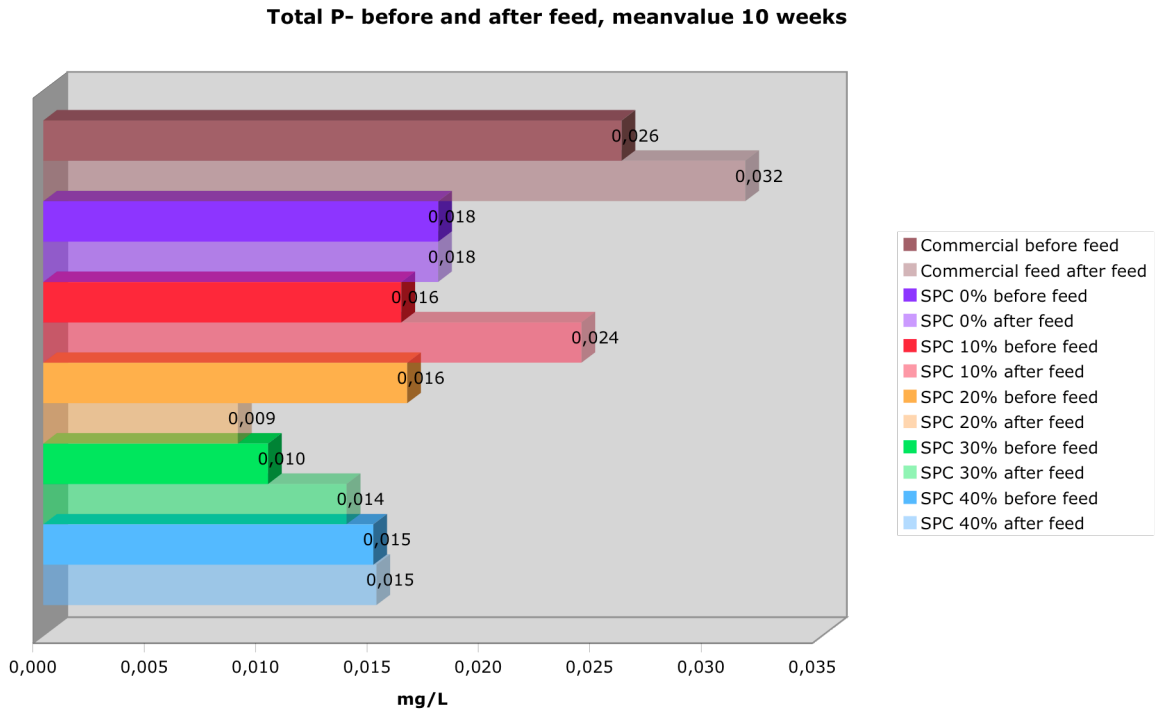


Figure 16. The TP mean values–before and after feed, in the above graph shows that the replacement of SPC at an 10 % level which is the optimum level of replacing fishmeal, gives before feed (-38 %) and after feed (- 25 %) water quality change. The 10 % percentage allows optimum fish growth while the mortality rate is still low. All percentages are taken from the fishmeal portion of the commercial feed which is made up approximately 30 % fishmeal (own creation). The values implies there are no risk for pollution since levels are a lot lower than the proclaimed pollution level of 0.2 to 0.3 mg/L for TP (Boyd, 2000, p 251).

Limits for concentration of Total Phosphorus as a potential pollutant according to Boyd (2000, p. 251) is 0.2 to 0.3 mg/L. The figure clearly shows that there is no risk for pollution due to TP with neither commercial feed nor replacements.

Ammonia

The Automated Phenate Method (Standard Methods 4500-NH_3 G, 20th Edition, 1998) was used together with a Technicon AA II Continuous-flow Autoanalyzer. The automated procedure for the determination of NH_3 in water utilizes the Berthelot Reaction, in which the formation of a green-colored compound believed to be closely related to indophenol occurs when the solution of an ammonium salt is added to sodium phenoxide followed by the addition of sodium hypochlorite (bleach). A solution of potassium sodium tartrate (Rochelle Salt) is added to the sample stream to eliminate the precipitation of the hydroxides of heavy metals that may be present. Ammonia concentration is determined colorimetrically at 630nm.

Ammonia from animal excretions and bacteria degradation is lost by diffusion, converted to organic nitrogen in microbial biomass, and transformed to nitrate by nitrifying bacteria. Nitrate is converted to nitrogen gas through denitrification and lost to the air. Figure 17 shows that the suggested SPC replacement of 10 % will increase the ammonia value (164 %) before feed but slightly decrease (9 %) the value after feed.

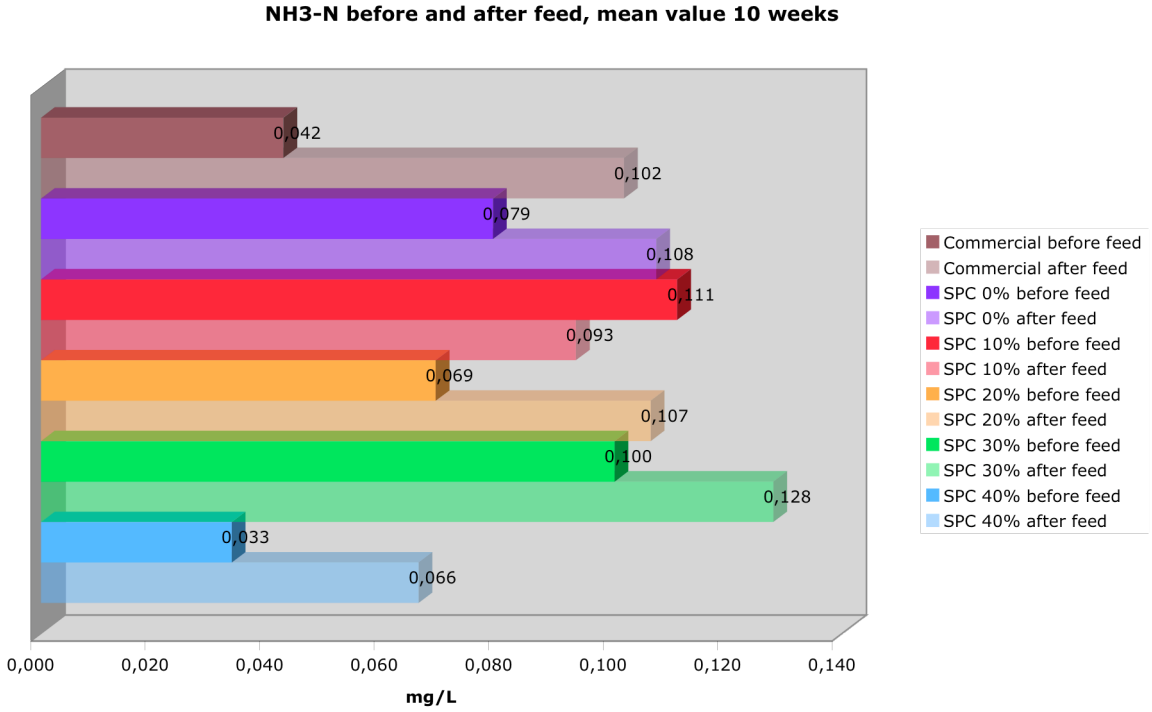


Figure 17. The NH3-N mean values–before and after feed, in the above graph shows that the replacement of SPC at an 10 % level which is the optimum level of replacing fishmeal, gives before feed (+ 164 %) and after feed (- 9 %) water quality change. The 10 % percentage allows optimum fish growth while the mortality rate is still low. All percentages are taken from the fishmeal portion of the commercial feed which is made up approximately 30 % fishmeal.

Even though the TP levels are decreasing with the 10 % SPC replacement, still the ammonia must be considered to not have been improved by the replacement which Gatlin and Hardy (2002, p. 155-165) imply should be the case when reducing total dietary phosphorus and using feedstuffs and supplements with high phosphorus availability. This has not been detected in this trial.

Total Suspendid Solids

Figure 18 shows the values of the commercial feed, in the trial before feed (36.6mg/L) and after feed, (47.6mg/L) can be improved by introducing more soybeanmeal in the fish diet. Limits of total suspendid solids as a potential pollutant are typically 20 to 30 mg/L (Boyd, 2000) indicating that introducing more soybeanmeal in the diet will decrease this chance as being a water pollutant.

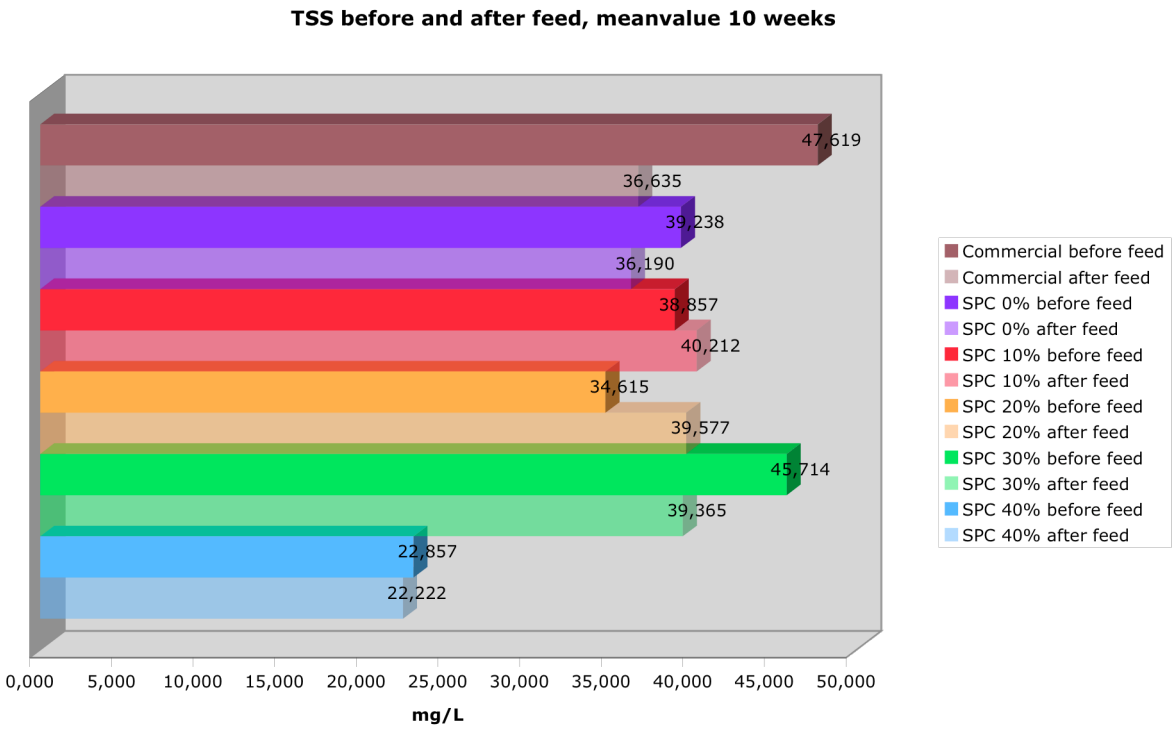


Figure 18. The TSS mean values–before and after feed, in the above graph shows that the replacement of SPC at an 10 % level which is the optimum level of replacing fishmeal, gives before feed (-18 %) and after feed (+ 9,7 %) water quality change. The 10 % percentage allows optimum fish growth while the mortality rate is still low. All percentages are taken from the fishmeal portion of the commercial feed which is made up approximately 30 % fishmeal.

Introducing too much soybeanmeal in the diet- it is shown that the fish leave more uneaten feed and therefore increase the TSS. The suggested replacement at 10 % more SPC, the TSS value can improve 18 % (before feed) but after feed increase the TSS value by 9.7 %

Pris: 100: - (exkl moms)

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