



Norwegian University of
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Human dimensions of natural resource management for the Vosso wild salmon population

A systems thinking approach

Nevena Gajic

Master in Industrial Ecology

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Supervisor: Annik Magerholm Fet, IØT

Co-supervisor: Cecilia Haskins, EPT

“A new way of thinking has become the necessary condition for responsible living and acting. If we maintain obsolete values and beliefs, a fragmented consciousness and self-centered spirit, we will continue to hold onto outdated goals and behaviors ”

- Dalai Lama

PREFACE

This thesis has been prepared under the Department of Industrial Economics and Technology Management at the Norwegian University of Science and Technology (NTNU). It has been submitted in partial fulfillment of the requirements for the MSc. Degree of Industrial Ecology, with a specialization in Environmental Politics and Management.

The choice for this theme is based on my interest in the social side of environmental problems. I believe that it is important to gain more understanding about the links that connect environment and society. The importance of social science in Industrial Ecology should not be disregarded. After all, technological solutions can be brilliantly constructed, but the success of implementation depends strongly on human values, interests and institutional organization.

This semester has been as a phase of discovery and learning. Shaping such an elaborate study was a challenging process, with ups and downs as time progressed. Even though not everything could go exactly according to plan, the process has been very enjoyable.

For this, I want to give my sincere thanks to Cecilia Haskins, my supervisor. Her endless enthusiasm and encouragement have carried me through this semester. Our talks were very pleasant and I very much appreciated the fact that she took ample time for our discussions.

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GLOSSARY

Definitions

Anadromous fish = fish which spawn in fresh water and spend a portion of their lives in the ocean.

Autecology = study of the ecology of an individual plant or species

Carrying capacity = maximum population size of the species that the environment can sustain indefinitely

Fish stock= are subpopulations of a particular species of fish

Gene bank = a collection of animals, plants, seeds, etc., maintained as a repository of genetic material, especially. to preserve genetic diversity.

Hatchery = an establishment for hatching the ova of fish by artificial means

Introgression = the movement of a gene from one species into the gene pool of another

Population biology= a study of populations of organisms

Spawning stock = part of a stock which is mature and breeding

Yolk sac = a membranous sac attached to an embryo, providing early nourishment in the form of yolk in fishes

Abbreviations

DN = Directorate for Nature

LFI = Laboratory for fresh water and inland fish

NJFF= Norway's fishing and hunting association

SE = Systems engineering

SSM = Soft System Methodology

SUMMARY

Vosso, the second-largest watershed in Norway, was considered special as it produced some of the biggest salmon in the country. This salmon had economic, cultural as well as ecological importance. Due to its diversity, it was regarded a unique biological resource. Yet in the late 1980s the stock collapsed, quite abruptly and unexpected. This triggered a large-scale scientific research and eventually led to a rescue project to restore the wild Vosso salmon.

The goal of this thesis was to explore the fundamental questions about the impact of human activity on nature and the conflicts of interest that exist within the management for the restoration of the wild salmon population in Vosso. The study aimed to answer the following question: *“How does the strategy of the salmon restoration project in Vosso address the human dimensions for the restoration of the wild Vosso salmon population on a short and long term?”*

A systems approach was used for data collection and analysis. According to Checkland’s Soft Systems Methodology, the researcher first started with an examination of the background of the problem. The second step was to examine systems thinking about the situation. This step was operationalized with help of interviews, a questionnaire, content analyses and a discourse analysis. The third step of SSM required the development of a common understanding of the change and the change processes needed among the stakeholders involved in the rescue project.

The strategy of the salmon restoration project in Vosso is mostly directed towards finding the causes for the decline of the Vosso salmon population. The measures taken to restore the salmon are primarily centered on producing salmon and treating sea lice. In the short term, this may lead to an increase of salmon in the river. But, if the sources of salmon threats are not eliminated, the survival of the salmon stock will be at risk, and the goal of reaching a sustainable salmon stock that reproduces naturally will be a challenging one. The inclusion of human dimensions in the rescue project is based on the involvement of people with different world views, neglecting differences in interest and centering on achieving the same objective: a wild salmon population that is able to reproduce naturally. However, salmon management in Vosso disregards long-term human dimensions: those human values embedded in institutions and passed on from generation to generation. For reaching sustainable salmon stocks, it is not only important to involve stakeholders with different values in salmon management, it is also crucial to understand the environmental discourses that trigger these values. This understanding needs to occur at all levels of management that influence the outcome of the salmon restoration project in Vosso. This study has shown that the salmon restoration management is trying to achieve sustainability, while employing a problem-solving discourse of administrative rationalism. For the achievement of a sustainable salmon population, the prevailing discourse of administrative rationalism in salmon management needs to make room for the discourse of sustainability.

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1. INTRODUCTION

The lack of a systemic approach hinders the development of effective wild salmon preservation management (Gajic 2010). During the past few centuries, a rapid development has taken place in science and technology, but we have been less successful in establishing a harmonious relationship between nature, humanity, science and technology. This is reflected by the enhancing exploitation of our natural capital, and growing magnitude of natural resource conflicts all over the world, among which those related to fisheries. Fragmented approaches have been used to construct physical, social and cultural realities (Banathy 1999). A more systemic approach is needed when analyzing salmon restoration projects. The purpose of this thesis is to examine how a systems approach can be used to explore the fundamental questions about the impact of human activity on nature and the conflicts of interest that exist within the management for the restoration of the wild salmon stock in Vosso, the second largest watershed in Norway.

1.1 BACKGROUND

Less than fifty years ago, the average Norwegian fisherman could not have imagined that the unique and internationally valued salmon population in Vosso would now be facing extinction. Vosso was considered special as it produced some of the largest salmon in the country. This salmon had economic, cultural as well as ecological importance. Due to its diversity, it was regarded a unique biological resource and therefore a great asset to biodiversity, in national as well as international context. Yet in the late 1980s the stock collapsed, quite abruptly and unexpected (Hoelting 2008; Hordaland 2009).

Because of rapidly declining catches, river fishing was prohibited in 1992 and the legal fishery in the fjords was reduced. Despite these actions, the salmon stock continued to decline. At the same time, salmon farming near Vosso developed at a fast rate. There is growing concern about the impact of farmed salmon escapees interbreeding with wild fish and consequently leading to introgression of wild gene pools. A reason for this is that salmon breeders commonly use artificial selection to increase the economic benefits of the salmon. This leads to salmon with a different physiology, behaviour and gene transcription (Gross 1998; Barlaup 2008). However, other industrial activities, among which a nearby hydropower plant in Evanger have likely contributed to the collapse of the Vosso salmon. On a local as well as national level concern was raised about the fate of the salmon population. If no adequate action is taken, the loss of perhaps the largest Atlantic salmon in the world seems inevitable (Barlaup 2008). Therefore a large scaled restoration project has been initiated to save the wild salmon and return its population to a sustainable level.

Nonetheless, reaching sustainability of the salmon stock in Vosso does not merely depend on understanding the ecological system. Salmon restoration management involves many actors. They come from a variety of disciplines, often characterized by conflicting interests. Even without gaps in ecological knowledge, differences in priorities are likely to occur when deciding which actions need to be taken. This makes successful restoration management a challenging business.

1.2 GOAL OF THIS THESIS AND RESEARCH QUESTIONS

As Pahl-Wostl et. al. (2008) note: *“the problem that we face when we deal with sustainability lies not so much in our lack of understanding of the functioning of ecological systems, but rather in our lack of understanding of socio-cultural systems and how they are structured and managed and interact with ecological systems”* (Pahl-Wostl et. al. 2008). The socio-cultural environment prescribes values and goals which together with the physical environment establish needs (real or perceived) (Rosenman & Gero 2006). The ways in which the value of the wild salmon is perceived by its stakeholders, will influence its restoration possibilities. It is a fact that many restoration projects have not met their stated objectives because of non-co-operation or even opposition from key stakeholders, who believed they would be adversely affected by change. Analyzing stakeholders can help to gain an understanding of a system, and to analyze the impact of changes to that system, by identifying the key stakeholders and assessing their respective interests. (Grimble 1998). For this to happen, we need to understand the collisions between and inside ecological and social systems. This thesis will focus on a salmon restoration project in the Norwegian watershed ‘Vosso’ in Hordaland, depicted in figure 1.1. The main objective of this dissertation is to explore the fundamental questions about the impact of human activity on nature and the conflicts of interest that exist within the project for the restoration of the wild salmon stock in Vosso. It builds on earlier research by the author and others.



Figure 1.1: Overview of the Vosso river (Løken 2010)

In order to gain an understanding of the human dimensions for the Vosso wild salmon restoration project the following research question has been chosen:

Q: “How does the strategy of the salmon restoration project in Vosso address the human dimensions for the restoration of the wild Vosso salmon population on a short and long term?”

This primary question was researched by exploring the following sub-questions:

Q₁: *What are the impacts of human activities on the wild salmon population in Vosso?*

Q₂: *Why is the Vosso population of wild salmon important to preserve?*

Q₃: *What is the strategy of the salmon management in Vosso?*

Q₄: *Who are the stakeholders and what are their attitudes and priorities?*

This thesis has been carried out as part of the Industrial Ecology program at NTNU. One of the challenges faced by industrial ecologists is to make sense of the diverse and complex connections between the society and the surrounding environment. A key feature of this scientific discipline is to see human societies as part of the global ecosystem and to try to understand the system as a whole. The boundaries of what can or must be changed, or preserved, shift over time as the nature of society’s configurations of natural systems, and their interrelations change (Brattebø et. al. 2007). This thesis offers a knowledge contribution to the field of descriptive Industrial Ecology. It seeks to analyze and describe existing human-environment relationships, by providing insights and perspectives from the analysis of social systems.

1.3 STRUCTURE OF THE THESIS

The second chapter of this thesis will offer a theoretical framework for the conducted study. The theory expounded here provides guidance for the study as well as foundations for the research methods that are explained in chapter 3. Chapter 4 describes the background of the case study: it provides general information about the Atlantic salmon in Norway and about Norwegian salmon management. Chapter 5 presents the research results. Hereafter the results are discussed in chapter 6 and a conclusion of the study is given in chapter 7, where the research question is answered and in which proposals for further research are stated.

2. THEORETICAL FRAMEWORK

The purpose of the theoretical framework described in this chapter is to inform the research. It establishes a set of lenses through which the researcher views the problem. The theories discussed below ease the understanding of the subject under study and form a foundation for the methods used during data collection.

2.1 NATURAL RESOURCE MANAGEMENT

The natural world provides a variety of services to the human community. Natural resources are essential inputs in the production of goods and services. These can be abiotic (non-renewable) or biotic (renewable), such as minerals, timber, water and fish. They are also called commodities or natural capital. However, these resources do not have purely material value. The natural world also generates a variety of amenity services with non-material values, including the scientific, recreational and aesthetic value of preserved natural environments (Krutilla and Fisher 1967 in Krautkraemer 1985).

Many economic activities, from the extraction of raw materials to the emission of wastes, damage resource amenities. According to Krautkraemer (2005), it is difficult to imagine any extractive use of natural resources that does not in some way affect natural resource amenities. The extraction of one element or the addition of large amounts of another can disrupt the entire balance of the ecosystem, with unforeseen consequences. Our understanding of ecosystems is incomplete, and there is much uncertainty about how they are affected by different uses and how they should be conserved (Krautkraemer 2005).

2.1.1 The importance of human dimensions in natural resource management

The environmental degradation has intensified attention on the relationship between science and decision-making on one hand, and technology and nature on the other. As Brattebø et al (2007) indicate: since the Enlightenment, science and technology have been seen as a tool to master nature and to provide endless growth. Ironically, now that nature is playing back at us, we again turn to science and technology to solve the ‘unintended consequences’ of modern society. The difference is that we acknowledge that science can help us solve some of the problems, but that the main obstacles lie in human behavior (Ibid.).

The central strategy of mainstream science has been to break phenomena into distinct components and remove them from their larger context (Stankey et. al. 2005). Nonetheless, it is a given that environmental issues do not present themselves in well-defined boxes. They do not exist by themselves but are perceived and conceived as such by observers through a cultural system of beliefs and values (Gauthier et. al. 1997). They tend to be interconnected and multidimensional. They are in one word complex. As Dryzek (2005) notes: “*ecosystems are complex, and our knowledge of them is limited, as the biological scientists are first to admit. Human social systems are complex too*”. The more complex a situation is, the larger the number of perspectives upon it, because it is harder to prove any of these wrong (Dryzek 2005).

Buckles (1999) proposes that natural resource problems have to be identified by analyzing different information sources, world views and values. This is because they have many dimensions. Because of these dimensions, natural resource conflicts usually have more causes, some direct and others underlying or contributing. A pluralistic approach that recognizes the multiple perspectives of stakeholders is needed to understand the situation and identify strategies for promoting change (Buckles 1999).

The concept of ‘human dimensions’ deals with assessment and application of social information in natural resources management (Manfredo et. al. 1998). It can be referred to as “*the study and practice of human values related to natural resources, how those values impact and are manifested in management, and how humans affect or are affected by natural resource management decisions*”(Decker et. al. 2001).

Understanding the human dimensions of natural resource conservation is essential and decision-making about the management of natural resources must ‘pair’ the human dimension with biological information. This gives the ability to respond to different social interests in conserving nature and resources for future generations. If human action is needed for the conservation of habitat and species, then one needs to know how people experience these environments and understand how they relate to them (Goodwin 1996).

Yet conservation biologists traditionally focus on scientific and technical aspects of species and ecosystems. Skills in policy processes, social sciences or communications that are not viewed as part of the professional identity mostly remain unaddressed. Jakobson & McDuff (1998) argue that conservation problems are primarily social and economic and that the role of the public and their environmental attitudes are important in affecting success or failure of conservation efforts. This is especially the case in the reintroduction of species. For example, people who believe that environmental problems such as those related to the salmon are real, tend to see people as part of the biological world, and think that we must act accordingly. Those who do not believe that environmental problems are real, tend to argue that technology will resolve problems. Many

recovery issues are perceptual; they have more to do with deeply held personal values about the government, outside influences and people's relationship to nature. Therefore, the importance of research on the human dimensions of conservation issues must be recognized (Stouder et al 1997 ; Jakobson & McDuff 1998).

2.1.2 Environmental attitudes and communication

Environmental attitudes are composed of belief and affect towards an object. In scientific sense it is not clear that attitudes exist. An attitude is a hypothetical construct about a mental state. However, although one cannot weigh attitudes or determine their bio-chemical nature, they are still powerful constructs. Changes in social structure, such as a law that needs an environmental impact statement, often seem to be influenced by public attitudes (Heberlein 1981).

According to Copola (2009) social structures can be compared with an ecosystem; no individual part makes sense without communication within the whole. The commonality of society, environment, and communication is that human beings form part of the environment, while social systems consist only of communication (Copola 2009). In order to analyze social structures, it is therefore important to focus on communication. Several researchers see it as the primary process by which human life is experienced; they say that communication constitutes reality (Littlejohn & Foss 2008).

Although there are many different definitions of what communication entails, the thing they have in common is the idea of information transfer: information that originates in one part of a system is formulated into a message that is transmitted to another part of that system. In human communication, the information corresponds to what are loosely referred to as ideas or mental representations (Krauss & Morsella 2000). They can be transferred orally or as a written text. Analyzing communication priorities can reveal environmental attitudes of a person or group.

2.1.3 Fisheries restoration management

Fisheries make up an important share of the world's natural resources. Nevertheless, many of the world's fisheries are in substantial decline, threatening the sustainability of the stocks and their associated ecosystems, but also the social and economic sustainability of fishing communities, and the contribution of fisheries to human food supply (Hammer et. al. 2010). Many fish populations have already become extinct or are facing extinction. This is why efforts are being made to restore some of the populations. Fisheries restoration management is a special form of natural resource management. It can be oriented around particular species, around community compositions or be centered on whole ecosystems or landscapes. The restoration of species is based on an understanding of the autecology and habitat requirements of the species of concern. Research issues

include the genetic structure of populations, population biology, minimum viable population size, issues of local adeptness and the kinds of interactions that may be important in establishing or maintaining populations (Ehrenfeld 2000).

Stouder et. al. (1997) documents that facts and data gain meaning only in the context of a set of conceptual and theoretical assumptions about how the world works. Many debates about the success of a scientific theory or fisheries management program are focused on arguments of data when in fact the roots of conflict lie in a deep-seated clash of world views about how the world is organized: the role of the scientists, managers, citizens and salmon that inhabit it. Understanding that data get their meaning from a conceptual context implies that the solutions to our management problems do not necessarily lie in gathering more and better data. More often than thought, long-standing resource crises can only be resolved through critical reexamination of our conceptual assumptions about how the world works and through creative analysis and synthesis of existing data from an alternative perspective (Ibid.)

2.1.4 Conflicts in fisheries management

Fisheries management is indeed characterized by conflicts. Conflicts are often described as disagreements and disputes over access to, and control and use, of natural resources (FAO 2000). However, according to Chatterji et. al. (2002), disputes arise when interests clash and are related to an action. A conflict on the other hand can exist without such a specific focus. It may be expressed through a problem or dispute, but the underlying conflict may be the cause of a superficial problem. They argue that conflict is based on perceptions and feelings, rather than facts. Therefore it can only be reasoned by dealing with perceptions and feelings as such (Chatterji et. al. 2002)

Natural conflicts may occur at a variety of levels, from within the household to local, regional, societal, and global scales. These conflicts often emerge because people have different uses for resources or want to manage them in different ways. Disagreements also arise when these interests and needs are incompatible, or when the priorities of some user groups are not considered in policies, programs and projects. In the last few decennia the body of literature focusing on these conflicts has increased rapidly. Most of this literature has concentrated on natural resource disputes and wars in developing countries. However conflicts of interest are an inevitable feature of all societies (Buckles and Rusnak 2000).

Common characteristics of disputes surrounding the management and conservation of Atlantic salmon are not very different from any other resource dispute involving human use and nature. According to Nielsen (2007), these conflicts involve primarily four elements: (1) competing demands for a limited resource; (2) conflict based on confusion and divergent interpretation of complex scientific information; (3) overlapping jurisdiction and decision-making authorities and

(4) competition among often incompatible strategies developed by different ownerships, each with their own historical or cultural perspective (Nielsen 2007 in Buckles 1999).

2.2 A SYSTEMS APPROACH TO NATURAL RESOURCE MANAGEMENT

The author of this thesis emphasizes systems thinking as a necessary approach for analyzing natural resource conflicts and preventing the occurrence of further unintended problems in fisheries management (Gajic 2010). But what is meant by systems thinking and, more importantly, what is its relevance to the management of natural resources?

In its most simple definition, a system is a composition of elements that work together to achieve a general attribute or purpose, which distinguishes the parts of the system from its surroundings. Systems are composed of components, attributes and relationships (Brattebø et. al. 2007). Systems thinkers regard a problem within the context of a system. It is a way of thinking about the world and relationships (Maani and Cavana 2007). This approach of systems thinking is fundamentally different from that of the traditional form of analysis. The word ‘analysis’ in fact means “to break into constituent parts” (Aronson 1998). A systems approach on the contrary is about seeing the forest *and* the trees, looking for patterns rather than focusing on isolated facts (Lyneis 1996; Sanal 2004). The systems thinking approach thus intends to look at a problem in its entirety, taking into account all the intertwined parameters. According to this way of thinking, the essential quality of a part of a system lies in its relationship with, and contribution to the whole (Ramo & St. Clair 1998; Banathy 1996).

2.2.1 Systems engineering

The first thing one may notice when tackling the large body of literature is that there is not merely one approach to systems thinking. Rather it has been translated into different operational approaches, and has evolved significantly in the last four decades. ‘Systems engineering’ belongs to the first stage of systems thinking. This stage is sometimes also referred to as “hard systems thinking”. This way of thinking assumes systems to exist in the real world. Practitioners believe the essence of ‘the system’ is not problematical, that the system’s objectives can be defined, and that alternative means of achieving them can be modeled and compared using some declared criteria. Problems are perceived as a search for an efficient means of achieving declared objectives or meeting declared needs (Checkland 1987). The successes of hard systems thinking in fields like engineering led to attempts to transfer it into the social systems environment (Banathy 1996). In the years after the Second World War, an interest in systems ideas developed in many fields (Checkland 1985), including the management of natural resources.

Social systems can be described as nets of relationships that are sustained through time, by a process of regulation. They can be perceived as tools of understanding devised by human minds for understanding situations among which are those where human beings appear as constituents (Vickers 1984 in Warfield 2006). The use of systems thinking for social issues has its foundation in the field of systems dynamics, founded in 1956 by Jay Forrester. He recognized the need for a better way of testing new ideas about social systems, in the same way we can test ideas about engineering (Aronson 1998).

Nevertheless, critique on applying ‘hard systems thinking’ in management and planning practices has increased during the intervening years. General system thinking depends greatly on abstract mathematical models which are far from the practice of the real world (Zexian & Xuhui 2010). The main constraint of this approach is that it does not take into account the perspectives of those people who are involved in the issue at hand. As Richardson & Midgley, (2007) note: *“It is simply the case that what is optimal from one perspective may, given a different value set from a different perspective, be completely unacceptable”*. With the inability to deal satisfactory with conflicting values, view points, policy preferences, ideologies, power relations, etc., the limitations of some of the ‘engineering’ approaches began to show through (Richardson & Midgley 2007).

2.2.2 Systems thinking

Human beings everywhere appear to share certain behavioral pathologies that cannot be removed. It is necessary to identify those pathologies and to design processes that circumvent them (Warfield 2006). In order to do this, one has to go beyond events to look for patterns of behavior and interrelationships which are responsible for behavior and events (Sanal 2004).

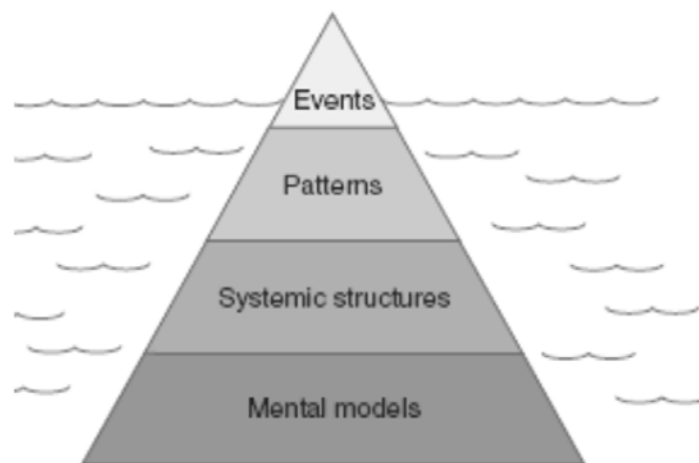


Figure 2.1: Four levels of thinking model (Maani & Cavana 2007)

A clear illustration of this is made by Maani and Cavana (2007). They use the analogy of an iceberg to illustrate the four levels of thinking as a framework for systemic interventions. As figure 2.1 illustrates: events present only the tip of the iceberg. Underneath, and invisible for those who do

not dive deeper is the rest of the iceberg. Nevertheless, while events only present a small part of the iceberg, most decisions and interventions take place at that level. This is because they are the most visible and often require immediate action and attention. The next level of thinking represents patterns where a larger set of events or data points is linked together to create a history. The layer underneath consists of systemic structures which reveal how such patterns relate to and affect each other. They unravel the complex relationships in systems. The last, deeper level of thinking is build up of the mental models of individuals and organizations that influence why things work the way they do. They reflect the assumptions, beliefs and values of a person (Nguyen et. al. 2009; Maani & Cavana 2007).

The recognition of the influence of these behavioral pathologies led to the emergence of soft systems thinking. This brought about a change in thinking about social systems during the late seventies and eighties (Banathy 1996). Instead of trying to build systems models of the world, the soft systems approaches seek to work with different interpretations of reality (Jackson 2009). The comparison between hard and soft system approaches is made in table 2.1.

Table 2.1: Comparing hard and soft systems approaches. Based on Checkland (1985) and Maani & Cavana (2007)

	Hard approaches	Soft approaches
Orientation	Oriented to goal seeking. Assumes the world contains systems which can be 'engineered'	Oriented to learning. Assumes that the world is problematical but can be explored using system models
Problem definition	Clear and single dimensional	Ambiguous and multidimensional
People and organization	Not normally taken into account	Are integral parts of the system
Data	Quantitative	Qualitative
Validity	Repeatable, comparable with the real world in some sense	Defensibly coherent, logically consistent, plausible
Advantages	Allows the use of powerful techniques	Keeps in touch with the human content of problem situations
Disadvantages	May need professional practitioners. May lose touch with aspects beyond the logic of the problem situation	Does not produce final answers. Accepts that inquiry is never-ending

2.2.3 Checkland's Soft System Methodology

The most famous soft systems approach is Checkland's Soft System Methodology (SSM). This is an organized way of tackling perceived problematical (social) situations. It organizes thinking about such situations so that action can be taken to bring about improvement, which often involves change. Also, it acknowledges that the complexity of problematic situations in real life stems from the fact that they contain multiple interacting perceptions of the world. The fact that people have different world views needs to be accepted when tackling problematic situations. Analyses must be made at a level that allows worldviews to be surfaced and examined. A second characteristic of problematic situations is that they always contain people who are trying to act *purposefully*, with intention, and not simply acting by instinct. In SSM the (social) world is taken to be very complex and characterized by clashes of worldview. It is continually being created and recreated by people thinking, talking and taking action (Checkland & Poulter 2006).

SSM can be seen as a learning cycle. The learning emerges via an organized process that shifts between a situation that exists in the real world and using models to capture thinking about the real world. These models serve to provide structure to the dialogue between people themselves and between the people and the researcher (Ibid.). Using SSM allows an overall research approach to be adopted that is appropriate for a specific situation, and lets it be adapted as work progresses. SSM can be divided in four different parts or seven stages, represented in figure 2.2 (Lester 2008). This diagram is read as a u-shaped progression, where part 1 incorporates stages 1 and 2, part 2 includes stages 3 and 4, part 3 stage 5 and, part 4 covers stages 5 until 7. These parts and their respective stages are discussed next.

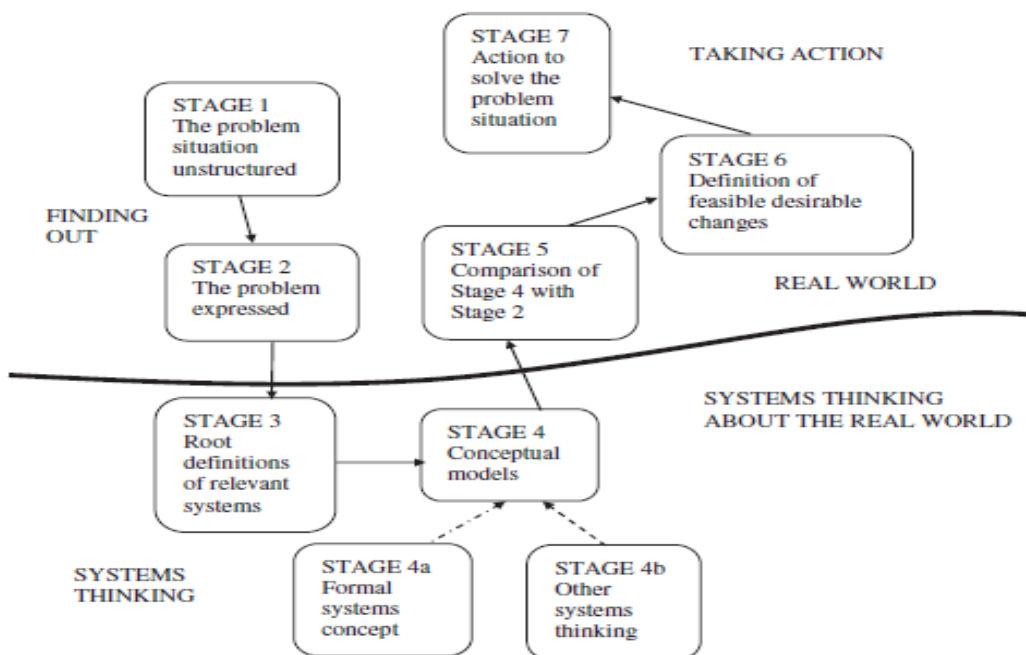


Figure 2.2: Checkland's Soft Systems Methodology (Finegan 1994 in Nidumolu et. al. 2006)

Part 1: Finding out

The first two stages involve the examination of the background of the problem. They are about identifying and providing a brief description of the situation it is desired to intervene in. This is expressed in the form of rich pictures, usually a diagrammatic representation of the problem situation, rather than just text (Checkland 1991; Lester 2008; Haklay 2002). The intention of these stages should be to capture all relevant information about a problem (Nidumolu et. al. 2006).

Part 2: Systems thinking about the real world

Stage three and four move out of the “real” world and into thinking about the real world. The analyst distances herself from the problem situation and analyses it using systems thinking (Haklay 2002). This is the stage from which everything else grows. That is why Checkland called it the “root definition” stage, and it can be perceived as the unique and most challenging part of the methodology (Williams 2005) A root definition describes, in an abstract way, the fundamental nature of a system when viewed from a particular viewpoint. It consists of three analyses of the human dimension of the situation (Nidumolu et. al. 2006):

- (1) Who are the key players in the situation and what worldviews or perspectives do they hold?
- (2) What is the cultural environment of the situation? In particular what roles, norms and values help shape the situation?
- (3) How is the situation affected by politics or power relations?

CATWOE

To answer these three questions, Checkland derived a method, usually recognized from the acronym ‘CATWOE’ (Checkland 1991). Elements of this analysis method include the people, the activities, the context and the world view. Of these elements, T is core of any root definition; E grounds it in the real situation, and C, O and A focus on human activity (Basden & Woodharper 2006).

Transformation (T) represents the purposeful activity to be modeled, expressed as a Transformation process. Traditionally, T has been formulated as transformation of some input to some output:

$$\text{Input} \rightarrow T \rightarrow \text{Output}$$

This formulation encourages the modeler to make links between the current situation (input) and the imagined future situation (output). Setting the current and imagined situations side by side help to understand whether the transformation is likely to be minor, radical, or impossible (Bergvall-Kåreborn et. al. 2004).

World view (W) is related to the world views and beliefs and explains what makes T meaningful. It should not be omitted from analyzes and design because it is closely related to participants’ perspectives (Bergvall-Kåreborn et. al. 2003).

Customers (C) are the beneficiaries and victims of the transformation. It is important to note that this group also includes the person or persons whom the system is intended to serve (Basden & Wood Harper 2006).

Actors (A) are defined as those individuals or organizations who would do the transformation (Checkland & Poulter 2006).

Owners/ decision-makers (O) of a system are defined as those who could stop the transformation, which is quite a wide definition. Owners should not be limited to only those who have formal power, as this narrows our view of who could be seen as the owner and on what grounds the transformation can be stopped. It should include other interesting and important power relations and informal power (Basden & Wood-Harper 2006).

Environment (E) consists of all the entities in the real world that pose constraints and limitations on the system. These environmental constraints will impact the solution and its success. It comprises all actual entities, relationships, events, concrete regulations and so on (Basden & Wood-Harper 2006).

CATWOE can be seen as a checklist, which does not necessarily represent a linear process. (Bergvall-Kåreborn et. al. 2004).

Part 3: Dialogue

The dialogue part (stage 5) involves examining the change model against the real-world situation. Often the change model needs adjusting, and sometimes the rich picture needs to be developed further. The other important function of this stage is to develop a common understanding of the change and the change processes among the key actors and stakeholders involved. CATWOE can be very useful in focusing this dialogue and enabling useful modifications to emerge (Lester 2008).

Part 4: Defining and taking action

Stages 6 and 7 involve developing the change model into a concrete plan, and taking action to implement the plan. The seven stages of SSM can in fact be seen as a *never-ending process of learning*. This dissertation will not go as far as discussing stages six and seven, due to both time and resource limits. Action to improve the situation will change its characteristics. It becomes a new (hopefully less problematical) situation, and the process continues on (Checkland & Poulter 2006). SSM is interpretative, so variations in interpreting the meanings of the elements are expected from researchers working in different contexts. Additionally, CATWOE does not represent reality but is a way of learning about our social reality (Bergvall-Kåreborn et. al. 2003).

In SSM, one has to accept the great difficulty of scientific experimental work in human situations, since each human situation is not just unique, but changes through time and exhibits multiple conflicting worldviews. Hence the pattern for the researcher is to enter a human situation and use that experience as the research object. In order to do that it is necessary to have a framework in advance that helps to make sense of the experience gained. This framework is offered by SSM and makes it possible for anyone outside the work to ‘recover’ the study, to see exactly what was done and how the conclusions were reached. This ‘recoverability’ requirement is obviously not as strong as in natural sciences, but then again, social situations are more complex than the phenomena studied in physics and chemistry labs (Checkland & Poulter 2006).

2.2.4 Systems thinking in fisheries management

How can systems thinking relate to natural resource management and fisheries management in particular? The developments of natural resource management and systems thinking are in fact partly intertwined. As systems thinking evolved, the 1990s was characterized by changes in how certain researchers went about their practice. There was a shift away from single disciplinary projects toward multidisciplinary and interdisciplinary research. During this time, there was also recognition that new approaches were needed that would allow knowledge and understanding to emerge from processes involving stakeholders. This led to the application of learning and action based participatory approaches such as SSM (Bosch et. al. 2007).

Recently several researchers have introduced systems thinking in fisheries, including the field of Industrial Ecology. Hamlin (1986) discusses some of the ways in which Systems Engineering (SE) has been and can be applied to fisheries problems. Utne (2006) discusses how the use of SE principles facilitates implementation of multi-disciplinary information from researchers to fisheries managers in the decision-making towards sustainable fisheries. Fet et. al. (2008) have constructed a framework for environmental analyses of fish food production systems based on systems engineering principles.

When analyzing existing literature, it can be reasoned that most Industrial Ecology studies on fisheries are based on hard systems methodologies (e.g. Papatryphon et. al. 2004; Andersen 2002; Hamlin 1986; Utne 2006; Fet et. al. 2008). Their objectives are in line with the two first parts of the Industrial Ecology definition, according to White (1994 in Brattebø et. al. 2007) : *‘the study of the flows of materials and energy in industrial and consumer activities, of the effects of these flows on the environment’* but less in line with the third part of the definition: *‘and of the influence of economic, political, regulatory and social factors on the flow, use and transformation of resources’* (White 1994 in Brattebø et al 2007). A systematic approach to decision-making and problem-solving certainly has an advantage over ad hoc thinking about a management task. However, one of Checkland’s (1991) primary objects to SE was that the approach started with the problem statement

as a given. But in the majority of social situations, and especially in fisheries restoration projects, the very definition of objectives will constitute a major part of the problem faced. It has become clear that fundamental differences in ecological values can produce very different opinions on the nature of the ecological outcome of the management that is acceptable (Checkland 1991; Jackson, 2000; Walters 1997). When looking at the evolution of systems thinking in fisheries, there seems to be a lag in the transition from hard systems thinking to soft systems thinking. A shift to soft systems thinking is important to facilitate successful fisheries restoration management.

3. RESEARCH METHODS

This chapter describes the different methods that have been used for data collection and analysis. These methods consist both of case study methods as well as supporting methods.

3.1 RESEARCH APPROACH

The researcher of this study takes the view that the social sciences are different from natural sciences in that the actions of people, individually and collectively, are based on their constructions of the nature of the world in which they operate. The actions of people are mediated through an interpretive process where the meanings people have about situations determine the actions that they take. This is called the *interpretive research* approach (Burton & Steane 2004).

The type of research conducted in this study can be characterized as a descriptive research, taking the form of a case study. The case can be a person, group, project, community or any other unit of social life. All data that are relevant to that case are gathered and organized in terms of the case. The case study method is an approach to studying a social phenomenon through a thorough analysis of one or more cases. (Kumar 2005). Such a phenomenon may be a project or program (Yin 2003).

Figure 3.1 represents how the research methods in this study are linked to the pyramid of systems thinking, introduced in figure 2.1. The pyramid is divided into the four layers described in section 2.2.2. In addition, the parts of each layer below the real world events are characterized as either case study methods or supporting methods. The small insert in the bottom two layers is based on the use of SSM. Checkland's SSM methodology was used to analyze the problematic situation in this case study. This methodology was operationalized by using various qualitative methods (narrative or textual descriptions of the phenomena under study) for data collection (Vanderstoep & Johnson 2009). The inclusion of multiple methods of data collection in a research project is called triangulation and is likely to increase the reliability of the observations (Bryman 2008; Mouton & Marais 1988).

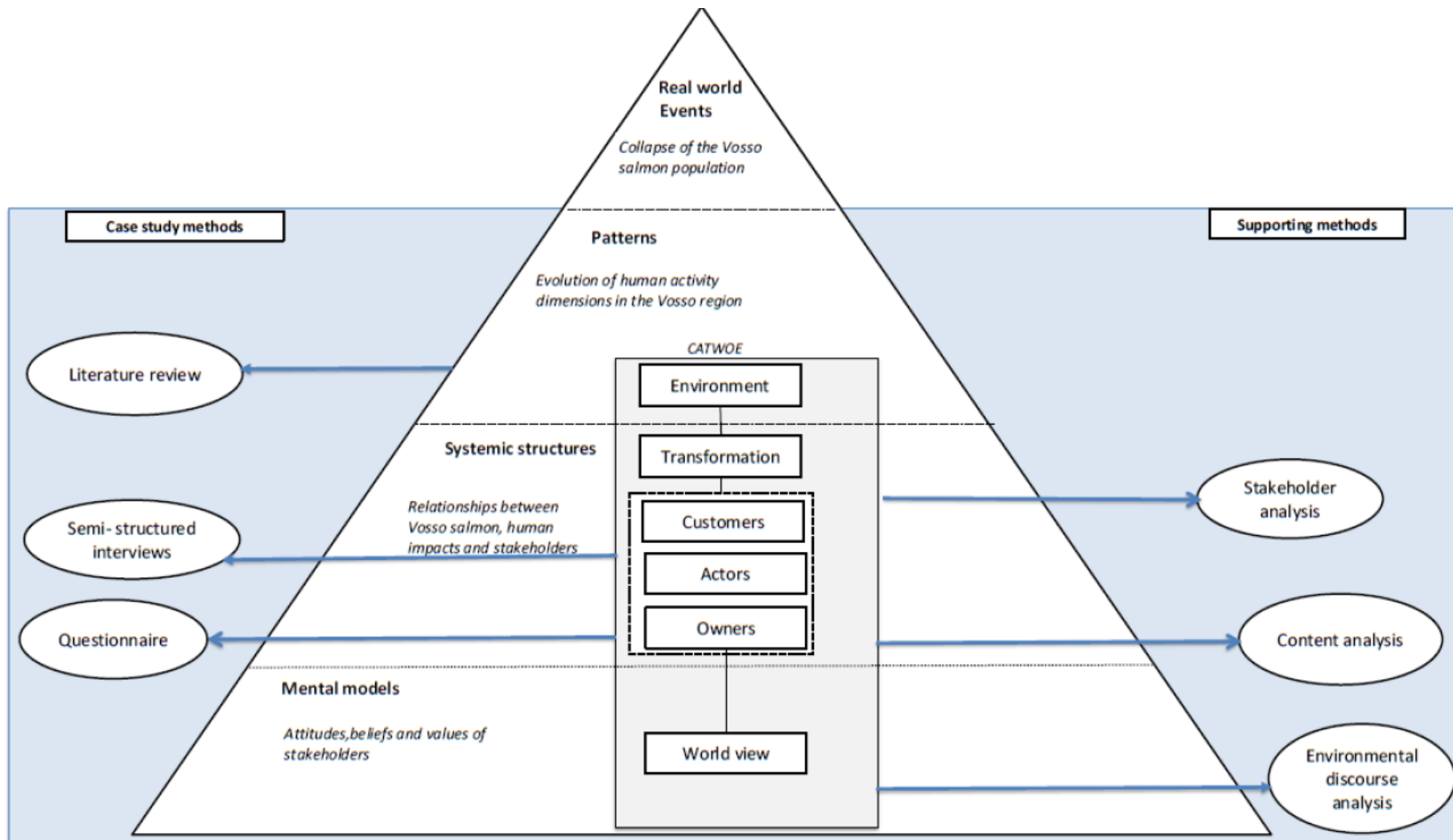


Figure 3.1: A systems thinking approach to research methods

3.2 CASE STUDY METHODS

The interpretive research approach makes interviews and an in-depth focus on the data suitable ways for data collection and analysis. It is likely to be investigated by studying a small number of case subjects in depth. It is therefore mostly associated with qualitative methods of data collection (Burton & Steane 2004). Several qualitative research techniques were used to collect data for this case study. These methods will be presented in this section, along with their possible advantages, disadvantages, reliability and validity.

3.2.1 Literature review

One of the important preliminary tasks when undertaking a research study is to go through existing literature in order to get acquainted with the available body of knowledge in the field of interest. Reviewing literature is not merely something that needs to be done at the beginning of the research. It is an integral part of the whole research process and has made a valuable contribution to almost every operational step in this study. In the beginning stages it helped to establish the theoretical roots of the study and to develop the methodology. Later on it was used to strengthen the knowledge base of the researcher (Kumar 2005).

A narrative literature review was carried out to generate understanding about the subjects of study. For interpretive researchers, the literature review is a means of gaining an initial impression of the topic area they want to understand through their research. The process of reviewing literature can be seen as a process of discovery (Bryman 2008). Different data sources were used for conducting the literature review. Most information in the theory chapter comes from scientific journals. Additionally, books and official websites are used. For the background information of the case study, a significant part of the data about the Vosso salmon rescue project was provided by the leading researcher of the project, gathered from local news media or found in published year reports of stakeholders. The advantage of carrying out a narrative literature review is that it is less focused and therefore aligned with the SSM methodology, where problem identification is a process of discovery. The disadvantage is that because it is less focused, it is difficult to know beforehand where the literature review will take you (Bryman 2008).

3.2.2 In-depth interviews

Interviewing is a commonly used method for collecting information from people. Any person-to-person interaction between two or more individuals with a specific purpose in mind is called an interview. In-depth interviewing is a qualitative research technique that involves conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea, program, or situation. In-depth interviews are useful when detailed information is

needed about a person's thoughts and behaviors. Interviews are often used to provide context to other data, offering a more complete picture of what happened in a project and why (Boyce & Neale 2006).

On the one hand, interviewing can be very flexible, when the interviewer has the freedom to formulate questions as they come to mind around the issue being investigated (known as an unstructured interview). On the other hand it can be inflexible, when the investigator needs to keep strictly to the questions decided beforehand (called a structured interview) (Kumar 2005). Both kinds of interview might be used in the same research. For example, the initial stage of a project might be exploratory and expansive. But once certain issues have been identified, the researcher might use more focused interviews (Woods 2006).

Two visits were made to Bergen. The first one had the purpose to learn more about the project and its participants. The second one had the goal to interview key stakeholders, and also included visits to Voss and Bolstadøyri. At the beginning stage of the research, the investigator flew to Bergen to conduct informal, unstructured face-to-face interviews with the research leader of the salmon rescue project from LFI-Unifob (a research organization that works to monitor and enhance salmonid populations) and the project coordinator of the Vosso rescue project '*Now or Never for the Vosso salmon*', from the County Governor of Hordaland. They became the key informants for this research: informants that direct the researcher to events or people likely to be helpful to the progress of the investigation (Bryman 2008). Data collection through unstructured interviewing can be extremely useful in situations where in-depth information is needed or little is known about the area (Kumar 2005). As the researcher gained knowledge and experience during the interviews, the questions asked of respondents became more focused, resulting in the establishment of semi-structured interviews with key stakeholders. An interview guide was used, but the interviewee was then allowed to respond freely (Bryman 2008). The motivation for carrying out interviews is largely grounded on the small number of data subjects involved in the case study.

Selection of data subjects

The most important groups of stakeholders are selected with help of the stakeholder analysis, presented in chapter 3.3.1. More information about how the stakeholder analysis has been carried out is found in chapter 5.2.1. The selection of key representatives for each stakeholder group was carried out with help of information from the key informants. Table 3.1 shows the stakeholders that have been approached for an interview or questionnaire and their relative importance in the management of the Vosso salmon.

Table 3.1: Selection of data subjects

Person	Stakeholder group	Stakeholder importance	Method
Research leader Vosso rescue project, from LFI Unifob	Scientist	Primary stakeholder	Face-to-face interview
Biologist	Scientist	Primary stakeholder	Face-to-face interview
Fisheries anthropologist	Scientist	Primary stakeholder	Face-to-face interview
Representative of Voss hatchery	Scientist/hatchery	Primary stakeholder	Face-to-face interview
River owner A	River owner	Primary stakeholder	Telephone interview
River owner B	River owner	Primary stakeholder	Face-to-face interview
River owner C	River owner	Primary stakeholder	Phone interview
Representative Hordaland commune/employee of Voss hatchery	Regional government	Primary stakeholder	Face-to-face interview
Fresh water fish manager from DN and Hordaland commune	Regional government/ National government	Primary stakeholder	Phone-interview
Sports fisherman	fisherman	Primary stakeholder	questionnaire
Employee tourist industry	Tourist industry	Secondary stakeholder	questionnaire
Marine Harvest	Fish farmer	Primary stakeholder	questionnaire
Lerøy	Fish farmer	Primary stakeholder	questionnaire
Sjøtroll	Fish farmer	Primary stakeholder	questionnaire
Blom Fiskeoppdrett AS	Fish farmer	Primary stakeholder	questionnaire
Fyllingsness Fisk	Fish farmer	Primary stakeholder	questionnaire
Fjord Drift AS	Fish farmer	Primary stakeholder	questionnaire
Eide Fjordbruk	Fish farmer	Secondary stakeholder	questionnaire
Salmobreed	Fish farm supplier	Secondary stakeholder	questionnaire
Ewos	Fish farm supplier	Secondary stakeholder	questionnaire
Havbruksinstituttet AS	Fish farm supplier	Secondary stakeholder	questionnaire
Alvestad	Fish farm supplier	Secondary stakeholder	questionnaire
Patogen	Fish farm supplier	Secondary stakeholder	questionnaire
Fhl	Fish farm supplier	Secondary stakeholder	questionnaire

Also, interviews were set up with a representative from Marine Harvest and with a representative from Uni Miljø. Unfortunately, these were cancelled at the last moment and no new date could be found that fitted their schedule.

From the total population involved directly in the Vosso salmon rescue project, some stakeholders have 'double stakeholder roles'. They are for example both river owner and representative of an NGO. Or they work both in the hatchery and for Hordaland commune.

Both phone-interviews as well as face-to-face interviews were conducted. The phone interviews were made using 'Skype', a computer program that allows calls to be made directly from the computer. They were recorded using 'Skype recorder', a program that allows conversations to be recorded directly to the computer. The choice for doing several phone interviews was motivated by both time and resource limits, since not all stakeholders were available for a face-to face interview in the period of investigation.

3.2.3 Online questionnaire

In addition to interviews with key stakeholders, an online questionnaire was set up to collect and compare data from relevant stakeholders in the case study. A questionnaire is a written list of questions, to which the answers are recorded by respondents. The difference between an interview schedule and a questionnaire is that in the former the interviewer asks the questions and records the respondent replies on an interview schedule, while in the latter respondents themselves record the replies (Kumar 2005). There are four main motivations for the use of a questionnaire in this study. The initial idea of the questionnaire was to make a short survey among the industrial partners involved in the project. Another important reason for choosing this method is related to the language barrier between the researcher and some of the data subjects, who do not speak English. This is why a questionnaire was made and translated into Norwegian. The third motivation is related to the issue of anonymity, since some of the stakeholders preferred to remain anonymous. The fourth reason is linked to time and resource limits. Due to different time schedules of the interviewees, it was difficult to set up an interview with all relevant stakeholders in the same time period. Sending out a questionnaire is both cheaper and usually requires less time to collect the answers.

The advantage of using online self-administered questionnaires is that they are cheaper and usually quicker to administer, since less time is spent travelling and because all questionnaires can be sent at the same time. Nonetheless, there are also some disadvantages attached to this method. The interviewer cannot explain the questions if they are unclear to the respondent. Furthermore, it is difficult to ask too many questions since this may result in 'respondent fatigue': respondents get tired of answering the questions. Another disadvantage is that the non-response rate in questionnaires may be higher than in face-to face interviews. This decreases the reliability of the results (Bryman 2008).

Use of Survey Monkey software

Survey Monkey Pro, a web based survey software was used as a tool to construct the questionnaires. This tool enables the composition of online surveys, which can be sent out directly to the respondents. It shows the questions one by one, preventing that respondents see all questions beforehand. In this way they are less influenced by follow-up questions, when answering the questionnaire. In addition it helps the researcher to analyze the data, as it offers response summaries and chart creation options among others.

3.2.4 Content of interviews and questionnaire

The questions in both the interviews as well as the questionnaires are selected to analyze the attitudes of different stakeholders with respect to the preservation of the Vosso salmon and the salmon restoration project. Most of them are chosen according to the CATWOE elements ‘transformation’ (e.g. *‘what is your preferred scenario for the future of Vosso salmon?’*) and ‘world views’ (e.g. *‘what is your perspective of the value of the Vosso salmon to past and future generations’*). Some questions have been explicitly put into place to help determine the environmental discourses of respondents, such as: *‘who should be responsible for deciding the future of the Vosso salmon?’* This questions was inspired by Dryzeks’s environmental discourse criteria.

The questions in both the questionnaire are sorted according to four different themes (see appendix B):

1. Problem formulation
2. Project strategy
3. Power relations
4. Expectations for the future

The questionnaires were designed, using open-ended questions as well as multiple-choice questions and questions with a Likert scale, which is the most suitable technique for measuring attitudes. This is a multiple-item measure of a set of attitudes relating to a particular area. The goal is to measure the intensity of feelings about the area in question (Bryman 2008). Open-ended questions provide the respondents the opportunity to give an answer to the question in their own words. As they allow for elaboration in a response, insights can be provided into the meanings that respondents attach to their actions and beliefs. But coding open-ended responses and comparisons between respondents is more difficult. Also, there may be a bias in the kinds of respondents who complete open-ended questions (Miller and Brewer 2003).

3.3 SUPPORTING METHODS

In addition to the methods mentioned in the former section, three supporting methods were applied: the stakeholder analysis, the content analysis and the environmental discourse analysis. These were helpful for setting up the interview and questionnaire and determining the environmental world views of actors involved. They were used to support and operationalize the CATWOE analysis (as represented in figure 3.1).

3.3.1 Stakeholder analysis

The customers, actors and owners of a problem or issue as identified by Checkland (1991), can also be viewed as the ‘stakeholders’ and consequently be detected by doing a stakeholder analysis. There are many definitions for the term ‘stakeholder’. Most of them stem from the field of corporate management. A central assumption there is the manager’s ability to manage stakeholder relationships. This is difficult to transport to other fields, such as natural resource management, where the power to control the system is at the heart of many debates (Buckles 1999). From a systems perspective, stakeholders comprise *“the set of individuals and organizations that have a vested interest in the problem and its solution”* (Sage 2000 in Trainor and Parnell 2007).

Stakeholder analysis can be defined as a methodology for gaining an understanding of a system, and for assessing the impact of changes to that system, by identifying the key stakeholders and assessing their interests. It is particularly relevant to the analysis of natural resource management where issues are characterized by (1) cross-cutting systems and stakeholder interests and (2) multiple uses and users of the resource. Natural systems are often central to natural resource problems but cut across social, economic, administrative and political boundaries (Grimble 1998). A stakeholder analysis is important as the initial problem statement is seldom the full statement of the problem from the perspective of all stakeholders. The main purpose of stakeholder analysis is to obtain various perspectives on the problem. This will provide a broader definition of the problem that captures the stakeholder perspectives (Trainor and Parnell 2007).

According to Mitchell et. al. (1997) stakeholders can be identified using three main attributes: power, legitimacy and urgency. However, according to Driscoll & Starik (2004) it is necessary to add a fourth attribute: ‘proximity’. Entities, including organizations that share the same physical space or are near to each other often affect one another. The greater the proximity, the more chance there is to develop stakeholder relationships. In addition to physical proximity, organizations can be said to be proximate if they share the same or similar ideas, approaches, and actions (Driscoll & Starik 2004).

Stakeholders can be divided into primary, secondary and tertiary stakeholders according to their score on proximity, urgency, legitimacy and power. Primary stakeholders require ongoing priority through their long-lived and multifaceted stake. (Haigh & Griffiths 2007). They can be seen as those who are most dependent upon the resource, and most likely to take an active part in managing it, while secondary and tertiary stakeholders are powerful voices that may include local government officials and those who live near the resource but do not greatly depend on it; and national level government officials and international conservation organizations (Pomeroy & Douvère 2008).

3.3.2 Content analysis

Content analysis is an approach to the analysis of documents and texts, that seeks to quantify content in terms of predetermined categories and in a systematic and replicable manner (Bryman 2008). Content analysis must predict or infer phenomena that cannot be observed directly. The inability to observe phenomena of interest tends to be the primary motivation for using content analysis. It can be used in any type of communication and the content can be quantified in a systematic and replicable manner in terms of predetermined categories. The analyst seeks answers to questions that go outside a text (Krippendorff 2004). In this study a content analysis has been carried out for the websites of industrial partners in the salmon rescue project. Also, local news paper messages have been analyzed to determine values and interests expressed by stakeholders.

Website analysis

The website is used increasingly as a communication tool by companies. Coinciding with the increased usage of the internet there is a growing awareness by companies of their social responsibilities, and growing demands for their accountability with respect to social and environmental impacts (Adams & Frost 2006). A website is a communication tool. The contents reflect which issues the company regards as important to communicate.

A rating sheet has been set up to measure the website communication priorities of the industrial partners with respect to the information disclosure of Vossolaugset. The rating is based on the presence or absence and the degree of specificity of each of the information items. In addition, an examination is carried out of how the companies communicate their values and responsibilities. This makes it possible to detect the existence of conflicts of interest within the Vosso salmon rescue project.

Analysis of local media messages

In addition to a website analysis, an analysis is carried out of interests and attitudes of stakeholders as expressed in local news papers. By comparing attitudes and interest expressed in interviews, news papers and on websites, an attempt is made to increase the reliability of the data in this study.

3.3.3 Environmental discourse analysis

SSM requires the identification of worldviews. In this thesis, the determination of environmental world views is inspired by Dryzek`s (2005) environmental discourse analysis. A discourse is a shared perception about the world, presented in words, which enables people to make sense of information. The discourses that people embrace reveal their identities; who they are, and what their core values tend to be (Korda et al 2008).

Most discourse analyses are anti-realist. They deny that there is an external reality. Instead they emphasize that different versions of reality exist, portrayed by members of the social setting being investigated. Dryzek (2005) offers a discourse analysis that can be applied to environmental affairs at all levels, from the global to the local, and across different issue areas such as resource depletion and wilderness protection. He distinguishes several different environmental discourses among which: (1) *survivalism*, (2) *promethean discourse*, (3) *administrative rationalism*; (4) *democratic pragmatism*; (5) *economic rationalism*, and (6) *sustainability*. A more detailed classification of each environmental discourse can be found in Appendix A.

The basic storyline of *survivalism* is that human demands on the carrying capacity of ecosystems threaten to explode out of control. It recognizes and emphasizes the resources upon which human beings depend for their existence. It also recognizes that the size of human population growth has a negative effect on natural resources (Dryzek 2005).

Prometheans do not believe in limits. They assume that humans left to their own devices will automatically generate solutions to problems. They have a mechanistic approach towards nature and believe that ‘natural resources’ are created by humans transforming matter. When it comes to biodiversity, the general belief is that nature is always creating species. Prometheans also believe that humans left to their own devices will automatically generate solutions to problems (Ibid.).

Administrative rationalism is a problem-solving discourse. It seeks to organize scientific and technical expertise into bureaucratic hierarchy in the service of the state. Managers and experts have a well-defined role and management is informed by the best available expertise. In administrative rationalism, the organization of environmental problems is characterized by dividing them into units, each of them belonging to a different department (Ibid.).

Democratic pragmatism on the other hand, may be characterized in terms of interactive problem solving. The relevant knowledge cannot be centralized in the hands of any individual or any administrative state structure. It is rather concentrated on public consultation. Impact assessment is carried out prior to allowing the establishment of an activity. Here, information from a variety of perspectives is systematically sought out (Ibid.).

In *economic rationalism*, the world exists of economic actors. They are either consumers or producers and are motivated by material self-interest. The social world is treated as a machine whose products meet human needs and wants. Economic rationalists oppose regulation. Instead they plead for informal cooperative relationships between government officials and polluters (Dryzek 2005).

In the *sustainability discourse*, the main belief is that economic growth should be promoted, but guided in ways that are both environmentally friendly and socially just. The discourse respects nature to a certain point. But it is treated mainly as something that provides services to humans. Sustainability is largely about social learning. It involves decentralized, exploratory and variable approaches. In a world that is dominated by market liberalism, sustainable development's prospects are poor unless there is a clear demonstration that environmental conservation is good for business profitability (Dryzek 2005).

3.4 RELIABILITY AND VALIDITY OF METHODS

Validity refers to the issue of whether the researcher measures what he or she intended to measure. Reliability is fundamentally concerned with the consistency of measures. Validity and reliability are related, because validity presumes reliability (Bryman 2008). Case studies have been criticized by some for lacking scientific reliability and for not addressing the issue of generalization. However, the strength of the case study is that it enables the researcher to gain a holistic view of a certain phenomenon or series of events and can provide a round picture since many sources of evidence are used (Noor 2008).

This study contains different methods to collect data. This mixture of different methods of data collection, called triangulation, adds to the reliability of this study. For example: interests and attitudes of the fish farmers involved in the project are not merely determined through questionnaires. In addition, they are cross-checked by doing a website analysis of the fish farm companies in the case study as well as by examining interests or attitudes expressed in the local media. This is called convergent validity: the validity of a measure ought to be gauged by comparing it to measures of the same concept, developed through other methods (Bryman 2008).

Next to convergent validity, other types of validity exist, including external validity and ecological validity. External validity is the question of whether the results of a study can be generalized beyond the specific research context of a study (Bryman 2008). Since a case study has been carried out, one can argue that the external validity is relatively weak. It would have increased, had a comparison of more case studies been carried out. However the ecological validity, which is the question of whether social scientific findings are applicable to people's every day, natural social

settings, is relatively high. This is deemed more important than the external validity, since this study focuses on the attitudes of stakeholders of a specific management project. The interviews and questionnaires capture the daily life conditions, opinions, values, attitudes and knowledge base of the people involved.

In-depth interviews stress ecological validity since they are very appropriate methods for analyzing interests and attitudes. This means that the information collected comes very close to the subject's real views. However, the answers cannot be compared statistically, since the data is qualitative (Moonie 2000). When used in the right way, interviews can be powerful instruments for finding out people's values and attitudes. A disadvantage of interviews may be that they can have a social desirability effect. This means that some respondents' answers are related to their perception of the social desirability of those answers, which can decrease the validity of replies (Bryman 2008).

The purpose of the questionnaires used in this study is not to make generalized conclusions, but to study one case in-depth. This makes the requirements for reliability and validity different from those studies that have the intention to make generalized conclusions. They stress ecological validity. Since the questionnaires have been standardized, they are easily reproducible, which eases the comparison between different data subjects.

Content analysis is a very transparent research method. The coding scheme can be clearly set out so that replications and follow-up studies are feasible. Because of this transparency, this method can be referred to as an objective method of analysis. This increases the reliability of data. It can also allow information to be gathered from social groups that are not easily accessible. However, it is almost impossible to have coding manuals without some interpretation of the researcher (Bryman 2008).

While content analysis is primarily based on observable, countable data, such as words, a discourse analysis will also pay attention to underlying semantic structures and make presuppositions, connections, strategies, etc. It will try to find the rules or principles underlying the structures of messages. The benefit of this method is that it can provide insights in complex social situations, but because it is more interpretative than content analysis, it is less reliable (van Dijk 1983).

4. BACKGROUND OF CASE STUDY

This chapter presents the background data that is helpful for gaining insight in the Vosso salmon situation. It covers information about the wild as well as farmed Atlantic salmon in Norway. It also includes information about the Vosso salmon specifically and about salmon management in Norway.

4.1 ATLANTIC SALMON AS A NATURAL RESOURCE IN NORWAY

Throughout history, Norwegians have made a living by harvesting the sea through fishing. Atlantic salmon fishing has long had significant social, cultural and economic importance for Norwegians. Norway has 450 rivers that sustain or once sustained self-reproducing Atlantic salmon stocks. About 40% of the remaining overall catches in the North Atlantic are caught in Norwegian coastal waters and salmon rivers. The wild salmon has historically been, and still is, important to Norwegian culture. The Norwegian wild salmon stocks caught the attention of British anglers in the mid-1800s. Since then the biggest revenue from wild salmon is derived from selling fishing permits and providing accommodation and guidance to foreign as well as Norwegian anglers. Approximately 150-200.000 anglers fish for salmon and sea trout every year. Most salmon rivers are located away from the major towns/cities of Norway, thus wild salmon provides significant economic benefits for the rural countryside (NASCO 2007; Liu et. al. 2010). However, the once abundant salmon resources have suffered a significant decline in recent years.

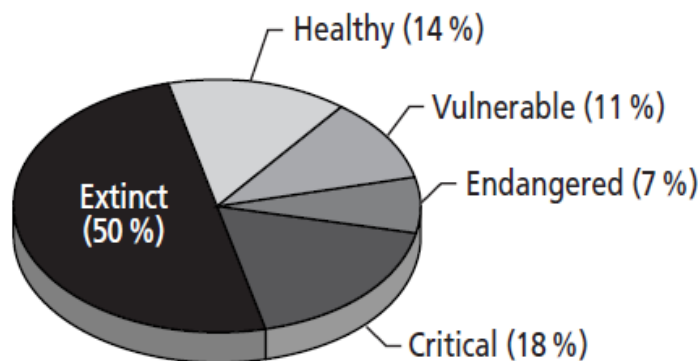


Figure 4.1: Categorization (%) of salmon-bearing rivers in Norway (WWF 2001)

Since the 1970s, the emergence of salmon farming has changed the dynamics of salmon sectors as well as the whole seafood industry both in Norway and worldwide. Salmon farming in Norway started as a means to rebuild the livelihoods of rural fishing communities due to declining wild fisheries in the late 1960s and the beginning of the 1970s (Liu et. al. 2010). In many rivers, the salmon has already become extinct. The categorization of different salmon-bearing rivers is represented in figure 4.1. It shows that as much as fifty percent of the salmon populations in

Norway have died out. The size composition has also changed. The percentage of small salmon has increased while the percentage of large salmon has declined (WWF 2001). This can be largely attributed to human activities. Yet ironically, because of humans the species has never been more abundant. This paradox arises because salmon is one of the world's most cultivated aquaculture species. Norway has become the world's largest producer of farmed salmon, and farmed salmon is now the fourth biggest export commodity (Verspoor et. al. 2007; Liu et. al. 2010). Atlantic salmon is the most important farmed species and Norwegian salmon is one of Norway's best-known brands internationally (Fhl 2005). However, salmon farming has caused some unintended consequences for the survival of the wild salmon.

4.2 WILD AND FARMED ATLANTIC SALMON POPULATIONS

4.2.1 Life cycle of Atlantic salmon

The striking characteristic of the Atlantic salmon is that their lifecycle takes place in two different ecosystems: the native river habitat and the saltwater ecosystem. They transform from a fresh water fish into a seawater fish (Aas 2011). Starting in the fresh water ecosystem of their native stream, the salmon goes through several different life stages before reaching maturation. The different life stages a salmon goes through are listed and defined in table 4.1 and depicted in figure 4.2.

Table 4.1: Basic salmon life-stage terminology (Based on graph by Hendry & Cragg-Hine 2003)

Life stage	Definition
Egg	The eggs begin developing straight after fertilization, and will hatch after about 180 days at normal water temperatures.
Alevin	From hatching to end of dependence on yolk sac for primary nutrition
Fry	From independence of yolk sac to end of first summer
Parr	From end of first summer to migration as smolt
Smolt	Fully silvered juvenile salmon migrating to sea
Grilse	Adult salmon after first winter in sea
Adult	Spawned adult

After a period spent in fresh water the young fish undergo an enormous behavioral and physiological change that allows them to adapt to the salty waters of the North Atlantic Ocean. After two years, when they reach the smolt stage, they migrate to the salt water ecosystems of the North Atlantic Ocean. These smolts migrate to the ocean in spring. Following one or more years at sea, the adult salmon return to their natal river to complete the cycle. Vosso salmon returning from marine feeding areas migrate from the outer coastal line through narrow fjords, until they reach the River Bolstadelva, the lower section of the river system. To reach the upper part of the river system, returning salmon must pass through the lake Evangervatn and the River Vosso before

reaching Lake Vangsvatn. Most salmon die after spawning but a small proportion, returns to spawn again (Sægrov et al. 1997; NASCO 2011).

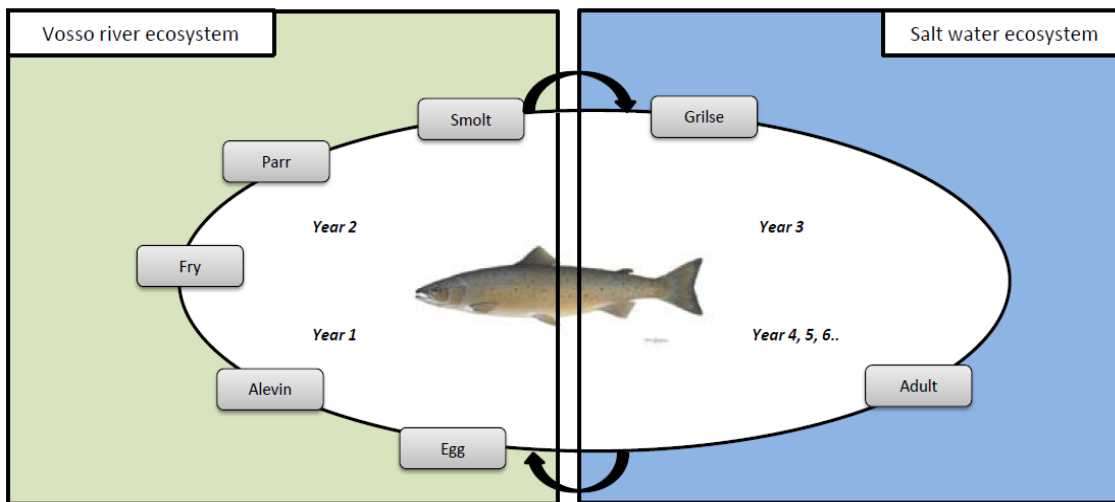


Figure 4.2: Wild Atlantic salmon life cycle (Based on krisweb 2011)

What characterizes salmon is their variety. They can take on many different forms within and between populations. Because Atlantic salmon are very attached to their natal river, gene flow between local populations is minimal, and salmon living in neighboring rivers are reproductively isolated. This has facilitated genetic differentiation among wild Atlantic salmon populations (Ayllon et. al. 2006).

4.2.2 Salmon farming in Vosso

Salmon farming in Norway started in the late 1960s as a government-supported activity to strengthen the livelihood of rural fishing communities facing depressed economies due to declining wild fisheries (Liu et. al. 2010). Nevertheless, it really began to take off at the start of the 1980s, when large-scale salmon production was introduced. Today, salmon makes up 90 per cent of the total sale of Norwegian fish farming (SSB 2007). Norway's production of farmed salmon and trout is in the forefront of fish farming developments in Europe and has been the most striking commercial success of the aquaculture industry (Ford 1984). Hordaland, the county where the Vosso watershed belongs to, is Norway's most important province for aquaculture. In 2005 nearly one-fifth of all salmon and trout from Norway were farmed there, i.e. some 102,000 tons of salmon and 20,000 tons of trout. There are about 200 fish farm sites and 861 employees in Hordaland county (SSB 2011).

The life cycle of the farmed salmon is comparable to that of the wild salmon, but shorter in time (compare figure 4.2 with figure 4.3). The cycle begins with the brood stock. These are the parent fish, selected for characteristics such as growth, disease resistance, maturation and color. They are held in a hatchery in large freshwater tanks where they become sexually mature and ready to spawn. Eggs from the females are mixed with milt (sperm) from the males to produce fertilized eggs. These eggs are kept in incubation tanks in fresh water at a steady temperature. The fry are relatively large. Throughout their life, the fish eat dry feed pellets. When the salmon fry are about six grams, they are moved to larger freshwater tanks or to an open net cage in a lake, where they grow into adults. After 12-22 months they are harvested (Marine Harvest 2008).

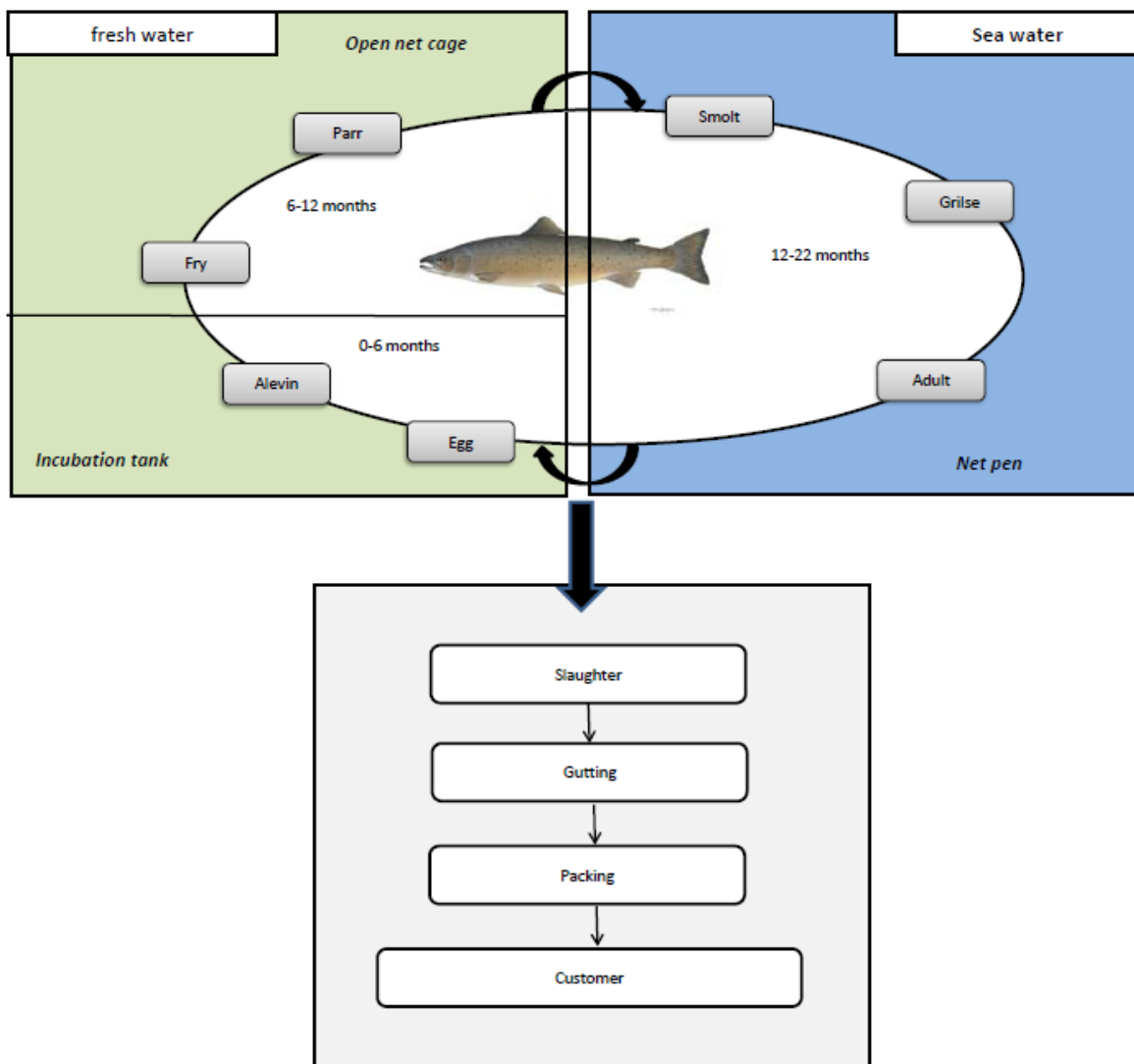


Figure 4.3: Farmed Atlantic salmon life cycle (Based on Marine Harvest 2008)

4. 3 THE VOSSO SALMON ENVIRONMENT AND STOCK

The River Vosso is the second largest watershed in western Norway. The river is a confluence of two other rivers: Raundalselva and Strandaalva. It flows through two lakes: Vangsvatnet and Evangervatnet, before it flows into Bolstadfjorden by Bolstadøyri (see figure 1.1). The watershed is a very popular place for kayaking and rafting (Norsk Skogmuseum 2011). Besides sports tourism, the river has also been famous for its Vosso salmon population. One distinguishable characteristic of the Vosso salmon is its weight: the average weights of the salmon varied from 9 to 12 kilogram. Often salmon could even reach a weight of 20 kilogram. The salmon has been an important resource for people living along the river and the fjords outside, which are less than 10.000 people. Discovery of fish hooks and bones at Skipshelleren by Straume show that Vosso salmon was exploited by humans as early as 3000 BC. The voluminous average stock, as well as the opportunity to catch very large salmon made the river a favorite destination for anglers both locally and abroad for over 150 years (Voss Hatchery 2011). Since the river is relatively big, it provides potential for a large salmon population.

One explanation for the extraordinary weight of the Vosso salmon stocks is the long migration route that the salmons have to undertake to reach the sea. Also, an unusually large proportion of the population stays in the sea for over several years. The migration route of the Vosso salmon follows a series of narrow fjords around the island of Osterøy (illustrated in figure 4.4), and further out toward the coast past the islands of Askøy, Sotra and Øygarden. The Vosso salmon was known to produce the biggest specimen. This is why it was prized in sport fishing and why it was more famous than other salmon populations in Norway. Wealthy people from America and Britain in the 1800s paid a lot of money to come and rent out houses along the river (Barlaup 2008; river owner C 2011).

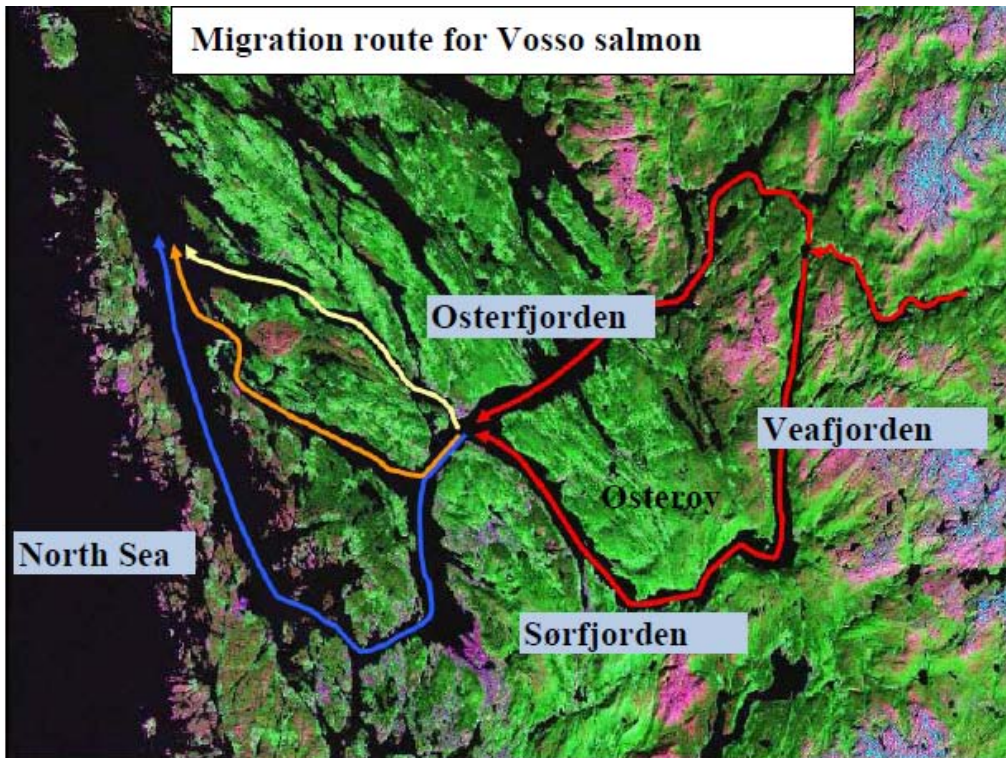


Figure 4.4: Migration route for Vosso salmon (Based on Barlaup 2010)

Figure 4.5 indicates that salmon catches were fluctuating throughout the years. However, the late 1980's show a dramatic decline in salmon catches in Vosso, without any upward going trends in the years after. In 1992 the situation was deemed so critical that the Directorate for Nature Management decided to close for all catches of anadromous salmonids in the watershed. In retrospect, the County Governor of Hordaland opened for a limited fishing for salmon, sea trout and brown trout in parts of the watercourse. Wild salmon, however, is still preserved in the entire watershed. Fishermen are only allowed to catch farmed salmon. If wild salmon are caught accidentally, they are to be delivered to the river guards or Vosso hatchery (Voss Hatchery 2011).

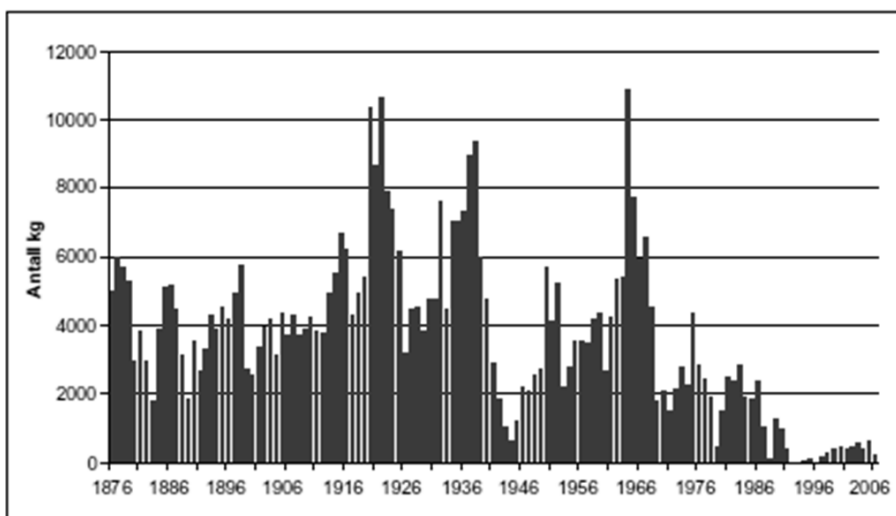


Figure 4.5: Wild Vosso salmon catch (in kg) from 1876-2006 (Barlaup 2008)

4.4 NATIONAL SALMON MANAGEMENT

The objectives of national management in Norway have been set up in such a way so that they reflect and integrate Norway's international obligations under the North Atlantic Salmon Conservation convention (NASCO). NASCO entered into force on 1 October 1983 and created an inter-governmental organization: the North Atlantic Salmon Conservation Organization (NASCO 2009). The legal basis and overall goal for the management of wild Atlantic salmon is "*to ensure that natural stocks of anadromous salmonids, fresh water fish and their habitats, as well as other fresh-water organisms, are managed in such a way as to maintain natural diversity and productivity*" (NASCO 2009). Salmon management should make use of the precautionary approach for the protection and restoration of Atlantic salmon habitat. It focuses on the protection of Atlantic salmon habitat as well as the development of plans for restoration of habitats that are negatively affected (Ibid.).

The 1992 Act relating to Salmonids and Fresh-water Fish etc. is an enabling act. Under the Salmon Act the salmon is protected and fishing may be permitted under special rules. Actions and measures on behalf of salmon are meant in part to prevent and compensate for pollution and intervention, and also to remove threatening factors and strengthen the size of natural stocks (NOU 1999).

In the case of salmon fishing, river recreational fishing and farming have different stakeholders, practices, traditions and management objectives. They are also managed by different governmental agencies. The Ministry of Environment is responsible for the wild salmon stocks and escaped farmed salmon, while the Ministry of Fisheries and Coastal Affairs is in charge of the salmon farming industry. Figure 4.6 shows the hierarchy of governmental salmon management in Norway. Conflicts over objectives and policies have arisen within the conservation, recreation and growth of the salmon aquaculture sector. Some of these conflicts are about land use between salmon farming and salmon fishing, but there are also conflicts within the wild salmon fisheries, such as fishing in the sea versus river recreational fishing (Liu et. al. 2010).

Land use is for the most part subject to local democratic management through the communes. These are again subject to control and monitoring by the County Governor, who is the representative of the central government on the county level. State controls over land use are carried out for fishing as well as for fish farming and hydropower. Especially salmon and sea trout fishing is strictly regulated. Property owners, also called river owners have the right to fish in rivers and lakes. They can also rent out these rights. Hydropower is considered to be a national as well as a local resource and is subject to comprehensive planning procedures. The National Assembly must give the final approval of major projects. (Anderssen 1998).

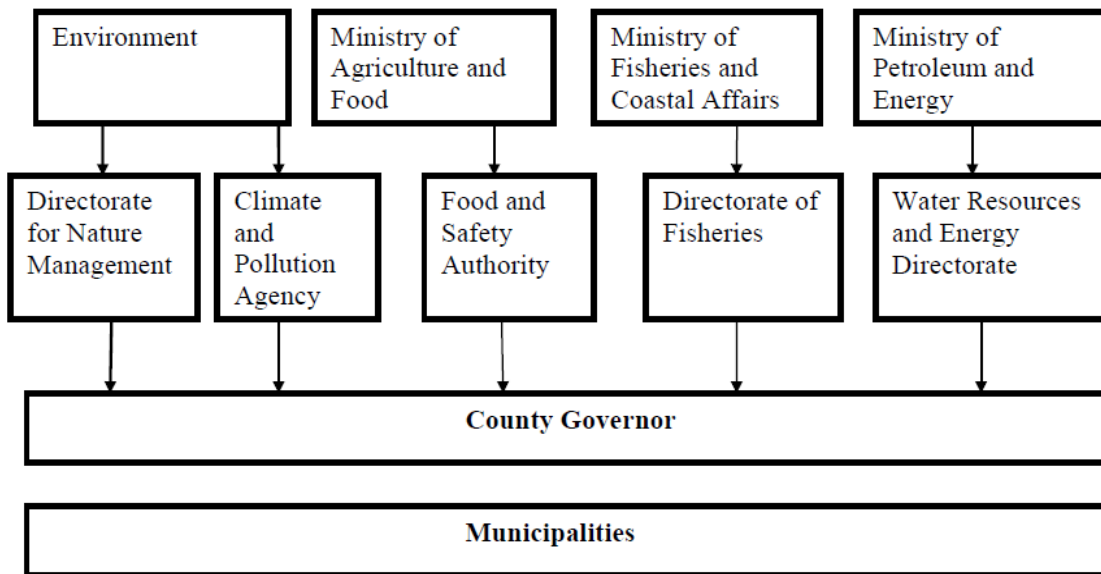


Figure 4.6: Hierarchy of national salmon management (DN 2011).

In order to facilitate stakeholder participation and influence in salmon management a number of local and regional councils have been established. On a national level salmon advisory and consultation meetings are normally held twice a year. National organizations of fishing right holders, recreational and commercial fishing interests, nature conservation, aquaculture and hydropower industries and relevant authorities are represented (NASCO 2009).

Nevertheless, the policy-making structure of Norway can be perceived as corporatist (Dryzek 2005). Concerning fisheries management, there has been no division of responsibilities to regions, but degrees of devolution have taken place through a system of (corporatist) consultation with professional organizations, user groups and other stakeholders involved. Although stakeholders can have an influence on management decisions either through an advisory role or via lobbying, final decisions are taken by the relevant Fisheries Ministries. Despite cases of regional decentralization, little is seen in terms of formal local level management. In addition, participation in policymaking processes has become a professional activity requiring particular resources and skills (LEI 2005).

In 2003 the Norwegian Parliament established a system of national salmon rivers and national salmon fjords where the wild Atlantic salmon is granted special protection. The intention of the national salmon rivers and national salmon fjords is to protect and restore salmon stocks to a level and composition that will maintain diversity. In the national salmon rivers no permission will be given to new enterprises or activities that might harm the wild salmon. In the national salmon fjords no additional salmon aquaculture plants will be established and existing installations will be subject to stricter standards for preventing escapes and controlling sea lice and other diseases (NASCO 2009). Vosso has been identified as a national salmon river.

The fjords around Østerøy are listed as national fjords. In addition the upstream watershed of Voss is permanently protected against hydropower development. This includes the waterways Strandaelva, Raundalen and Bordalsvatn River (Miljøstatus Voss 2010).

In the last two decades, several salmon restoration projects have been incorporated in Norway. The first project was initiated in the beginning of the 1990s. At that time the focus was on embankments and landscape, vegetation, placement of big stones in riverbeds and the breaking up of straight river courses (canalization). In lack of a plan for the habitat restoration, measures were carried through as single projects, without any plan and prioritizing. Gradually this changed to development of general plans where focus was set on entire rivers and entire watersheds, among which the river Vosso (NASCO 2009).

4.5 THE VOSSO SALMON RESCUE PROJECT

Due to concerns raised by the local community, a large scaled research programme was started in 2000 to identify the the possible reasons for the decline of the Vosso salmon population. It was initiated by the Directorate for Nature and had the objective to provide a basis for assessing which measures are best suited in the long run to preserve the Vosso salmon (Barlaup 2008). The project ended in 2007 and enabled the establishment of large datasets of the Vosso salmon status and possible salmon threats. In addition, the Nordhordland fish health network (2005-2009) was set up. This was a voluntary association of local salmon farmers. In practice it concentrated on reducing the number of sea lice in the sea when the Vosso smolt migrates through the fjords. Synchronous treatment of farms throughout the migration route was used as a strategy to achieve this aim. The network also aimed to build a greater sense of the importance of restoring the Vosso salmon among employees at fish farming facilities (Hoelting 2008).

With an increase in data about the Vosso salmon, it was deemed possible to set up a rescue plan. The rescue action for Vosso salmon, called ``*Now or never for the Vosso salmon*`` is a publicly managed initiative building on the previous Vosso research project and has a ten-year perspective (from 2010-2020). After the abolishment of the Nordhordland fish network, another private initiative has been established to preserve the Vosso salmon. This was done after a relatively stormy meeting in spring 2007 between fish farmers, researchers, the authority and other wild salmon aspirants. This initiative, called *Vossolaug*, was organized as a contractual partnership between central fish farm operators in the region, especially those with salmon and trout production in the migration route for Vosso smolts (Vossolaug 2010).

Project strategy

The main strategy of the rescue plan for the Vosso salmon consists of three parts: (1) the cultivation of salmon eggs, fry and smolt from genetic material in the national gene bank, which are released into the Vosso river; (2) comprehensive measures to reduce the effect of the different threat factors and (3) the establishment of a live gene bank, by taking genetic material from salmon in the river (Barlaup 2008). Different actors are involved in the project, among which the Hordaland county governor, the Voss municipality and several research groups. Vossolaugget and the Voss hatchery are contributing to the rescue project by producing and releasing Vosso salmon in the river. The organizational hierarchy is represented in figure 4.7.

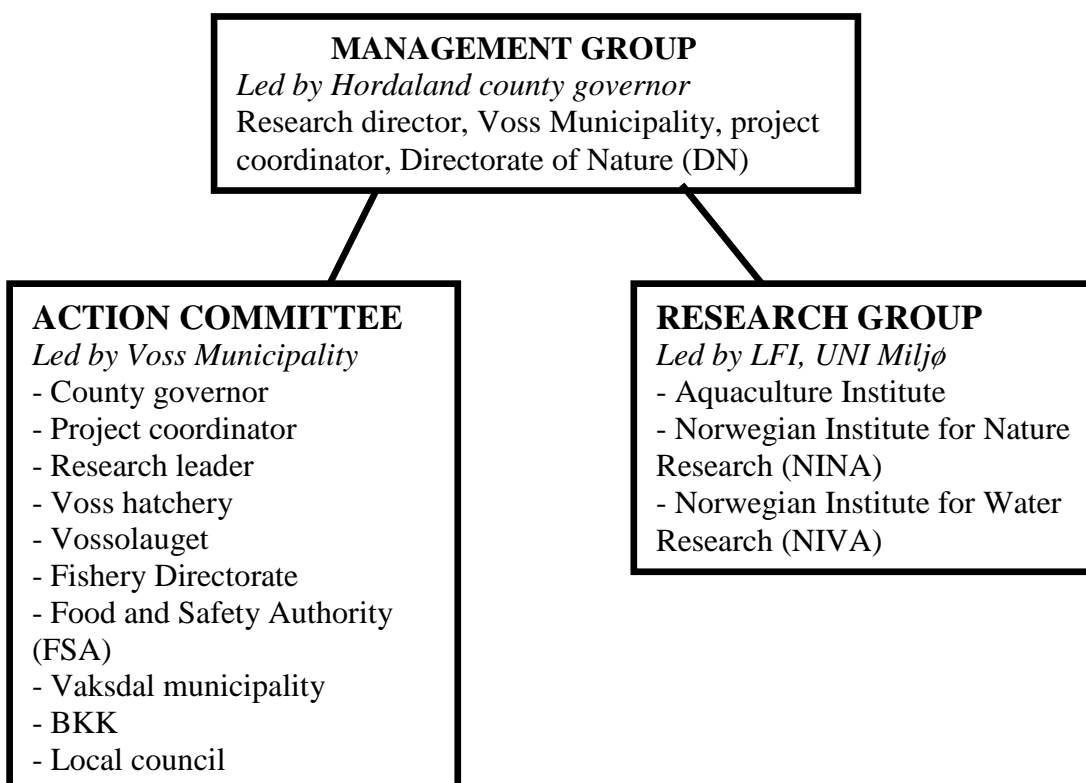


Figure 4.7: Hierarchy of project organization (Hordaland 2009b)

Vosso salmon management is characterized by a variety of actors, which have different responsibilities (introduced in figure 4.6). The food and Safety Authority, together with the fish farm industry is responsible for tackling threats related to sea lice and fish diseases. However, the Directorate of Fisheries, along with the fish farming industry, has the main responsibility for farmed fish. The chemical water quality is supervised by the Directorate of Nature and the County Governor, while the responsibility of water regulation and other physical interventions in the watershed lies in hands of the Public Road Administration, together with Voss commune and the Norwegian Water Resources and Energy Directorate (Hordaland 2009b).

Research group

The research group is led by the Laboratorium for fresh water and inland fish (LFI) and UNI Milljø. They carry out research on water biology and inland fisheries among others. Next to doing research, they work on restoring the salmon stock. The main actions taken to rescue the Vosso salmon are represented in table 4.2. For the purpose of investigating the smolt, smolt traps have been constructed (depicted in figure 4.8). These allow the researchers to catch salmon for both research purposes as well as for the collection of genetic materials. Based on these catches they can determine the origin of the smolt. If the salmon is of wild origin, it is possible to find out whether it has been produced at the Voss Hatchery. Salmon from the hatchery get a metal snout-mark or their adipose fin is clipped. The researchers also set out salmon in the river and surrounding rivers and fjords, among which Raundalselva and Sjørfjorden (Barlaup 2008).

Table 4.2: Measures to save the wild salmon population in Vosso (Based on Miljøstatus Voss 2010)

Fresh water	Brackish lake/ inner fjord	Sea water
<ul style="list-style-type: none">● Setting out eggs and fry● Releasing marked smolts to detect survival● Monitoring water quality● Monitoring the smolt quality● Monitoring the time of smolt migration each year● Registration of spawning● Removal of escaped farmed salmon	<ul style="list-style-type: none">● Setting out of marked smolts to register survival in fjords and the sea● Monitoring of aluminum concentrations● Registration of migrating salmon● Removal of escaped farmed salmon and rainbow trout	<ul style="list-style-type: none">● Setting out marked smolts to register survival in the sea● Registration of sea lice on migrating salmon and sea trout smolts● Mapping the migration route for salmon smolt



Figure 4.8: Smolttrap in Bolstadøyri

Gene bank

The genebank operations are based on a national programme. The main purpose of this programme is to create living reservoirs of genetic material which can later be used to reestablish or enhance stocks that are threatened. The Atlantic salmon are captured from rivers as adults and kept in tanks for a short period, until milt and eggs can be stripped. Eggs from females are fertilised using milt from males, disinfected and transferred to hatching facilities (shown in figure 4.9) (Verspoor et. al. 2007).

Voss hatchery

The fish are reared in the local hatchery. Here, small larvae are fed until they grow into fry, parr or smolts. Hereafter, the fish are set out in the river. The local hatchery in Vosso is a small hatchery, established in 1992. Salt is used as a natural disinfect and natural fish selection is encouraged. The aim is to release smolts of all sizes into the river (Miljøstatus 2007; Verspoor et. al. 2007; employee Voss hatchery 2011). Most water in the hatchery is taken from the river, but when the water level in the river is very low, water from community resources is used (Vossolaugget year report 2009).

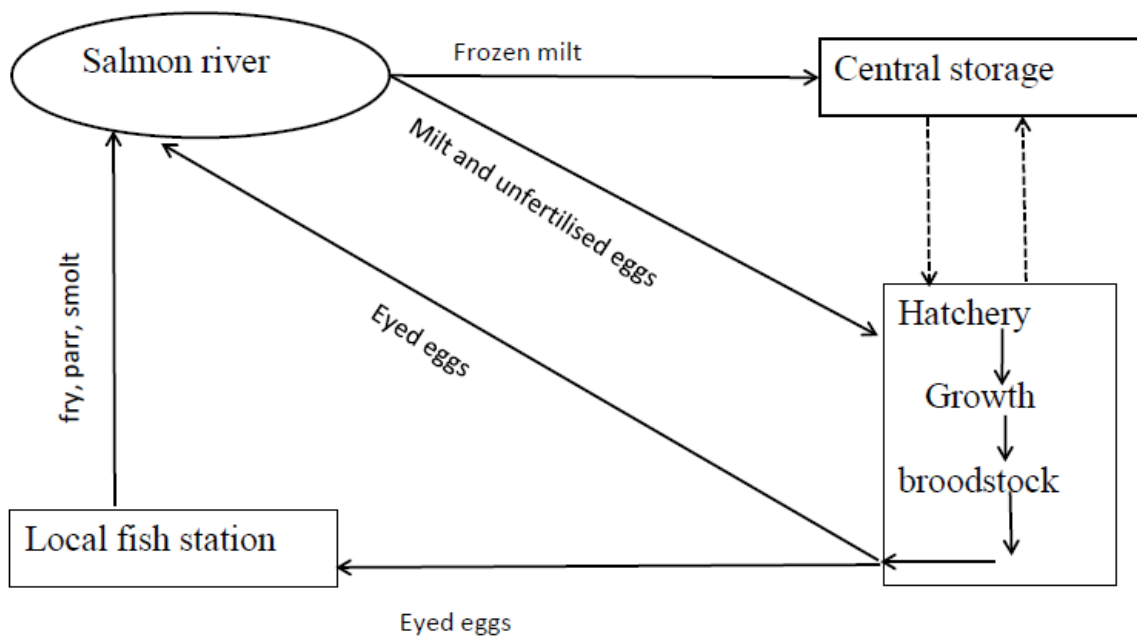


Figure 4.9 Schematic of operations for the gene bank programme (Verspoor et. al. 2007)

Vossolaugget

Vossolaugget's main focus is to produce and release smolts in the period 2009-2013 in the Vosso river system, in combination with open tank-based hauling of the smolt through its natural route of migration. These activities are the basis of the project budget. The plan is to release between 100.000 and 150.000 smolts in the production facility established by Vossolaugget in the Evanger Lake. These will be medicated against sea lice and released in a specially build tank before they will be set out in the fjord. Furthermore, in 2010 Vossolaugget has contributed financially to

research activities. Vossolaugget's efforts are currently limited to 5 years, while the rescue project has a longer time perspective. Vossolaugget's ambition is to contribute to bringing up the population of Vosso salmon to a level where natural spawning takes over again and the organization also hopes that the technology developed will be applicable for other critically endangered salmon stocks (Vossolaugget year report 2010).

The production circumstances of wild smolt differ slightly between the Voss hatchery and the smolt production facility of Vossolaugget. The main difference is that the Evanger smolts are offered a more natural environment than the smolts kept at the hatchery. Conditions concerning light and temperature are more natural at Evanger. In addition, the smolts at Evanger have more space than the hatchery smolts. In sum, this means that the Evanger smolts will be resemble natural smolts to a larger extent than the hatchery smolts. However, it is still unclear whether this will influence their survival in the sea in any significant way. Nevertheless, it is expected that the Evanger smolts will have a better chance of surviving than the hatchery smolts (Vossolaugget year report 2010; research leader Vosso rescue project 2011).

Government

The Vosso rescue project is initiated by the Directorate of Nature (DN), who is the biggest sponsor of the project. Both the county governor and the Directorate of Nature Management have the responsibility for the wild salmon. DN is responsible at the national level, while the county governor has the responsibility at a regional level. The management group consists of four persons and is led by the Hordaland county governor (introduced in figure 4.7) (Hordaland 2009b; fresh water fish manager from DN 2011).

Sports fishermen and river owners

Anglers are involved indirectly as they take part in the fishing for escaped salmon in the autumn. Some of them are also involved in the work at the hatchery as volunteers, whenever there is need for extra work (Fresh water fish manager from DN 2011). Some of them belong to local NGOs that have been put in place to increase the cooperation between different stakeholders, such as Østerfjord Villfisklag and Hardanger Villfisklag.

Sponsors

In addition to these rescue strategies, there are also actors that are not directly involved in the development and implementation of the rescue plan, but contribute financially. The sponsors and their relative contribution are represented in figure 4.10. The hydropower plant is the largest private financial contributor.

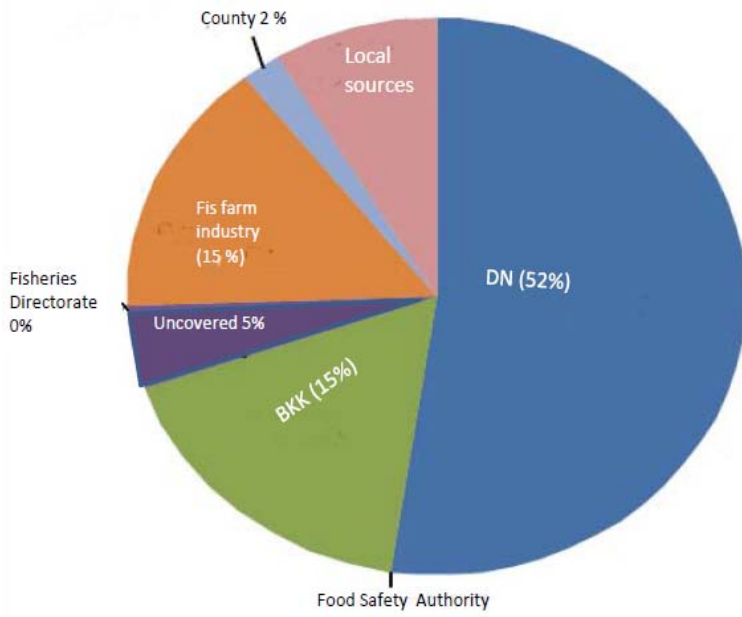


Figure 4.10: Division of financial resources according to actors (Vossolaugget year report 2010)

5. RESULTS

This chapter presents the results obtained from both a literature study as well as from empirical research. First the human impacts on the Vosso salmon are explored. Consequently, systems' thinking about the Vosso salmon situation is analyzed. This is in accordance with the SSM methodology.

5.1 EXPLORATION OF HUMAN IMPACTS ON VOSSO SALMON

The size of salmon stocks can vary greatly between years. The causes of variation can be both natural and manmade. In Atlantic salmon there is generally a good correlation between the numbers of smolts that go out and those that return (Verspoor et. al. 2007). Variation in smolt production as a result of various factors in the watercourse will therefore contribute to fluctuations in the spawning stock (Barlaup 2008).

5.1.1 Human impacts

The human activities described in this thesis have been selected by doing a literature review of activities that are documented to have a (possible) impact on the Vosso salmon. However, one has to acknowledge that there may be more, unknown, factors that have played a part in the collapse of the Vosso salmon. Figure 5.1 presents the most important human activities that plausibly have had an impact on the decline of the Vosso salmon population and their location in the salmon migration route.

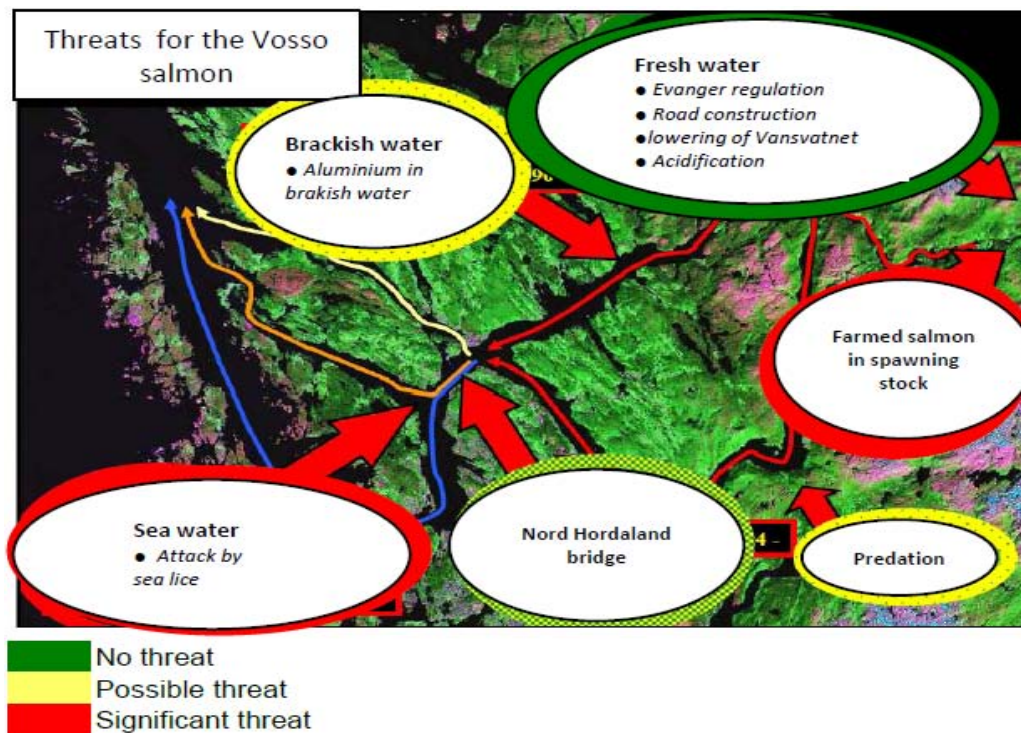


Figure 5.1: Threats for the Vosso salmon Source figure (based on Hordaland 2009a)

Fishing impacts

Today, overfishing is acknowledged to pose a serious threat to the preservation of wild salmon. Because of rapidly declining catches, river fishing in Vosso was prohibited in 1992 and the legal fishery in the fjords was reduced. Despite these actions the spawning stock in the river has continued to decline. Fishing prevents an already deteriorating salmon stock from recovering. However, as fishing is not allowed anymore, it does not pose a direct threat to the wild salmon any longer (Sægrov et. al. 1997).

Fish farm impacts

Recent studies have shown that fish farms can pose a threat to wild salmon in a number of ways. A major challenge is the escape of farmed fish into the river. In addition, the waste from fish farms can negatively impact the habitat of wild salmon (Fleming et. al. 2000; Gross 1998; Sægrov et. al. 1997).

Escapees have been reported in all regions where fish are reared in open cages. Farmed salmon can generate genetic as well as ecological impacts. These impacts, which can be direct or indirect, are depicted in figure 5.2. Direct impacts occur through interbreeding, introgression and competition for food and predation. Indirect impacts take place through artificial selection, drift, inbreeding, by transmission of diseases and parasites and through competition for habitat space (Fleming et. al. 2000; Gross 1998).

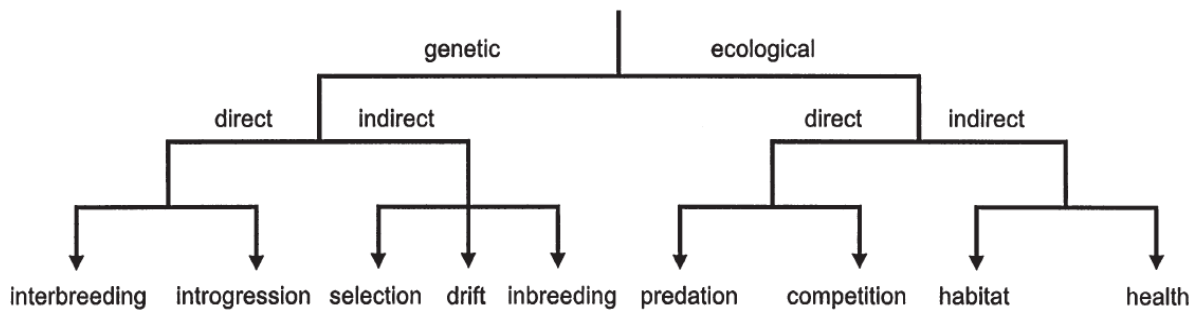


Figure 5.2: The genetic and ecological impacts associated with Atlantic salmon escaping from aquaculture (Gross 1998)

Another danger caused by fish farms is the untreated sewage discharge, including contaminated feed with chemicals, toxic residues, nitrogen, phosphorus, copper and zinc released directly into coastal waters. Discharges from fish farms contain the same types of nutrients and organic matter as domestic waste water and agriculture discharges and they have the same impact on environmental conditions in fjords and coastal waters. If there are several fish farms in a fjord, their overall discharges may cause eutrophication: decomposition of organic material released in the water can result in oxygen depletion in the fjord environment. This is not currently a problem in Norway, but there are indications that problems may arise in certain fjords (Bellona 2009; Miljøstatus 2008).

Other industrial activities

Pollution from agriculture and sewage has previously impacted smaller parts of the watercourse. There are few industrial enterprises along the river, but some problems have been registered with laundry activities in Evanger (Miljøstatus Voss 2010).

Furthermore, the hydropower plant in Evanger, owned by the energy company BKK, has had a negative effect on fish production due to a reduced water flow. Slower moving waters in a reservoir can strongly affect salmon for two reasons. Firstly, fish can become disoriented in slower moving waters. Secondly, they may increase the time that smolts need to reach the sea. The disorientation and the longer travel time lead to an increased exposure to predators (FWEE 1999). The transfer of water through Evanger plants also resulted in a significant deterioration of the water chemistry, leading to acidification. To counteract this acidification, the water from power plants in Evanger has been limed in the period 1994-2005. As a result of reduced acid rain and increased pH, liming ceased in 2006. The water chemistry from the Evanger hydropower plant is therefore no longer seen as a threat to salmon stocks in the river unless conditions worsen. But one cannot exclude the possibility that water regulation has had other, less direct and not very measurable effects that may have affected fish stocks negatively. Examples of such possible adverse effects are altered water flow and temperature conditions (Barlaup 2008).

Studies have also shown that the aluminum concentration in brackish water areas around Osterøy is at a level that can have a negative impact on the survival of smolt that migrate from Vosso to the sea. Experiments that were carried out show that the smolt can get relatively high concentrations of aluminum on the gills. Salmon are negatively affected by aluminum. Higher concentrations in the river occur due to acidification. Aluminum affects properties that are important for salt tolerance, and thus marine survival of migrating salmon smolts. Both the amount of aluminum in the water and quantity of aluminum accumulated in the gills of the Vosso smolt are at levels that are considered unacceptable. The levels do not cause acute mortality, but do lead to decreased disease resistance, increased vulnerability of sea lice infection, changes in fish behavior and reduced growth (Barlaup 2008).

Figure 5.3 has been constructed by the researcher during earlier research, as an attempt to link the different human impacts together in one system, to show their interconnections with the Vosso salmon stock. It is a system based on systems engineering, describing the 'real world' events. The Vosso salmon ecosystem consists of both the river ecosystem as well as the migration areas towards the sea.

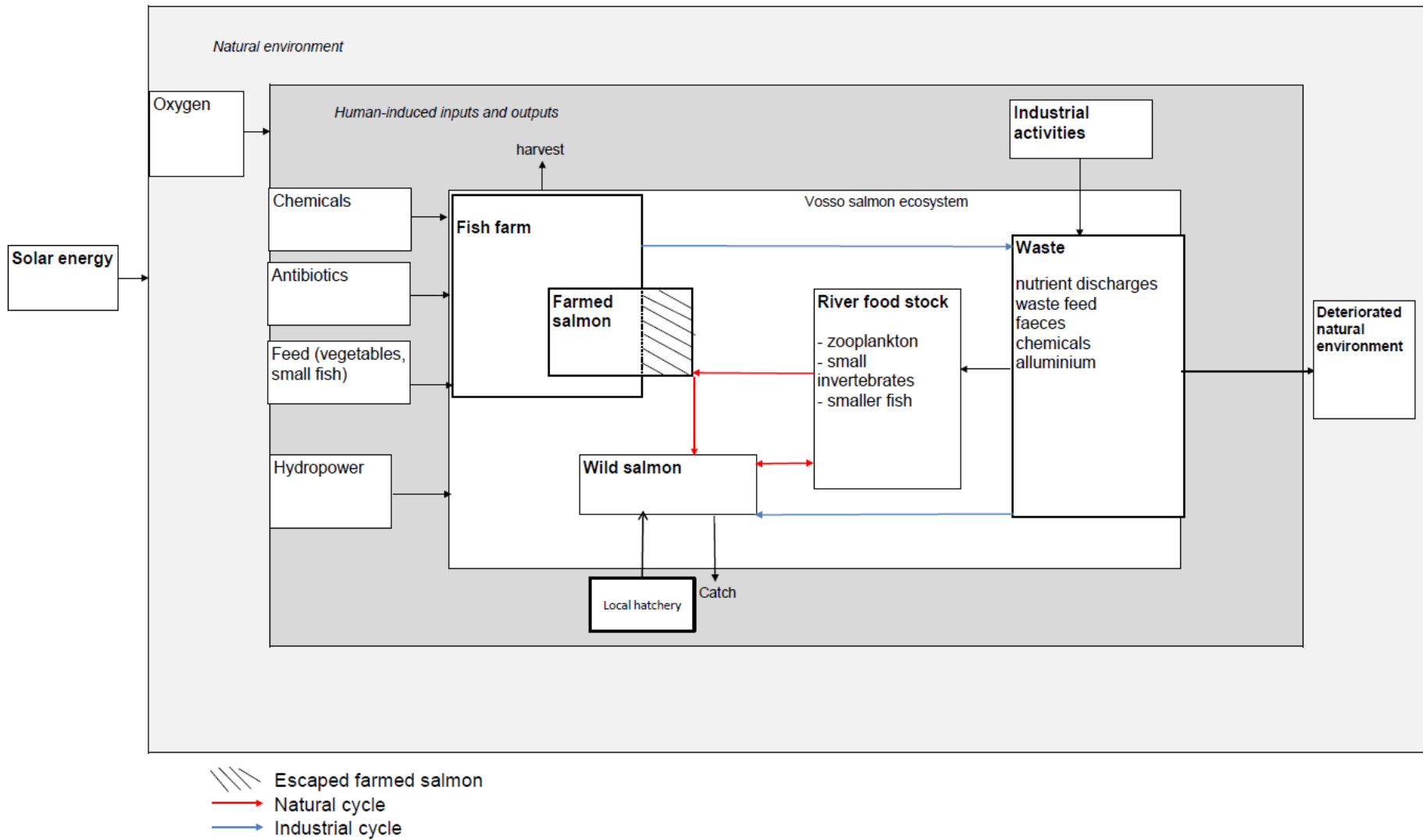


Figure 5.3: Human impacts on Vosso salmon (Gajic 2010)

5.1.2 Timeline of human activity impacts

A timeline of human activities related to the salmon stock and environment has been constructed in order to document possible patterns in the situation. The information used to construct this table is based on the literature review, the interviews and the analyzed media messages.

Table 5.1: Timeline of human activities

Date	Event	Description	Human impact on salmon stock (*)
1850	First foreign tourists	First tourists came from abroad to fish in the river	?
1969	Evanger regulation	Regulation of the water course led to reductions in smolt production in Teigdalselva and Bolstad River, as it worsened hydrological conditions	-
1980s	Attack by sea lice	Experiments indicate that sea lice can cause high mortality on migrating wild smolts from Vosso	-
Late 1980s until 2020	The original stock is kept in a live gene bank	The main purpose is to create living reservoirs of genetic material which can be used to reestablish the threatened salmon stock	+
1989-1991	Road construction	Deterioration of feeding areas in a 700 m long downstream area	-
1990-1994	Acidification of water quality in freshwater due to acid rain	This leads to higher aluminum concentrations, which have negative effects on juvenile fish production, smolt quality and the survival chance of smolt in the sea	-
1991	Lowering of lake bed	Significantly increased mortality of salmon due to stranding	-
1992	Establishment of local hatchery in Voss	The main purpose is to help sustain the salmon, by using roe from the gene bank to rear salmon and release them into the river	+
1992	Ban on salmon fishing, by Directorate of Nature	This regulation was introduced because the salmon situation was deemed critical	+
1993-	Farmed salmon dominates in spawning stock	Interbreeding between farmed salmon and wild salmon has affected the genetic composition of salmon stocks. Also, competition occurs between offspring of wild salmon and farmed salmon	-

1994-	Building of Nord Hordaland bridge	Results from experiments indicate that the bridge can be an obstacle to migrating smolts. It may increase their vulnerability to predation and sea-lice attacks	-
1994-2005	Liming of water	To counteract acidification, the water from power plants in Evanger has been limed	+
2000-2007	Vosso project, initiated by Directorate of Nature	Due to concerns raised by the local community, a large scaled research programme was started back in 2000 to identify the the possible reasons for the collapse of the Vosso salmon population.	?
2005-2009	Nordhordland Fish health Network	A voluntary association of local salmon farmers was established to help restore the Vosso salmon	+
2005	Hardangerfjord Villfisklag was established	This is a non-governmental organization, established to stimulate dialogue between fishermen and river owners	0
2008-2012	Vossolaugset	A voluntary cooperation of fish farmers was introduced to help restore the Vosso salmon.	+
2010-	Plans published for dam building in Raundalselva	The Voss council is exploring the possibilities for hydropower in the protected river Raundalen, part of the Vosso watershed	?
2010-2020	Rescue project 'Now or Never for the Vosso salmon'	A rescue plan has been developed, based on results from the Vosso project	+
2010	Osterfjord Villfisklag was set up	Osterfjord Villfisklag is an NGO that wants to ensure a long-term sustainable management of the local anadromous fish stocks that use the South and Osterfjord as feeding and migration area. Made to stimulate cooperation between all actors locally, regionally and nationally	?
2011	Lerøy establishes fish farm in Sandvik Sjørfjorden	The fish farm is located at the migration route of the Vosso salmon	?
2011	Norway's Fishery and Hunting organization (NJFF) annual meeting about establishment of fish farm in Sjørfjorden.	NJFF-Hordaland does not agree with the allowance of another fish farm and requires that the local decision on the affected municipalities must be emphasized to a far greater degree than we see in this case.	0
2011	Marine Harvest is planning to introduce closed cage facilities	Such plants have been regarded as both more expensive to build and operate. The problems caused by sea lice, disease and farmed escapes, in addition to stringent regulations from the government have turned the mood	0
2011	Lerøy is planning to use floating fish farms	In this construction, water is pumped into the plant from deep water without salmon lice	0

(*) + = positive impact - = negative impact 0 = no direct impact ? = unknown impact

5.2 SYSTEMS THINKING ABOUT THE VOSSO SALMON SITUATION

5.2.1 Stakeholder analysis

The stakeholder analysis was carried with help of a literature review. In addition, short, informal interviews were conducted with the research leader of the Vosso salmon rescue project and the project coordinator of Hordaland, who both suggested a number of relevant contact persons. The stakeholders consist of actors that are financially involved in the rescue project. In addition, other stakeholders were identified that have an indirect stake in the project. These include fishermen, customers of farmed fish products, the media, NGO's, local communities and the Norwegian society, now and in the future. Subsequently, the stakeholders were divided into primary, secondary or tertiary stakeholders after considering their proximity to the Vosso salmon, the sense of urgency they feel for its rescue, their legitimacy and the power they exercise in the project. The results are shown in table 5.2.

Table 5.2: Stakeholders of the Vosso salmon rescue project

Stakeholders	Primary	Secondary	Tertiary
Fishermen	x		
Fish farm suppliers		x	
Salmon farmers	x		
River owners	x		
Customers of farmed salmon products			x
Governmental management agencies	x		
Scientists	x		
Non-governmental organizations		x	
Banks			x
Tourist industry in Hordaland		x	
Hydropower plant		x	
Other industries causing acidification			x
Local media		x	
Norwegian society, now and in the future			x

5.2.2 Content analysis

Two types of content analyses were carried out in this study: the website analysis, presented in this section and an analysis of local news messages from the Hordaland area, which is found in Appendix D. The information gathered from the content analyses provides an input for the determination of the environmental discourses supported by the stakeholders of the Vosso salmon rescue project. Five different criteria have been predetermined to compare the website communication priorities of Vossolaug members in relation to the Vosso rescue project. These will be discussed next.

1. Is information about Vossolaug available?

Since all the companies subject to the website analysis are involved in Vossolaug, the expectation is that mentioning Vossolaug on the website denotes that the company perceives it as something worthwhile to communicate about. This question can help to determine if the company considers its involvement in Vossolaug a communication priority.

2. Is attention paid to salmon threats in general?

However, if the company does not mention Vossolaug, this does not necessarily mean that it does not express interest in salmon threats in general. This question is included to scrutinize if salmon threats are perceived as a communication priority.

3. What is the length of information?

An implicit assumption is made that a positive relationship exists between the length of information about a subject and its communication priority.

4. Is information easy to find?

If a company wants its website visitors to read about a certain subject, it will try to make sure that this information is easy to find. The more difficult the information is to find, the less prioritized one can assume the theme to be by the company.

5. Does the company carry out sustainability reporting?

Assessing if the company carries out sustainability reporting can say something about the prioritization of the environmental issues in general.

The assessment of the websites from Vossolaug members is presented in table 5.3. Overall, 'green' means that a company addresses the questions comprehensively, 'yellow' means that it has some information available, while red shows that the website contains little or no information.

The author of this thesis made an attempt to decrease the subjectivity in the assessment of these qualitative data, by coding them in a way that is replicable for other researchers (e.g. using number of sentences and number of mouse clicks). An attempt was made to make the categories mutually exclusive. For example, as indicated in table 5.3: when information about Vossolaugget is available, question 4 (about how easy the information is to find), applies to Vossolaugget. When this information is not available, the question applies to information about salmon threats in general.

Table 5.3: Communication priorities for Vossolaugget and salmon threats in general

Organization /Company	1. Information about Vossolaugget Link to Vossolaugget year report	2.Information about salmon threats	3 ^A . Length of information	4 ^B . Information is easy to find	5. Sustainability reporting
Marine Harvest	yes/no	yes	medium	fairly easy	yes
Lerøy	no/no	no	short	easy	yes
Sjøtroll	no/no	yes	medium	n/a	no
Blom Fiskeoppdrett	no/no	no	n/a	n/a	no
Fyllingsnes Fisk	no/no	no	n/a	n/a	no
Fjord Drift	no website	n/a	n/a	n/a	no
Eide FjordBruk	no/no	no	n/a	n/a	no
Fish farm suppliers					
Salmobreed	yes/yes	yes	short	easy	no
EWOS	yes/no	yes	Lengthy	easy	yes
HI Havbruksinstituttet	yes/yes	yes	short	Fairly easy	no
Alvestad Marin	no/no	no	n/a	n/a	no
VAKI	yes/no	no	medium	Fairly easy	no
PATOGEN	yes/yes	yes	medium	Fairly easy	no
Umbrella organizations					
Norwegian Seafood Federation	no/no	yes	lengthy	easy	no

A: when 1 = *yes* → 3 concerns information about Vossolaugget
 When 1 = *no* → information concerns salmon threats in general
 > 15 sentences = *lengthy*
 5-15 sentences = *medium*
 < 5 sentences = *short*

B When 1 = *yes* → 4 concerns information about Vossolaugget
 When 1 = *no* → information concerns environment/salmon threats in general
 < 3 mouse clicks = *easy*
 3 – 5 mouse clicks = *fairly easy*
 > 5 mouse clicks = *difficult*

Table 5.4 contains the summary of the most prevelant information found on the website of each company. This is information about the visions and goals of the the company emphasized on the website.

Table 5.4: General communication priorities of Vossolauget members

Company/Organization	Communication priorities in general
<i>Fish farms</i>	
Marine Harvest	As the world's leading aquaculture company, it accepts to have a responsibility to lead progress in aquaculture and to provide consumers with increasing amounts of healthy, nutritious food without compromising the environment or the freedom of others, both now and for future generations. On its website, the company provides relatively detailed information on the negative impacts of aquaculture. Furthermore, yearly sustainability reports are available.
Lerøy	Lerøy Seafood Group's vision is to be the leading and most profitable global supplier of seafood. The company concentrates on providing high quality products, thereby developing profitable, efficient and binding partnerships in terms of both supply and marketing. It aims to minimize any negative impact on the environment throughout the entire value chain. The goal is to select systems for production and logistics which reduce any negative impact on the environment, as long as these are technically and financially justifiable.
Sjøtroll	Sjøtroll is one of the country's main producers and suppliers of farmed and processed salmon and trout. Through its range of companies, the group manages the full value chain, from production of brood stock and roe to the fish being slaughtered and processed. It presents itself as one of the oldest fishery families in the community. It emphasizes the healthy aspects of eating salmon, the welfare of the fish, stringent production facility requirements in terms of water quality and the freshness of their products.
Blom Fiskeoppdrett	A proud family business which has been one of the founders of what is now one of Norway's largest exports industries. Sees itself as a contributor to the community through jobs, wealth creation and activity in the municipalities. The company shall be developed and operated for the benefit of local communities, employees and owners. The importance of small businesses for the community is emphasized, and the company assures that everything will be done to let local businesses enjoy the benefits of the company's existence, as this is economically important.
Fyllingsnes Fisk	Does not have an own website. Only short information about the company is available on http://www.havdyrkerne.no , containing the name of the daily leader and the number of employees and emphasizing that the company is known for its silvery fish with red flesh and that the production is aimed at Asian customers
Fjord Drift	Does not have a website. The only information available is contact information of the company.
Eide FjordBruk	A family company. Provides a history of the company's foundation. Information is directed towards the production and packaging process of salmon, accompanied by pictures.

Table 5.4- continued

<i>Fish farm suppliers</i>	
Salmobreed	SalmoBreed AS is a breeding company with a family based breeding program, developing a forward-looking genetic product adapted to the production of Atlantic salmon and Rainbow trout. The products of Salmobreed distinguish themselves through good growth, increased resistance to diseases, product quality and reduced early maturation. It pays attention to fish health and diseases in general and to Vossolaugset.
EWOS	EWOS is a fish feed supplier. The website has a separate heading called 'sustainable aquaculture' in which it is stated that EWOS makes significant investments in R&D, systems and people to ensure that the mission of sustainable aquaculture is respected in the production of aquaculture feed. Under this heading it explains which actions have been taken to make their business more sustainable. Furthermore they mention that they are one of the first companies to have an ISO 2200 certification.
HI Havbruksinstituttet	It was founded in 2000 to provide services within for the fish farm industry. Their services are advising, biological quality assurance and production optimization. It mentions two projects in which it is involved: Vossolaugset and PD-free, which aims to reduce the risk of outbreaks and the further spread of the PD virus infection
Alvestad Marin	Alvestad Marin AS is a leading supplier of products and system solutions to the fish farming business. They want to develop, manufacture and market products and services to the aquaculture business in the Norwegian and international markets. By means of good contact with the business, the development will be governed by the need for efficiency improvement, quality improvement and quality assurance. No mentioning of corporate social responsibility.
VAKI	VAKI is a leading company in development, manufacture and marketing of hi-tech equipment for fish farming and the environmental market. Continuous product development in collaboration with customers and other partners is one of the company's main priorities. According to their website, they strive to meet the needs that arise with their customers and look for new opportunities where their technological expertise can be incorporated.
PATOGEN	PATOGEN is a biotechnology company that develops and sells gene technology analyses that are used to reduce disease-related loss in the aquaculture industry. The company wants its services to contribute to increased profitability and predictability in the aquaculture industry by preventing infection and disease and contribute to meeting its customers' ever stricter requirements for cost-efficient, animal-friendly production of Atlantic salmon, rainbow trout and cod.
<i>Umbrella organizations</i>	
Norwegian Seafood Federation	The Norwegian Seafood Federation represents the majority of companies within the fisheries and aquaculture sectors in Norway. FHL is working to ensure good conditions for the seafood industry and to provide the best possible service to member companies. Most articles on the newsfeed are related to salmon threats from sea lice.

The industrial partners from Vossolaugget were sorted according to their main website communication priorities, taking the information from the website analysis into consideration. A schematic representation of this is given in figure 5.4. This figure shows a hierarchy of four different interests: *organizational*, *economic*, *societal* and *environmental* interests. If a company is listed as ‘environmental’ it means that it takes all four interests into account in its main communication priorities. Two out of seven fish farm companies have environmental issues among their communication priorities, while four out of eight fish farm suppliers cover environmental issues as part of their website information.

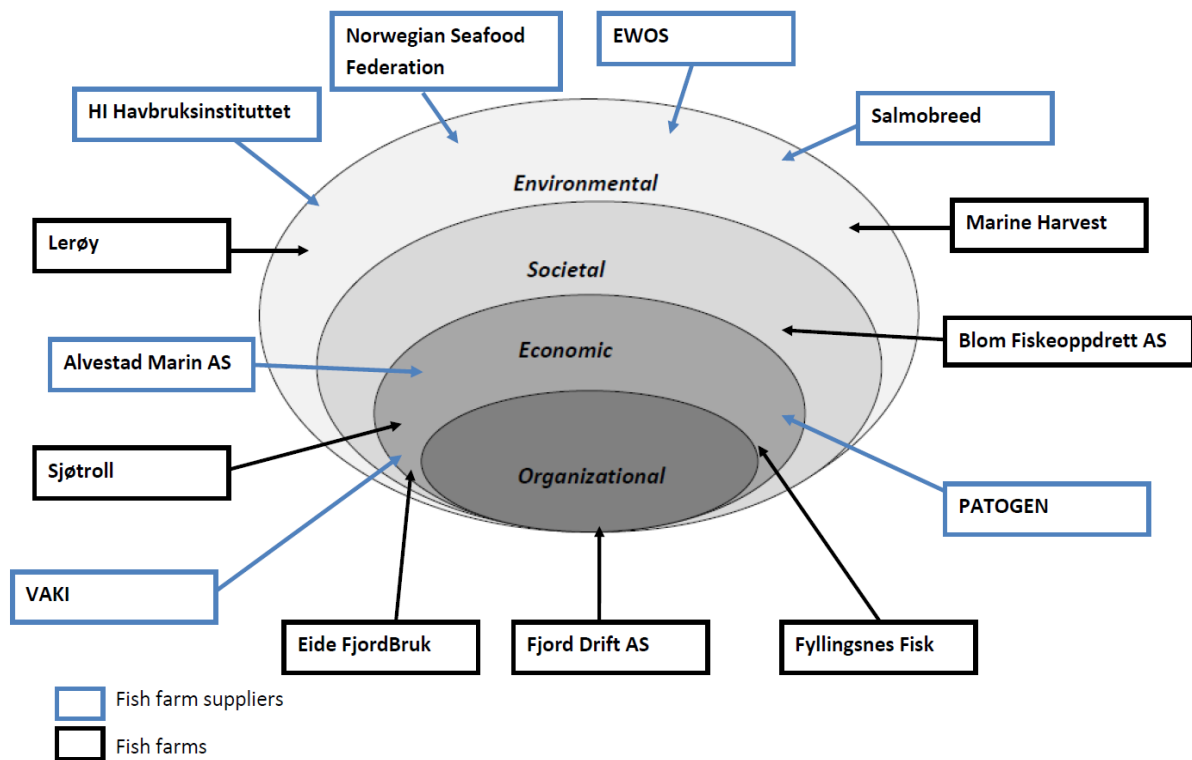


Figure 5.4: Website communication priorities of Vossolaugget members

5.2.3 Interview results

The primary purpose of the interviews is to find out the attitudes of the different actors towards the extinction of the Vosso salmon and possible conflicts of interest within the rescue project for the wild salmon. This section presents a summary of the interview results. The main findings are listed according to corresponding themes. The complete interviews can be found in Appendix C.

1. Why should the Vosso salmon be rescued?

The respondents name five main reasons why the wild salmon in Vosso should be rescued. These responses have been listed according to their frequency of mention:

1. It is one of the biggest salmon populations in the world (5/9 respondents)
2. The Vosso salmon is of economic importance (4/9 respondents)
3. It is a national obligation (2/9 respondents)
4. It is an emblematic fish (2/9 respondents)
5. The Vosso salmon is important for biodiversity (2/9 respondents)
6. The Vosso salmon is important for the local community's way of life (1/9 respondents)

2. How is the cooperation between different actors perceived?

Six out of nine respondents commented on the cooperation between the various actors. There is a deviation in the way cooperation is perceived by different actors. A summary of the opinions expressed towards cooperation is listed below. The list starts with the most positive attitudes and ends with the least positive ones:

- The cooperation is very good. We're meeting a lot of scientists. Maybe the Vosso project is the best example of cooperation between fish farmers and nature management
- They [the fish farmers] have been more and more aware that something needs to be done. That's good. I like to see that we are cooperating more as one unit
- The cooperation is quite good, but there are a lot of people involved. It is a challenge having everybody working for the same cause
- The project can be characterized by the involvement of stakeholders that do not only have divergent interests, but also different responsibilities. There are many different government departments responsible for the restoration of the wild salmon, each with a different responsibility

- Fish farmers and the Directorate of Nature have been a bit unwilling to cooperate. They do what they can but, like the others, they like to show that they can [do it]
- The hydropower plant is mostly interested in producing electricity. And the same goes for fish farmers, they are mostly interested in producing fish

3. Which factors can contribute to the success of the project?

Several interviewees have pointed out positive aspects of the project strategy. A summary is given below:

- The biggest achievement [of the project], has been the integration of stakeholders with different interests. Furthermore, through the project fundamental datasets have been established, with concrete data. Had the scientists not established concrete data, then the second project would not have come into existence
- This project may be building a bridge. I have good faith. There are people with different interests, but now they understand each other better
- It was hard in the start because as you might know there has been a good dialogue between the fish farmers and the environmental management. So the Vosso project has been a good example on how it can be
- There is less hostility [in Norway], more working together, but there is still a sense among wild salmon advocates that there needs to be salmon farming industry on land, there need to be some solutions
- They [the scientists] are working both on just getting basic biology knowledge, and they are also working on things that we can use to reintroduce it into the river and just measuring whether or not these effects are working. So there is a parallel of these two things working. And they have come a long way in the sense of biology, and they have come a long way in the sense of doing work to reintroduce the salmon, but the end results will be in the next few years so I think there are a lot of good results here
- In the last few years the knowledge of fish farmers seems to have increased and their approach to restore the wild salmon has widened. First their main goal was to increase the number of smolts in the river. The goal of the Voss hatchery was broader; they were aiming to reach natural reproduction of the salmon. Now fish farmers are involved in more ways

4. What are some challenges for a successful completion of the project?

The opinions about possible challenges facing a successful completion of the project can be divided according to five different categories: *geographical challenges*, *challenges due to time lapse*, *challenges related to governmental authorities*, *challenges related to fish farming* and *financial challenges*.

Geographical challenges

- The biggest difference [of Vosso river compared to other rivers] is that other rivers have a shorter distance from the river to the sea. This makes rescuing the salmon [in Vosso] a bigger challenge
- There is a high mortality out in the sea, where we don't have control over.
- It is difficult to get solid data in the fjords and the seas

Challenges due to time lapse

- So much time has passed since the collapse of the wild salmon. The big salmon is especially valued by those who have seen it in real life. And since the stock collapsed in the late 1980s, it has been quite some time since its abundance in the river. The contemporary politicians possibly have never seen it in real life, which is why they might attribute a smaller value to it. This means that the wild salmon is slowly losing spokespersons
- It has been a really long time since the salmon has crashed. A lot of things have changed. There have been changes in ocean, changes in hydroelectric power, changes when the flow of water comes out. There are all these sea lice and issues with salmon farms. It seems kind of unlikely to me that this is going to work

Challenges related to governmental authorities

- They [the government] like to start things, because then they will be elected again. That's the problem. And these fish farmers, they get their permits. And there are things they should do and should not do to get the permit. And if they have not been doing anything illegal, they haven't done anything wrong as I see it. Decisions have been made from the government. And they should have been more careful when they started such a big thing as the fish farming, do some researching first and at least do it on a smaller scale
- There are different departments that have responsibility for some of the problems. For example the hydropower plant industry and the farming industry. So that makes it a little bit more complicated
- The problem is to do something about the situation. There the authorities have to work harder, because there is a lot of money in the fish farm industry. It is very important for the economic situation in the country. So I think that's the biggest problem

Challenges related to fish farming

- The biggest threat in all of our county is the fish farming. There is no doubt about it. We are not sure if there might be another threat that we don't know
- I think that they [the fish farmers] want to do the same thing, but at the same time it's all about how it looks from the outside, the media and their possibilities of being able to go out and say that they're doing it, or that we're doing it

- In Vosso, they have spent a lot of money and they are trying to find solutions. But I think the big problem is these fish farms and as long as they are in these fjords, the problem will continue
- There are slightly different views on how the smolt has to be selected and put out into the river. The Voss hatchery wants to encourage natural selection. They set out both ‘well fit’ fish as well as fish that are less fit and are not encouraging the use of vaccines. This would undermine the process of natural selection and in the end lead to fish with less diversity. Farmers on the contrary, are used to artificial selection of the ‘strongest fish’

Financial challenges

- We have a good organization, and it works. One of the main reasons for why we are not succeeding that well is lack of money. We should have more money to work faster
- The farming industry does not give enough money or resources

5. How can the wild salmon and fish farming coexist?

Different requirements are named by respondents that are needed for the wild salmon and the farmed salmon to coexist. The reasons are listed below:

- When it comes for example to Hardanger area, it seems that there is too much farming going on. The areas between them are too small and there seems to be too much farming in general. So in some of these areas the farming intensity needs to be lower or not to be increased.
- I think that the fish farms should be on land. In a newspaper in Bergen two days ago, they tried to make some arrangements based on concrete. It would be on the water. But it would make it much more difficult for the fish to escape
- I think the whole sea farm industry is a threat, not only to the salmon, but to the life in the fjords in general, because of pollution. So I think they should stop to have the fish farms in the fjords, or in open water
- I saw in the news paper yesterday that they were talking about making big installations of concrete, floating on the water and put the farm in there so they could lock it and take uninfected water and things like that, because these parasites they are very costly for them and they can’t use very much things like chemicals or penicillin because their market will disappear. So I think we can cooperate with them. I think so.
- Both power plants and the farming industry, they have a good economy. They do well, so they should participate in this rescue operation. They do have the resources and the responsibility
- Fish farms can contribute by making their technology available

6. Who should be responsible for deciding the future of the Vosso salmon?

Some respondents have expressed their opinion about who should have the main responsibility for deciding the future of the Vosso salmon. All of them agree that the national government has the main responsibility.

- The highest level has to be the government, the environmental department. But we must not forget the County governor in Hordaland, and they have to cooperate with the more local people, like the fishermen and the river owners and the local hunting and fishing association. They are all in the local advisory board and have meetings here every year to discuss the issues locally
- Policies have to be the government. So the decisions about what actually the management is. The people can't decide that, the government has to decide that. But I assume that the government in Norway, since it is a democracy, should listen to what people want
- The government, there is no sense that they should regulate themselves. Industries they are well intentioned. Maybe there are hundreds of farms that are doing great, but then you have a couple that don't care. Then that affects everything
- I think that the politicians on a national level should be. They should have the responsibility for this. It is a national task. It is not for the river owners to lead this. And I think also that the government understands this responsibility.

5.2.4 Questionnaire results

An online questionnaire was sent out (attached in Appendix B). to find out the attitudes of those stakeholders who were not accessible for an interview, either due to a language barrier, lack of time or higher sensitivity to anonymity preservation of their answers .The primary aim was to find out about the attitudes of the industrial partners involved in Vossolaugget. In addition, the questionnaire was sent out to the tourist office in Voss, as well as to a sports fisherman. Unfortunately, the response rate for the industrial partners was very low. Only 2 out of 14 industrial partners answered the questionnaire (even after the project coordinator of Vossolaugget had sent out two reminders). In addition, the questionnaire has been answered by a local sports fisherman as well as a representative of the tourist office in Voss. The answers to the questionnaire have been listed in this section.

Problem formulation

1. Why are you involved in the Vosso rescue project?

This question was posed in order to reveal the main interests behind the involvement of the stakeholders in the rescue project.

- *Member Vossolaugset 1:* We got a request from the Voss hatchery to share our experiences with regard to the cage farming of smolt. We were of course willing to do this
- *Sports fisherman:* Trying my best to contribute to various posts on discussion forums, local newspapers and Bergens Tidende to focus on the river and the research that has been going on for over 50 years, without anyone who really can prove what the cause of collapse is for the world's most major growing salmon population
- *Tourist office in Voss:* Important to save the salmon population. It is also important for the future of the tourist industry

2. What are the consequences if the Vosso salmon population becomes extinct?

The reason for posing this question is to find out the values attached to the salmon by different stakeholders. Three out of four respondents answered this question.

- *Member Vossolaugset 1:* that will be a loss. Then we must try to find other methods to restore the stock
- *Sports fisherman:* Even today, there is no income for sport fishing in the river Vosso. This is noticeable when looking at the number of foreign tourists fishing in Voss. The result is little interest from foreign tourists who have put a lot of economics in the municipality. Sports stores have not sold fishing for salmon and sea trout fishing for over 20 years
- *Tourist office in Voss:* Life in the river becomes poorer. We lose an attraction

3. Has your perspective on the situation of the Vosso salmon changed during the years?

This question was included to find out more about the attitudes of the stakeholders. Again, three out of four respondents answered the question.

- *Member Vossolaugset 1:* No, it is worth preserving. Measures of Vossolaugset should be given attention and support so that the work can help to strengthen and preserve the stock
- *Sports fisherman:* Yes, I have fished in the river since 1971. As a fly fisherman especially after 15 July, there were always a 4-5 sea trout in an afternoon fishing trip and a salmon or two. The last 15 years I must fish an entire season to achieve the same amount, because the salmon are protected. During the last years, one had the same chance for catching salmon as for catching sea trout. But the season of 2010 was the first year I can remember not to have seen sea trout.

- *Tourist office in Voss*: reasons seem complicated and interlinked, but now we know that farmed salmon and sea lice are probably the most serious threats

Project strategy

4. What is necessary for the fish farms and the wild salmon to coexist?

- *Member Vossolaugset 1*: keeping the focus on wild salmon stocks so that measures can be taken to strengthen it. Gain knowledge about the causes that put stocks directly or indirectly in danger. Utilize the knowledge that currently exists in fish farming. There is no reason why fish farming and wild salmon should be able to coexist. We must carefully continue with the measures, so that evaluation of each measure provides us with accurate and valuable information
- *Member Vossolaugset 2*: Understanding the farming business and focusing on the wild salmon as a species and not so much on one river
- *Sports fisherman*: a self-regulation system in which the fish farm industry pays a fine every time an escaped farmed fish is caught and a fine is paid by the fisherman, every time a wild salmon is caught
- *Tourist office in Voss*: Cooperation with the farming industry needed to save the wild salmon

5. What additional knowledge do you need to know to better understand the situation in Vosso?

- *Member Vossolaugset 1*: it is important to have knowledge of local changes in river and river mouth. Historical population trends together with local changes can put focus on direct measures that need to be taken in the river
- *Member Vossolaugset 2*: more about water quality in the watershed. What happens to smolts from the river to the outer fjords
- *Sports fisherman*: That there has been a slight temperature rise in the sea over the past 20 years has been proven by meteorological expertise. When I was young, it was a sensation every time the mackerel came, and was in the fjord systems a month from August to September. Today mackerel are in the fjord system throughout the year. What impact this has on the smolt migration of salmon and sea trout is unknown to me
- *Tourist office in Voss*: we have good knowledge but need to know more about what is going on at the smolt migration routes

6. Has your participation in the project resulted in changes in your management practices?

This question was included in order to determine if any changes have occurred in stakeholder behavior.

- *Member Vossolaugset 1*: It has helped to focus attention on how the farming industry would like to contribute to help the wild salmon stocks. It has given us the opportunity to contribute knowledge that can help, and as we can see results in terms of practical implementation. It is also easier for us to contribute financially or with knowledge when the project can demonstrate results that are well documented by knowledgeable authorities
- *Member Vossolaugset 2*: no
- *Sports fisherman*: when I catch salmon now, I release them gently
- *Tourist office in Voss*: no

Power relations

7. Describe the interactions between the participants in the project

This is a multiple choice question containing a Likert scale. The respondents could choose between five different options: (1) *disagreements between the participants in the project are resolved amicably*; (2) *there is sufficient dialogue between the project participants*; (3) *the amount of dialogue has grown over the years*; (4) *there are individuals or groups that dominate the dialogue* and (5) *there are actors missing from the project*.

- *Member Vossolaugset 1*: neutral for all statements
- *Member Vossolaugset 2*: Agrees that disputes between project participants are resolved in a satisfactory manner. Agrees that the dialogue between the actors has increased during the years. Disagrees that some actors are missing from the project. Neutral in relation to other statements
- *Sports fisherman*: disagrees that the dialogue between participants has increased. Neutral in relation to other statements

8. How would you describe your influence in the project?

This question was posed to get more insight in the power relations between the stakeholders.

- *Member Vossolaugset 1*: Modest role in the initial phase of the fish farming
- *Member Vossolaugset 2*: medium

- *Sports fisherman*: It could me more. It is expensive and not very future-oriented to have a monopoly of scientists to determine how many fish there are in the river at any given time. Local hunting and fishing associations can certainly be of assistance with training on how to see the difference between farmed fish and wild fish.
- *Tourist industry*: ok

Expectations for the future

9. What is your perspective on the value of the wild salmon to past and future generations?

This is a multiple choice question. The respondents could choose between four different choices: "*Laissez-faire*", *pragmatic*, *sustainability* and *growth*. This question was chosen to help determine the world views of the respondents. Each of the respondents had a different perspective:

- *Member Vossolaugset 1*: "*Laissez-faire*" - let Vosso's salmon stocks adapt in a natural way to the changing conditions in the river
- *Member Vossolaugset 2*: Pragmatic - the past is the past and future generations will only know what they can experience themselves
- *Sports fisherman*: Sustainability - future generations deserve the same experiences as earlier generations
- *Tourist office in Voss*: Biodiversity – There is an intrinsic value in all species and Vosso's salmon stocks must not become extinct

10. Who should be responsible for deciding about the future of the Vosso salmon?

This is a multiple choice question. The respondents could choose between six different options: *the public authorities*; *the public authorities together with the industry*; *river owners*; *the local society*, *the fish farm industry*; and *scientists*. This question was inspired by Dryzek's (2005) environmental discourse criteria in order to ease the determination of worldviews embedded by the respondents.

- *Member Vossolaugset 1*: Public authorities and the local society
- *Member Vossolaugset 2*: Public authorities together with the industry, fish farmers, river owners
- *Sports fisherman*: Public authorities, the local society and the river owners
- *Tourist office in Voss*: Public authorities

5.2.5 Environmental discourse analysis

With help of on the results gained from both the content analysis and the interviews and questionnaires, a discourse analysis was carried out. This was done with help of predefined criteria from Dryzek (2005). For this purpose, the stakeholders have been clustered into four different groups: *scientists, government, fish farmers* and *local community*. The researcher recognizes that there may be differences in discourse between individuals belonging to the same group. However, the focus of this study is on the predominant discourse that prevails in a group. Two different types of discourse are considered: a ‘general environmental discourse’ and a ‘problem solving discourse’. The results are summarized in table 5.5.

Scientists

The general environmental discourse of the scientists involved in the Vosso rescue project can be described as belonging to ‘survivalism’. They are mainly biologists and subscribe to the concept of ‘carrying capacity’- the maximum population of a species that an ecosystem can support. When the population of a species grows to the point where carrying capacity is exceeded, the population will crash. However, these scientists do not take the population crash as something irreversible. They believe that nature is rightfully subordinated to human problem solving. This is illustrated by the belief that artificial production of fish will eventually lead to a naturally spawning stock. Another characteristic of those prescribing to survivalism is to assume that human population growth is the main cause of environmental problems (Dryzek 2005). This is illustrated in a quote from one of the interviewees, when asking about the main threats to the salmon: *“in general, it’s human population growth I guess. That’s the main issue. Hadn’t we been here, then there would be much more salmon around”*. The problem-solving discourse embedded by scientists best fits that of administrative rationalism: ‘leave it to the experts’. As expressed by the marine biologist in the interview: *‘it makes no sense that they [the industries] should regulate themselves...So it needs to be controlled, it needs to be regulated somehow’*. This is in accordance with the belief that public policy is a matter of technical, expert choice and not a question on which non-specialists have any rightful say (Dryzek 2005). When centering on the project organization, displayed in figure 4.7, one sees that it first and foremost involves experts: scientific expertise as well as fish production expertise (from fish farmers). Emphasis in both Vossolaugset as well as the scientific rescue plan is put on minimizing threats: producing smolt, catching escapees and treating sea lice and not on preventing threats from occurring. This corresponds with the idea of administrative rationalism.

Government

The Norwegian government on national, regional and local level takes on a general discourse approach of ‘sustainability’ when it comes to saving the wild salmon in Vosso. They focus on economic growth, environmental protection and distributive justice. This is represented by the various governmental departments that have been given the responsibility for salmon management (introduced in figure 4.6) and illustrated by opinions from governmental representatives expressed in the media: *‘we have seen the salmon and of course it has to be preserved for the coming generations’* (BT, see Appendix D), which expresses environmental concerns. But at the same time, the national government reassures farmers that they can continue their contemporary business and that the *regulations will not lead to a decrease in production* (BT, see Appendix D). This mixture of concern and reassurance is typical for a problem-solving discourse of administrative rationalism. Also in accordance with administrative rationalism, an emphasis is put on the role of experts. As one representative of the local government notes when asked if there are actors missing from the project: *‘we are trying to get those experts at any time we need. If we know of any experts that could be useful we always try to contact them. So we have had contact with a whole lot of experts. There is not a lack of experts’*.

Fish farmers

As has been confirmed by the website analysis as well as the opinions expressed in the media, the fish farm industry is mainly driven by economic interests. Their communication priorities are predominantly economic, as ratified by the website analysis as well as the interests and attitudes they have expressed in the media. The fish farm industry fears a reduction in fish production due to stringent environmental regulations, and utters concern towards the loss of jobs and profit (as illustrated in media messages found in Appendix D). Strict regulations are opposed and the main believe is that the solution for saving the wild salmon lies in technology. This is visible in the strategy applied by Vossolaugset as well as the expressed ambitions to one day apply the developed technology for the restoration of other critically endangered salmon stocks. Fish farmers are less keen on recognizing limitations, as illustrated by the attitude of one fish farmer towards the consequences of Vosso salmon extinction: *‘that will be a loss. Then we must try to find other methods to restore the stock’*. The same mechanistic approach is employed in their business as well as in their project contribution. The focus lies primarily on smolt production. These attitudes are in line with the problem-solving discourse of ‘economic’ rationalism. This is also illustrated in the responses given in the questionnaire, indicating the future value of the Vosso salmon as ‘laissez-faire’ and ‘pragmatic’.

Local community

The cluster of 'local community' consists of the river owners, the tourist industry and sports fishermen living in the surrounding area and those belonging to local non-governmental groups such as Hardanger Villfisklag and Osterfjord Villfisklag. Often, there is an overlap between those different sub-groups: river owners can be keen on fishing and at the same time constitute a part of a local NGO to save the wild salmon. Although this group is more diverse than the other stakeholder groups, a reigning discourse can be deduced: that of sustainability. This very discourse combines aims that seem incompatible at first sight: economy, environment and justice. Therefore they support the general discourse of 'sustainability'. The local community connects the wild salmon to progress. As one local interviewee has put it: *``not having the wild salmon also has an economic impact and impact on our community. It is a small village and now most people are moving to towns to get an income. It has become a very quiet place``*. Both the representative from the tourist office in Voss and the sports fisherman underline the importance of salmon for the tourist business. Their assumption is that the local community can help to save the salmon. This is why they have established several non-governmental organizations, among which Hardanger Villakslag and Osterfjord Villakslag: to stimulate cooperation between all actors locally, regionally and nationally. This is coherent with the vision of democratic pragmatism, which emphasizes many different agents and interactive political relationships.

Table 5.5: Stakeholder discourses

Stakeholders	Basic entities recognized or constructed	Assumptions about natural relationships	Agents and their motives	Key metaphors/rhetorical devices	General environmental discourse	Problem solving discourse
Scientists	- Population growth - Finite stocks of resources	- Humans can restore nature	- Experts, motivated by public interest	Tragedy of the commons, crash	Survivalism	Administrative rationalism
Government	Experts, managers	- People are subordinate to the state	- Experts, motivated by public interest	Mixture of concern and reassurance	Sustainable development	Administrative rationalism
Fish farmers	Markets, prices, technology, people	- Hierarchy of humans	- Economic actors, motivated by material interest	Jobs, production, technology	Promethean	Economic rationalism
Local community	- Biodiversity - Economy, - Community - Citizens	- Cooperation - Environment and economy go together - conceptions of public interest	- Many agents at different levels - Motivation of a mix of material self-interest and public interest	- Nature as symbol - Connection to progress	Sustainable development	Democratic pragmatism

5.3 VALIDITY AND RELIABILITY OF RESULTS

In the methodology section, the concepts of reliability and validity were presented. This section focuses on the reliability and validity of the obtained results.

5.3.1 Interviews

The researcher considers the information gathered from interviews to be reliable and valid in two different ways: both considering the content of the questions as well as the received responses.

First of all, it is believed that the questions posed in the interview reflect the subjects that the researcher intended to analyze. The questions were discussed with the supervisor and approved. There was no confusion about the content of the questions, among the respondents. One respondent answered in Norwegian, but both the questions and the answers were translated into English by a helpful colleague.

Secondly, it is fair to assume that social desirability did not play a significant role in the choice of answers. The answers of the respondents took both challenges and successes of the project into consideration. Nevertheless, the face-to-face interviews revealed more information than the phone-interviews. The interviewees on the phone had the tendency to keep the conversation shorter. On the other hand, they inclined to give more focused answers and did not stray from the main interview themes. The interviews were recorded on tape and transcribed to increase the validity of the results.

5.3.2 Questionnaire

To determine the validity and reliability of the questionnaire, two aspects are considered: the content of the questionnaire as well as the answers that were obtained by this method.

The content of the questionnaire is considered appropriate for this study, since the questions helped to determine stakeholder interests and attitudes. The open-ended questions left the respondent free to formulate the answer in the way he or she desired. This freedom of choosing their own manner of wording encouraged the revelation of environmental discourses. The multiple choice questions as well as the question with the Likert scale are suitable for measuring attitudes as they provide ample different attitude scales and answer alternatives. Because of the inclusion of a neutral point, the respondent is not forced to choose an opinion if he does not have one. This increases the reliability of the respondents answer. In addition, the questionnaire has been approved by the supervisor and priority send to both the coordinator of Vossolaugget as well as the research leader, providing them a chance to comment on the questions.

Nonetheless, the questionnaire was subject to a low response rate, even though the researcher has done her best to increase the response rate. This was attempted in four different ways. Firstly, a short questionnaire was constructed, to avoid respondent fatigue. Secondly, 'Survey Monkey', a simple to use online tool was chosen for the construction of the questionnaire. This was done in order to ease the fulfillment of the questionnaire. Thirdly, the questions were translated into Norwegian, by an acquaintance that was fluent in both English and Norwegian. This removed any language barriers that could discourage the data subjects from responding. Finally, two reminders were sent out by the coordinator of Vossolaugset, with a word of encouragement. The motivation for this was the belief that the data subjects are more prone to answer if approached by somebody they know. Despite these measures, only two out of the 14 Vossolaugset members replied, out of which one did not answer the first three questions.

Only assumptions can be made about the reasons for the low response rate. One reason that could have contributed to the unwillingness to respond is the fact that the companies have received a lot of external attention lately. As one non-respondent indicated: *``I am very sorry - but we do get a lot of questionnaires, and do not have the opportunity to assist them all``*. The low response rate indicates that any received responses cannot be generalized for the whole group. But one thing that is fair to assume from this non-response rate is that most companies receiving the questionnaire do not have Vossolaugset as a high communication priority. Otherwise they would have taken more effort to respond to the short questionnaire. This is also reinforced by the website analysis.

Aside from the low response rate, the questionnaire did help to provide insights in the attitudes of the fish farmers. The returned answers were not solid enough as a standalone method for making generalized conclusions, but they were used as an illustration of conclusions that were already gained with help of other methods. The questionnaire is considered a good replacement of the interview method, for persons who were not accessible for an interview.

5.3.3 Content and discourse analysis

Even though the low response rate of the questionnaire prevented the researcher from making generalized conclusions about the interests and attitudes of the fish farmers and suppliers involved in Vossolaugset, the conduct of a content analysis still revealed the attitudes of fish farmers and fish farm suppliers. This was done in two additional ways: by looking at their website communication priorities and by analyzing the interests and attitudes they express in the local media. This method triangulation enabled the researcher nonetheless to make generalized conclusions about the Vossolaugset members.

The researcher took great care to ensure that the results from the website analysis and media analysis are reliable. The categories and criteria chosen for the content analyses overlap with what the researcher intends to measure: attitudes, interests and communication priorities of different stakeholders. Also, the coding in the website analysis has been conducted in such a way that it is replicable. This is because the variables are expressed as quantitative data, such as the number of mouse clicks and the number of sentences. The reproducibility of the website analysis increases its reliability.

The criteria used in the discourse analysis have been predetermined by Dryzek, who is an expert in his field. The discourse analysis can be subject to misinterpretations of the researcher. Also, the researcher admits that a discourse analysis is only a simplified representation of the complex relations and differences that exist in interests and attitudes of individuals as well as in those of groups. However, the fact that the description of the different discourses given by Dryzek is straightforward and elaborate, simplified the creation of linkages between stakeholder interests and environmental discourses. The attitudes and interests of each stakeholder group as revealed in this study seem to be well encapsulated by the offered environmental discourses.

6. DISCUSSION

In this section, the results from the literature study and the empirical data are analyzed with help of CATWOE. This analysis helps to reveal some paradoxes surrounding the Vosso salmon rescue project. Based on these contradictions, suggestions are made for policy-makers that may help to improve the current management situation.

6.1 ANALYSIS OF THE RESULTS USING CATWOE

An essential part of CATWOE is the identification of the transformation process. It explains which processes or systems are affected by the issue, and which transformation is required. In this case, the Vosso salmon population has collapsed, as a result of different human activities that have taken place in the river and sea habitat of the salmon. The two most acute threats to the stock have been identified as genetic impacts from escaped farmed salmon, and increased mortality of migrating smolts caused by salmon lice from fish farming. Additionally, studies have revealed that elevated levels of aluminum in brackish water may affect smolt survival. A transformation is needed towards a stock that is able to replenish itself naturally. This transformation process has taken the form of the salmon rescue project '*Now or Never for the Vosso salmon*'. The main strategy consists of three parts: (1) the cultivation of salmon eggs from genetic material in the national gene bank and the placement of this material into the river in the form of eggs, fry and smolt; (2) comprehensive measures to reduce the effect of the different threat factors and (3) the establishment of a live gene bank, by taking genetic material from salmon in the river.

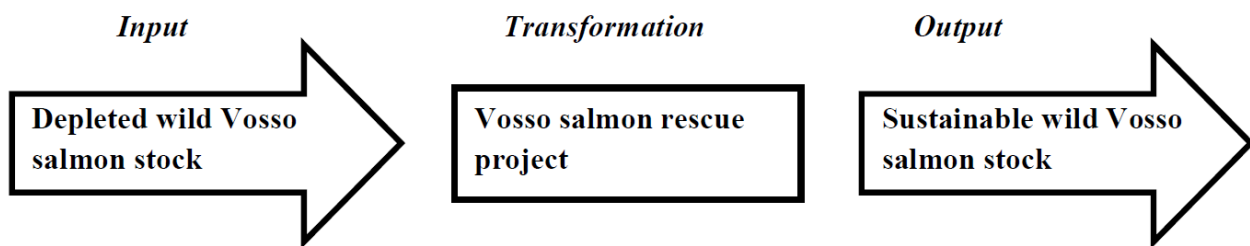


Figure 6.1: Transformation process

Different stakeholders are involved in this salmon rescue action, either directly or indirectly. They can be subdivided into three groups: customers, actors and owners. One stakeholder can belong to more groups. Actors are defined as those individuals or organizations that would do the transformation. Customers are the beneficiaries and victims of the transformation. Owners are those who could stop the transformation. The division of the stakeholders into customers, actors and owners is represented in table 6.1.

Table 6.1: Customers, owners and actors of the Vosso salmon rescue project

Stakeholders	Customer	Owner	Actor
Fishermen	x		
Fish farm suppliers	x		x
Salmon farmers	x	x	x
River owners	x	x	x
Customers of farmed salmon products	x		
Governmental management agencies		x	x
Scientists		x	x
Non-governmental organizations	x		
Banks	x		
Tourist industry in Hordaland	x		x
Hydropower plant	x		x
Other industries causing acidification	x		
Local media	x		
Norwegian society, now and in the future	x		

Next, according to CATWOE, the environmental constraints that exist for the salmon management are analyzed. Those are constraints and limitations that exist in the ‘real world’ and which will impact the solution and its success. From both the literature review as well as the empirical research, some environmental constraints can be observed concerning the Vosso salmon rescue project.

The main project and environmental constraints are (1) *uncovered project expenses*; (2) *fragmented management structures*; (3) *time limits*, and (4) *limitations of hatchery technology*

(1) Uncovered project expenses

Figure 5.5 indicates that part of the expenses related to the rescue project remain uncovered. This is confirmed by interview sources. The lack of money is considered a hindrance to the successful implementation of the rescue project. When considering the duration of income flows, an inconsistency exists between the duration of income from governmental sources and that coming from industrial sources. The industry has secured income for a five year-period, while governmental income flows are guaranteed for a period of ten years. This is in line with the different world views held by industry and government. While the industrial focus is on short-term benefits, that of the government is more sustainable and it acknowledges that a lot of money needs to be spend now to provide benefits for the local community on a long-term perspective.

(2) Time limits

However, a *physical* time limit exists for restoring the Vosso salmon population. This limit is linked to the preservation of salmon eggs in the gene bank. Since their preservation time is about ten years, the rescue plan has to be carried out during the coming decade.

Also, a *perceptual* time limit exists. More than two decades have passed since the collapse of the wild Vosso salmon. The big salmon is especially valued by those who have seen it in real life. And since the stock collapsed in the late 1980s, there is a time gap between its collapse and the emergence of restoration efforts. The contemporary politicians possibly have never seen a fully mature Vosso salmon with their own eyes, which is why they might attribute a smaller value to it. This may explain why the wild salmon is slowly losing spokespersons.

(3) Fragmented management structures

Another constraint can be discovered in the governmental salmon management structure. This structure can be indicated as fragmented. Different departments, with conflicting interests are responsible for the preservation of the salmon. This leads to practices that seem incompatible: such as establishing national salmon rivers and at the same time making new plans for hydropower plants. Or putting stricter environmental regulations on fish farms and meanwhile allowing the establishment of a new fish farm at the migration route of the Vosso salmon. Although the general aim of the government is to promote sustainability, the practice of it is dominated by administrative rationalism.

Nonetheless, it is not just the governmental structure that is fragmented. The organization of the wild Vosso salmon production is also characterized by divergent approaches. The smolt production is controlled by both the Voss hatchery and the fish farmers' hatchery in Evanger. They have slightly different views on how smolt has to be selected and released into the river. Voss hatchery wants to encourage natural selection. They set out both 'well fit' fish as well as fish that are less fit and do not encourage the use of vaccines. According to them, this would undermine the process of natural selection and in the end lead to fish with less diversity. However, the smolt from Evanger shows more similarity with natural smolt.

In addition to the rescue project, there are some initiatives, established by locals to stimulate cooperation between actors locally, regionally and nationally. These initiatives are not formally part of the Vosso salmon rescue project.

(4) Limitations of hatchery technology

This difference in smolt from Evanger and that from the Voss hatchery can partly be explained by the technology available in the production facilities. The facility in Voss is smaller in comparison to the one in Evanger. Also, temperature and light conditions are different. These differences lead to different environmental conditions and consequently to a difference in smolt size.

Next, CATWOE requires the identification of the world view prevailing in the situation. The environmental world view of the stakeholders determines how they look upon the transformation process. Since various stakeholders are involved with diverse interests, it is not surprising that differences exist in world view. By using Dryzek's environmental discourse analysis, environmental discourses have been detected for the involved stakeholders in chapter 5. These are summarized in figure 6.2.

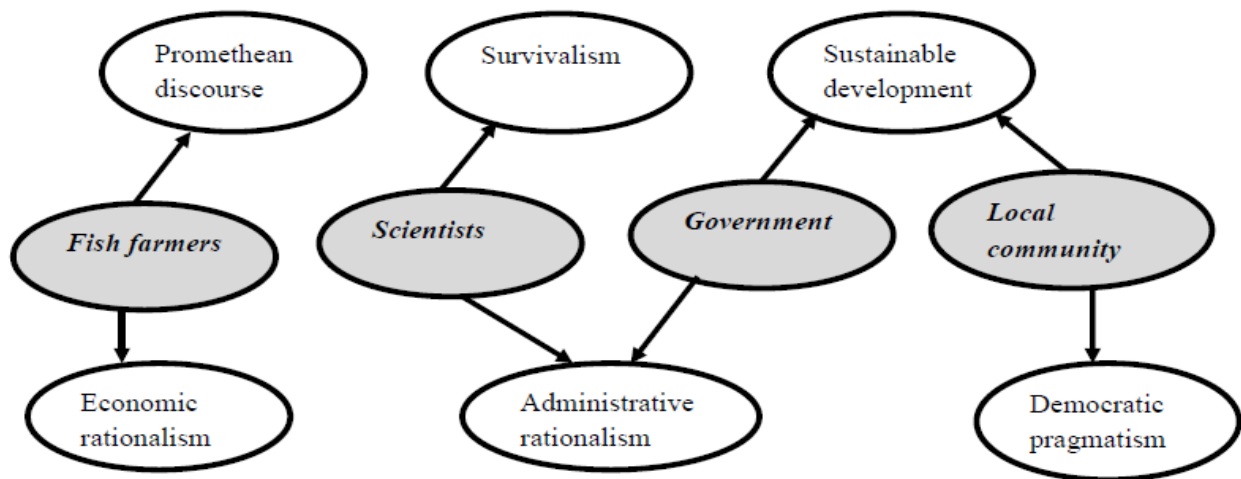


Figure 6.2: Environmental world views

Figure 6.2 shows that the various stakeholders subscribe to different environmental discourses. These different environmental world views lead to divergent motives and approaches for contributing to the transformation process. The management responsible for the rescue action consists of scientists and managers. This is verified by figure 4.7. This means that the predominant management approach in the rescue plan can be characterized as belonging to administrative rationalism. Typical for this approach is the minimization of interactions across different subsets. Although the Vosso rescue project is one of the few projects in Norway where dialogue is encouraged between different stakeholders, the formal management remains in hands of the government and scientific experts. It implies hierarchy based on expertise and the best way to cope with a problem is to break it down into smaller sets. This approach may be challenging for complex problems, with many interactions and elements. Because of this, problem-displacement can occur (Dryzek 2005).

6.2 PARADOXES THAT EMERGE FROM ANALYSIS

From the analysis of results, several paradoxes can be detected. These paradoxes in Vosso salmon management occur on both national as well as local level and may negatively influence the successful completion of the Vosso salmon rescue project.

The paradox of the precautionary approach

As discussed in chapter 4.3, the national salmon regulations require the use of a precautionary approach in the management of salmon. The whole principle of the precautionary approach is about acting to avoid serious or irreversible potential harm, despite lack of scientific certainty. However, the need for salmon 'restoration' by itself shows that serious harm has already taken place. Despite this, the burden of proof seems to be placed on those actors who want a change in the situation. They have to prove that there is a problem. After all, the guarantee of financing the project requires the delivery of concrete evidence. Since the issue of the salmon collapse in Vosso is characterized by multiple human interactions, it is a complex issue. After many years of research, the exact cause of the salmon collapse is still not known, although there are strong scientific indications that fish farming is causing the most serious threat to the Vosso salmon. The river environment has been identified as non-threatening by scientists. The biggest threats seem to occur at the smolt migration route from fresh water to the sea. And this is exactly where scientific knowledge is lacking. Truly applying the precautionary principle would mean that the potential threats of salmon farms located in the migration route of the Vosso salmon should be mitigated, despite of a paucity of solid scientific evidence.

The paradox of national salmon rivers for salmon protection

These threats located in the sea make one doubt the use of listing Vosso as a protected salmon river when the salmons have to migrate through a larger, partly unprotected area. The migration route of the Vosso salmon is exquisitely long. It follows a series of narrow fjords, including Sjørfjorden. Nevertheless, this fjord has not been listed as a national salmon fjord, allowing salmon farming to take place. This raises the question about the utility of salmon fjords and rivers for salmon protection. Protecting one part of the Vosso salmon migration route does not mitigate threats occurring throughout the entire route. Moreover, one might wonder what the value of a national salmon river is, if there is no guarantee that it will remain protected in the future. This doubt results from plans revealed to build extra hydropower plants in a national river: Raundalselva, a yet unregulated river that flows into Vosso. Media messages have revealed that, if the plans are accepted, Vosso salmon might be negatively influenced by this regulation.

The paradox of reaching sustainability through an approach of administrative rationalism

Perhaps the reason for not adequately applying the precautionary principle can be sought in the administrative rationalism approach of the government. The national government strives to achieve a sustainable salmon management. However, sustainability involves decentralized, exploratory and variable approaches. It is about a shift away from the state to both higher and lower levels of political organization, about networked governance instead of top-down administration. But, the actual approach to fisheries management shows some contrast with the goals of sustainability. Although local stakeholders can have an influence on management decisions either through an advisory role or via lobbying, final decisions are taken by the relevant Fisheries Ministries. Despite regional decentralization, little is seen in terms of formal local level management. Participation in policymaking processes has become a professional activity that requires particular resources and skills. This underlines the approach of administrative rationalism. An example of this approach can be seen in Vaksdal commune. As disclosed by media messages, the Directorate of Fisheries has obliged the Vaksdal municipality to accept the establishment of a fish farm from Lerøy at Sandvik Sørfjorden, located at the migration route of the endangered Vosso salmon. This decision has been made despite strong objections of the municipality against the fish farm.

On the project level some doubts can be raised about the sustainability issue as well. As indicated by the project strategy, most emphasis is placed on setting out smolt into river, brackish water and sea and on monitoring water and fish quality. In addition, fish farmers treat their fish against sea lice. Although these methods are deemed necessary for the accumulation of knowledge about the state of the wild salmon in Vosso, and for treating the salmon threats, they seem to be focusing on the treatment of symptoms instead of tackling the source of the threats. One can argue that this is not preliminary the task of scientists, but needs to be triggered at institutional levels. If the threats are not eliminated, the migrating salmon will have a hard time surviving. Continuous human effort will be needed to sustain the Vosso salmon stock. This will make the accomplishment of a naturally spawning wild salmon stock a hard goal to reach.

Sustainability is about combining economic growth and environmental protection. It tries to integrate economy, environment and social justice. Although this Vosso salmon rescue project may be one in which many different actors are involved and in which most cooperation between different actors occurs, these interactions are not formalized at the local level. Despite the *vertical* communication structure existing between the national, regional and local environmental departments for the Vosso rescue project, more *lateral* communication is necessary between different departments responsible for salmon management. Fragmented management approaches form an obstacle to sustainability goals in the Vosso rescue project and can lead to practices that are incompatible and in which economic interests seem to be overriding.

The paradox of artificial wild salmon

The case of the Vosso salmon shows how man`s role in nature has evolved up to the level that he does not only use nature as a resource, such as the fishermen did when fishing for salmon. In addition he transforms and designs it by changing river chemistry and water flows, by the introduction of farmed salmon and through the use of gene banks. All these changes affect the survival chance of the wild salmon. Paradoxically, this human appropriation of nature`s role has put the salmon stock in danger, but at the same time, human intervention in the Vosso salmon ecosystem is considered necessary in order to reverse the status of the Vosso salmon from practically extinct to sustainable.

The fundamental question here is: to the extent that wild salmon in Vosso is only likely to survive in the future by human production that sustains it, how `wild` does this make the new generations of Vosso salmon? The farmed salmon originates from the same genes as the Vosso salmon. The reason behind this is that fish farmers used Vosso salmon for one of the primary strains of fish. Ironically, the Vosso salmon is now threatened by its own descendants, though genetically mutated during the years due to human intervention, by artificial selection.

The salmon produced due to this rescue project are set out into fresh water and sea, as eggs, but also as fry and smolt. The longer they stay in the hatchery, the more influence the environmental conditions of the hatchery will have on the development of the smolt. There are differences in production circumstances between the Voss hatchery and the production facility for wild smolt owned by fish farmers. This results in changes in size between the salmon from the two facilities. Surprisingly, smolts from Evanger resemble natural smolts more than those originating from the hatchery.

However, there is a similarity between the production of farmed smolt and that of wild smolt: both are raised in an artificial environment. There is no denial that the fluctuating environmental circumstances in the river are different from the controlled environment of the hatcheries. Hatcheries produce fish that are able to survive in the hatchery. This is a protected environment, while the salmon will eventually have to survive in a different, non-protected environment, subject to harmful human activities. This leaves one wondering to what extent the environment of the reared salmon represents the environment of the wild salmon stock, prior to its decline. What characterizes and differentiates local salmon populations is their ability to adapt to their surroundings. Even if these hatchery fish manage to survive in a different environment, how well will they resemble the original Vosso stock over a long time-period, taking the changing environment into consideration?

6.3 RECOMMENDATIONS FOR POLICY-MAKERS

These paradoxes lead to the need for a systemic approach to salmon management in Vosso. The real success must not only be sought in scientific achievements. Instead a holistic approach needs to be taken that considers the interrelations between all the different factors and actors influencing salmon management.

An alteration is needed of human activities. Advanced technology can play a role in both salmon production and in the mitigation of threats. It has become clear that the advanced technology used by fish farmers in the Evanger hatchery produces fish that are more natural than those of the hatchery. Furthermore, technology such as the use of closed systems on land, instead of open-cage systems currently used in fish farming, can help to mitigate some of the threats posed by fish farming. Recent revelations about plans for the use of closed systems seem promising.

However, it would be too simple to assume that the solution lies merely in technological improvements. New technology can certainly help to reduce the threats facing the Vosso salmon. Nonetheless, both changes in technology and the acquisition of new knowledge by scientists cannot completely eliminate these threats. It is not just the salmon that needs to become sustainable; a shift has to be made at societal level. Learning is needed at institutional levels to facilitate salmon preservation management in Vosso. The fragmented governmental approaches should be integrated between and across all levels in order to establish a more sustainable overall management. This salmon rescue project has shown that the local community is interested in restoring the wild salmon. Several initiatives have been put in place to increase the cooperation between different stakeholders, such as Østerfjord Villakslag and Hardanger Villakslag. Local participation needs to be formalized, so that voices of the local community can be incorporated in the starting phase of plans that are potentially harmful for salmon habitat. Formalizing local participation may also lead to a better coordination and integration of local initiatives, making local involvement in salmon management more efficient.

Also, the use of national salmon rivers needs to be reconsidered as a protection measure for salmon populations. The migration route of the Vosso salmon follows areas that are not officially identified as protected. Instead of focusing on rivers or fjords, more focus should be placed on an ecosystem approach. In this case it would be useful to protect the entire Vosso salmon migration route from harmful activities and not just parts of it.

Policy-makers should make better use of the precautionary principle: if there really is a wish for the preservation of wild salmon, measures need to be taken despite of a lack of solid scientific evidence. Focusing on prevention instead of symptom cure will decrease the need for salmon restoration projects in the future.

7. CONCLUSION AND FURTHER RESEARCH

The goal of this thesis was to explore the fundamental questions about the impact of human activity on nature and the conflicts of interest that exist within the management for the restoration of the wild salmon population in Vosso. The study aimed to answer the following question: *“How does the strategy of the salmon restoration project in Vosso address the human dimensions for the restoration of the wild Vosso salmon population on a short and long term?”*

The concept of human dimensions is the study and practice of human values related to natural resources, how those values impact and are manifested in management, and how humans affect or are affected by natural resources management decisions. The use of Checkland’s Soft Systems Methodology (SSM) has helped to structure the goal of the study. It has offered a framework for analyzing the Vosso salmon situation.

This study has revealed some interesting findings. It has become clear that the interest for preservation of the Vosso salmon is mainly motivated by its extraordinary size and the economic benefits it can generate for the community. They desire a sustainable salmon stock that can be harvested to provide economic benefits. A variety of interests exists within this project. Roughly, they can be divided into three different categories: environmental, social and economic interests. The Vosso rescue project distinguishes itself by the fact that the project leaders have successfully managed to involve stakeholders with very divergent interests in the salmon rescue action. It includes actors who are responsible for some of the salmon threats as well as those who are affected by the loss of wild salmon.

As results of this study have shown, the salmon restoration project in Vosso is mostly directed towards finding the causes for the decline of the Vosso salmon population. The measures taken to restore the salmon primarily center on producing salmon and treating sea lice. On a short term, the inclusion of human dimensions in the rescue project is based on the involvement of actors with different world views, neglecting differences in interest and focusing on achieving the same objective: a wild salmon population that is able to reproduce naturally. However, Vosso salmon management is less concerned with eliminating sources of these salmon dangers. If these threats remain to exist in the Vosso salmon habitats, the goal of reaching a sustainable Vosso salmon population will be a challenging one. This is because salmon management in Vosso disregards long-term human dimensions: those human values embedded in institutions and passed on from generation to generation. For reaching sustainable salmon stocks, it is not merely important to combine stakeholders that hold different values in salmon management, it is also crucial to understand the environmental discourses that trigger these values. This understanding needs to occur at all levels of salmon management that influence the outcome of the restoration project in Vosso. This study has shown that the Vosso salmon management is trying to achieve sustainability,

while employing a problem-solving discourse of administrative rationalism. This results in a fragmented salmon management approach and practices that seem paradoxical. Less attention is paid on the inclusion of systemic approaches. For the achievement of a sustainable salmon management a convergence of social, economic and environmental values is required. The prevailing problem-solving discourse of administrative rationalism in salmon management needs to make room for the discourse of sustainability, by increasing communication between and across departments and individuals involved in the salmon rescue project, either directly or indirectly. This will lead to more integrated management approaches and hopefully a decrease of harmful human activities in salmon habitats.

Further research could embark on a bigger-scaled investigation of attitudes and interests of fish farmers in the Vosso area. Another intriguing study could focus on the determination of the intrinsic value of the Vosso salmon. It seems that the motivation for restoring the wild salmon is mostly triggered by economic interests. By carrying out a contingent valuation study, the non-material values of the Vosso salmon could be revealed and assessed against values attributed to salmon farming in the Hordaland area. This salmon situation in Vosso can be perceived as symbolizing for larger scaled natural resource problems that are happening all around the world due to contemporary relationships between nature and humanity. Strongly deteriorating natural resources are a result of this relationship. Perhaps the time has come to shift our focus from continuously transforming nature for our purposes to a modification of our societal structures for the preservation of nature.

References

- Aas, Ø. (2011), *Atlantic Salmon Ecology*. Chichester: Blackwell Publishing.
- Adams, C.A. and Frost, G.R. (2006), *Accessibility and Functionality of the Corporate Web Site: Implications for Sustainability Reporting*. In *Business Strategy and the Environment*, 15: 275–287.
- Andersen, O. (2002), *Transport of fish from Norway: energy analysis using industrial ecology as the framework*. In *Journal of Cleaner Production*, 10: 581-588.
- Anderssen, A. (1998), *The Land Tenure System in Norway, and Local Democracy in Relation to Land Issues*. Presented by advisor to the County Governor, Sogn og Fjordane. Available from: <http://www.caledonia.org.uk/land/tenure.htm> (accessed 16 June 2011).
- Aronson, D. (1998), *Overview of Systems Thinking*. Available from http://www.thinking.net/Systems_Thinking/OverviewSTarticle.pdf (accessed 22 February 2011).
- Ayllon, F., Martinez, J.L., Juanes, F., Gephard, S. & Garcia-Vazquez (2006), *Genetic history of the population of Atlantic salmon, *Salmo salar* L., under restoration in the Connecticut River, USA*. In *ICES Journal of Marine Science*, 63: 1286-1289.
- Banathy, B.H. (1996) *Designing Social Systems in a Changing World*. New York: Plenum
- Banathy, B.H. (1999) *Call for Participation: Humanity, Science, Technology: The Systemic Foundations of the Information Age*. Available from: <http://iss.org/world/en/node/22/print> (accessed on 5 February 2011).
- Barlaup, Bjørn, T. (ed.) (2008), *Nå eller aldri for Vossolaksen– anbefalte tiltak med bakgrunn i bestandsutvikling og trusselfaktorer. DN-utredning 2008-9*. Available online: <http://www.dirnat.no/content/632/Na-eller-aldri-for-Vossolaksen-> (accessed 6 February 2011).
- Barlaup, Bjørn, T. (2010), *Status for Vossolaksen- FoU-aktivitet i prosjektet 2010*. Power point slides
- Basden, A. and Woodharper, A.T. (2006), *A Philosophical Discussion of the Root Definition in Soft Systems Thinking: An Enrichment of CATWOE*. In *Systems Research and Behavioral Science*, 23: 61-87.
- Bellona (2009), *Discharge from Fish Farms*. Available online: http://www.bellona.org/aquaculture/tema_aquaculture/Discharges (Accessed on 12 February 2011).
- Bergvall-Kåreborn B., Mirijamdotter A., and Basden, A. (2004) *Basic principles of SSM modeling: an examination of CATWOE from a soft perspective*. In *Systemic Practice and Action Research* 17: 55–73.
- Bergens Tidende (2011). Available online: <http://www.bt.no/> (access dates are listed in Appendix D).

- Blom Fiske oppdrett AS (2011), *Blom Fiske oppdrett AS*. Available online: <http://www.blomsea.no/> (accessed on 13 March 2011).
- Bosch, O.J.H., King, C.A., Herbohn, J.L., Russell, I.W. and Smith, C.S. (2007), *Getting the big picture in natural resource management - systems thinking as 'method' for scientists, policy makers and other stakeholders*. In *Systems Research and Behavioral Science*, 24: 217-232.
- Boyce, C. and Neale, P. (2006), *Conducting In-Depth Interviews: A Guide for Designing and Conducting In-Depth Interviews for Evaluation Input*. Pathfinder International. Available online: http://www.esf-agentschap.be/uploadedFiles/Voor_ESF_promotoren/Zelfevaluatie_ESF-project/m_e_tool_series_indepth_interviews.pdf (accessed on 7 April 2011).
- Brattebø, H., Røine, K., Opoku, H. & Ehrenfeld, J.R. (eds.) (2007), *Introduction to Industrial Ecology- Theory, Methods and Applications. Part D: Implementing industrial ecology*. In Compendium NTNU.
- Bryman, A. (2008), *Social Research Methods*. New York: Oxford University Press.
- Buckles, D. (ed.). (1999), *Cultivating peace: conflict and collaboration in natural resource management..* Ottawa: International Development Research Centre and World Bank.
- Buckles, D (ed.). and Rusnak, G. (2000), *Conflict and collaboration in natural resource management*. in *Cultivating peace: conflict and collaboration in natural resource management: 1-10*. Washington: International Development Research Centre and World Bank Institute.
- Burton, S. and Steane, P. (2004), *Surviving your thesis*. London: Routledge.
- Chatterji, M., Arlosoroff S. and Guha, G. (2002), *Conflict management of water resources*. Surrey: Ashgate Publishing Ltd.
- Checkland, P. (1991), *From framework through experience to learning: the essential nature of action research*. In *Information Systems Research: Contemporary Approaches and Emergent Traditions* (eds. Nissen,H.E., Klein, H.K. and Hirschheim, R.A). Elsevier Science Publishers B.V: Amsterdam.
- Checkland, P. & Poulter, J. (2006) , *Learning for Action: A Short Definitive Account of Soft Systems Methodology, and Its Use Practitioners, Teachers and Students*, Chichester, UK: Wiley.
- Checkland, P. (1985), *From Optimizing to Learning: A Development of Systems Thinking for the 1990s*. In: *The Journal of the Operational Research Society*, 36:757-767
- Checkland, P.B. (1987), *The application of systems thinking in real-world problem-situations: the emergence of soft systems methodology*. In *New Directions in Management Science*, (eds. M.C. Jackson and P. Keys). Gower: Aldershot
- Decker, D. J., T. L. Brown, and W. F. Siemer (2001). *Evolution of people–wildlife relations*. In *Human dimensions of wildlife management in North America*, 3 (22). Bethesda: The Wildlife Society.

Directorate for Nature (DN) (2011), *The salmon management in Norway 2011*. Kolarctic kick off meeting, Vadsø 15 March 2011. Available online: www.fylkesmannen.no/The_salmon_management_in_Norway_Sturla_Brørs_dG8N0.pdf.file (accessed 18 May 2011).

Dijk, van, T.A. (1983), *Discourse Analysis: Its Development and Application to the Structure of News*. In *Journal of Communication*, 33(2). In *The Annenberg School of Communications*.

Driscoll, C. & Starik M. (2004), *The primordial stakeholder: advancing the conceptual consideration of stakeholder status for the natural environment*. In *Journal of Business Ethics*, 49(1): 55–73.

Dryzek, J.S. (2005) *Environmental discourses*. Oxford: Oxford University Press.

Ehrenfeld J.G. (2000), *Defining the Limits of Restoration: The Need for Realistic Goals*. In *Restoration Ecology*, 8 (1): 2-9

Eide Fjordbruk (2011), *Eide Fjordbruk*. Available online: <http://www.eidefjordbruk.no/> (accessed on 13 March 2011).

Ewos (2011), *Ewos. Knowledge makes the difference*. Available online: <http://www.ewos.com/portal/wps/wcm/connect/ewosnorway/no/frontpage/>(accessed on 13 March 2011).

FAO (Food and Agricultural Organization) (2000) *Conflict and natural resource management*. Rome, Italy.

Fet, A.M, Schau, E.M. & Haskins, C. (2009), A Framework for Environmental Analyses of Fish Food Production Systems Based on Systems Engineering Principles. In *Systems Engineering*, 13 (2).

Fhl (2005), *Industri*. Available online: <http://www.fhl.no/industri/> (accessed on 2 april 2011)

Fleming, I.A., Hindar, K., Mjølner, I.B, Jonsson, B., Balstad, T. and Lamberg, A. (2000), *Lifetime success and interactions of farm salmon invading a native population*. In *the Royal Society*, 267: 1517-1523

Ford R. (1984), *Norwegian Salmon and Trout Farming*, *Marine Fisheries Review*. Available online: <http://spo.nmfs.noaa.gov/mfr463/mfr4635.pdf>

FWEE (1999) How A Hydroelectric Project Can Affect A River. Available online: <http://www.fwee.org/hpar.html> (accessed on 19 February 2011).

Fyllingsness Fisk (2011), *Fyllingsness Fisk* Available online: <http://www.havdyrkerne.no/index.php?f=08050148&sid=3&eid=132&spid=267&mosid=3&moeid=149> (accessed on 13 March 2011).

Gajic, N. (2010) *Restoring the wild salmon in Vosso: like a fish out of water?* Specialization project NTNU.

- Gauthier, B., Guilbert, L. and Pelletier, M.L. (1997), *Soft Systems Methodology and Problem Framing: Development of an Environmental Problem Solving Model Respecting a New Emergent Reflexive Paradigm*. In *Canadian Journal of Environmental Education*, 2.
- Goodwin, H. (1996), *Natural Resource Management: the Human Dimension*. In *Biodiversity and Conservation*, 7(6): 837-845.
- Grimble, R. (1998), *Stakeholder Methodologies in Natural Resource Management*. Greenwich: Natural Resources Institute.
- Gross, M. R. (1998), *One species with two biologies: Atlantic salmon (Salmo salar) in the wild and in aquaculture*. In *Aquaculture Science*, 55: 131–144.
- Haigh, N. and Griffiths, A. (2007), *The Natural Environment as a Primary Stakeholder: the Case of Climate Change*. In *Business Strategy and the Environment*, 18 : 347–359.
- Haklay, M.E. (2002), *Public Environmental Information Systems*. Thesis submitted for doctor degree. Department of Geography. University of London
- Hamlin, C. (1986), *The Fisheries- why Systems Engineering?* In *OCEANS* 86: 643-648. Ocean Research Corporation, Kennebunk, ME, United States of America.
- Heberlein, T.A. (1981), *Environmental attitudes*. In *Zeitschrift für Umweltpolitik*, 2:241-270.
- Hendry, K. and Cragg-Hine, D. (2003), *Ecology of the Atlantic Salmon*. In *Conserving Natura 2000 Rivers*. Ecology Series No. 7. Available online: http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=file&fil=SMURF_salmon.pdf (accessed 5 april 2011).
- Hi Havbruksinstituttet AS (2011), *Hi Havbruksinstituttet AS*. Available online: <http://www.hi.no/> (accessed on 14 March 2011).
- Hoelting, K. (2008), *Norway's Vosso Salmon: Measuring Past, Present and Future Cultural Importance, and Prospects for Restoration*. Unpublished draft.
- Hordaland (2009a), *Vossolaksen- bestandstatus trusselfaktorer og tiltak* . Available online: <http://www.hordaland.no/PageFiles/25550/Monika%20Haugland.pdf> (Accessed on 10 February 2011).
- Hordaland (2009b), *Nå eller aldri for Vossolaksen. Plan for redningsaksjon 2010-2020*. Available online: hordaland.miljostatus.no/Nå_eller_aldri_for_Vossolaksen_Plan_for_redningsaksjon_2010-2020_3WDKC.pdf.file: (accessed on 22 June 2011).
- Jackson, M.C. (2000), *Systems approaches to management*. New York: Kluwer Academic/ Plenum Publishers.
- Jakobson, S.K. and McDuff, M.D. (1998), *Training Idiot Savants: The Lack of Human Dimensions in Conservation Biology*. In *Conservation Biology*, 12(2).

- Korda, R.C. Hills, J.M. and Gray, T.S. (2008), *Fishery decline in Utila: Disentangling the web of governance*. In *Marine Policy* 32: 968–979.
- Krauss, R.M. and Morsella, E. (2000), *Communication and Conflict*. Pre-editing version of a chapter that appeared in M. Deutsch & P. Coleman, (Eds.), *The handbook of constructive conflict resolution: Theory and practice* (131-143). San Francisco: Jossey-Bass.
- Krautkraemer, J.A. (2005), *Economics of natural resource scarcity: The state of the debate*. Discussion paper. Available from: <http://www.rff.org>. (accessed 13 February 2011).
- Krautkraemer, J.A. (1985), *Optimal Growth, Resource Amenities and the Preservation of Natural environments*. In *The Review of Economic Studies*, 52 (1).
- Krippendorff, K. (2004), *Content analysis: an introduction to its methodology*. California: Sage Publications.
- Krisweb (2011), *Introduction to Atlantic salmon life cycle*. Available online: http://www.krisweb.com/krisshoopscot/krisdb/html/krisweb/aqualife/atlantic_salmon_lifecycle.htm (accessed on 7 april 2011).
- Kumar, R. (2005), *Research methodology. A Step-by-Step Guide for Beginners*. London: Sage publications.
- LEI (2005), *Sharing responsibilities in fisheries management*. Available online: http://www.lei.dlo.nl/publicaties/PDF/2005/7_xxx/7_05_05.pdf (accessed on 1 May 2011).
- Lerøy (2011), *Lerøy*. Available online: <http://www.leroy.no/> (accessed on 13 March 2011).
- Littlejohn, S.W. and Foss, K.A. (2008), *Theories of Human Communication*. Belmont: Thomson Wadsworth.
- Liu, Y., Olaussen, J.O. & Skonhoft, A. (2010), *Wild and farmed salmon in Norway—A review*. In *Marine Policy*, 35 (3): 413-418.
- Løken, O.C.E (2010), *Fra MarinVEST til Vossolaugget. En følgeevaluering av VRI Hordaland i prosessen frem mot Vossolaugget*. Master oppgave. Institutt for økonomi og ressursforvaltning.
- Lyneis, D. (1996), *Systems Thinking "in 25 Words or Less"*. Available online: http://www.clexchange.org/ftp/documents/whyk12sd/Y_1995-08STIn25WordsOrLess.pdf (accessed on 22 february 2011).
- Maani, K., E. & Cavana, R., Y. (2007), *Systems Thinking, System Dynamic: Managing Change and Complexity* (2 ed.). Pearson: Prentice Hall.
- Manfredo, M.J. Decker, D.J. & Duda, M.D. (1998), *What is the Future for Human Dimensions of Wildlife?* In *Trans.* 63rd No. American Wildlife and Natural Resources Conference.
- Marine Harvest (2008), *Seafood value chain*. Available online: <http://www.marineharvest.com/en/Seafood-Value-Chain1/Freshwater/> (accessed on 27 April 2011).

Marine Harvest (2011), *About Marine Harvest* Available online: <http://www.marineharvest.com/> (accessed on 3 May 2011).

Miljøstatus (2007), *Voss klekkeri*. Available online: http://voss.miljostatus.no/msf_themepage.aspx?m=3392 (accessed on 13 June 2011).

Miljøstatus (2008), *Municipal waste water*. Available online: <http://www.miljostatus.no/en/Topics/Water-pollution/Eutrophication/Eutrophication/Municipal-waste-water/> (accessed on 12 February 2011).

Miljøstatus I Voss (2010), *Laks*. Available online: http://voss.miljostatus.no/msf_themepage.aspx?m=3390 (accessed on 18 March 2011).

Miller, R. L., & Brewer, J. D. (2003), *The A-Z of Social Research: A Dictionary of key social science research concepts*. Thousand Oaks, CA: Sage Publications.

Moonie, N. (2000), *Advanced Health and Social Care*. Oxford: Heineman Educational Publishers.

Mouton, J. & Marais, H.C. (1988), *Basic concepts in the methodology of the social sciences*. Human Sciences Research Council: Pretoria, South-Africa.

NASCO (2009), *Protection, Restoration and Enhancement of Salmon Habitat Focus Area Report. Norway. IP (09)11*. Available online: http://www.nasco.int/pdf/far_habitat/HabitatFAR_Norway.pdf (accessed on 18 march 2011).

NASCO (2011), *The Atlantic Salmon*. Available online: <http://www.nasco.int/atlanticsalmon.html> (accessed on 21 march 2011).

Nguyen, N.C. Bosch, O.J.H. & Maani, K.E. (2009), *The Importance of Systems Thinking and Practice for Creating Biosphere Reserves as “Learning Laboratories For Sustainable Development*. In 53rd Meeting of The International Society for the Systems Sciences University of Queensland, Brisbane, Australia.

Nidumolu, U.B., De Bie, C.A.J.M., van Keulen, H., Skidmore, A.K. and Harmsen, K. (2006), *Review of a land use planning programme through the soft systems methodology*. In *Land Use Policy*, 23 (2):187-203.

Noor, K.B.M. (2008), *Case Study: A Strategic Research Methodology*. In *American Journal of Applied Sciences*, 5 (11):1602-1604.

Norsk Skogmuseum (2011), *Vosso*. Available online: <http://www.skogmus.no/> (accessed on 10 June 2011).

NOU (1999), *Til laks åt alle kan ingen gjera?* Available online: <http://www.regjeringen.no/nb/dep/md/dok/nou-er/1999/nou-1999-09/2.html?id=141592> (accessed on 5 april 2011).

Pahl-Wostl, C. Mostert, E. and Tabara, D. (2008), *The Growing Importance of Social Learning in Water Resources Management and Sustainability Science*. In *Ecology and Society* 13 (1): 24.

Papatryphon, E. Petit, J. Kaushik, S.J. and van der Werf, H.M.G. (2004), *Environmental Impact Assessment of Salmonid Feeds Using Life Cycle Assessment (LCA)*. In *AMBIO: A Journal of the Human Environment*, 33(6): 316-323.

PATOGEN AS (2011), *Patogen analyse AS*. Available online: <http://www.patogen.com/default.aspx?menu=2006&id=143> (accessed on 14 March 2011).

Pomeroy, R. and Douvre, F. (2008), *The engagement of stakeholders in the marine spatial planning process*. In *Marine Policy*, 32(5): 816-822.

Ramo, S. and St Clair, R. (1998), *The Systems Approach*. Anaheim: KNI, Inc.

Richardson, K.A. and Midgley, G. (2007), *Systems theory and complexity: Part 4 The evolution of systems thinking*. In *E:CO*, 9: 163-179.

Rosenman, M. A and Gero J. S (2006), *Purpose and function in design: from the socio-cultural to the technological*. *Design Studies*. 19: 161–186. Elsevier Science Ltd Printed in Great Britain.

Sægrov, H., Hindar, S, Kålås, S and Lura, H. (1997), *Escaped farmed Atlantic salmon replace the original stock in the River Vosso, western Norway*. In *ICES Journal of Marine Science*, 54: 1166-1172.

Salmobreed (2011), *Salmobreed*. Available online: <http://www.salmobreed.no/> (accessed on 14 March 2011).

Sanal , R.P. (2004), *Systems Thinking*. In *Science India- The national Science magazine*. Available online: http://www.sanalnair.org/articles/Systems_Thinking.pdf (accessed on 3 March 2011).

Sjøtroll (2011), *Sjøtroll Ein smak av rein natur*. Available online: <http://www.sjotroll.no/> (accessed on 13 March 2011).

SSB (2007), *Fishing and fish farming*. Available online: http://www.ssb.no/fiskeri_havbruk_en/ (accessed on 6 April 2011).

SSB (2011), *Akvakultur. Foreløpige tall, 2010*. Available online: <http://www.ssb.no/fiskeoppdrett/> (accessed on 8 April 2011).

Stankey, George H.; Clark, Roger N.; Bormann and Bernard T. (2005), *Adaptive management of natural resources: theory, concepts, and management institutions*. Available online: http://www.fs.fed.us/pnw/pubs/pnw_gtr654.pdf (accessed on 11 May 2011).

Stouder, D.J., Bisson, P.A and Naiman, R.J. (1997), *Pacific Salmon and their Ecosystems Status and future options*. New York: Chapman & Hall.

Trainor , T.E. and Parnell, G.S. (2007), *Using stakeholder analysis to define the problem in systems engineering*, Proc 17th Annual International Symposium INCOSE, San Diego.

Utne, I.B. (2006), *Systems engineering principles in fisheries management*. In *Marine Policy*,30 (6): 624-634

VAKI (2011), *VAKI*. Available online: <http://www.vaki.is/> (accessed on 14 March 2011).

Vanderstoep, S. W., & Johnson, D. D. (2009), *Research methods for everyday life: Blending qualitative and quantitative approaches*. San Francisco: Jossey-Bass.

Verspoor E., Stradmeyer, L and Nielsen, J.L.(eds.) (2007), *The Atlantic Salmon: Genetics, conservation and management*. Oxford: Blackwell publishing.

Voss Hatchery (2011), *Vossolaksen – særtrekk*. Available online: <http://vossklekkeri.no/index.php/779727> (accessed on 14 May 2011)

Vossolaugget year report (2009), *Felles Innsats For Berging av Vossolaksen. Årsrapport for Vossolaugget. 2008/2009*. Available online: www.salmobreed.no/sfresamplere.aspx?src=536 (accessed on 28 april 2011).

Vossolaugget year report (2010), *Felles Innsats For Berging av Vossolaksen. Årsrapport for Vossolaugget. 2010*. Available online: <http://www.hi.no/bilder/filer/Vossolauggetarsrapport2010-4.pdf> (accessed on 1 april 2011).

Walters C, N.W. (2009), *Rhetorical Analysis of Stakeholders in Environmental Communication: A Model*. In *Technical Communication Quarterly*, 6(1): 9-24.

Walters, C. (1997), *Challenges in adaptive management of riparian and coastal ecosystems*. In *Ecology and Society*. 1(2).

Warfield, J.N. (2006), *An Introduction to Systems Science*. London: World Scientific Publishing Co. Pte.Ltd.

Williams, B. (2005), *Soft Systems Methodology*. Available on <http://users.actrix.co.nz/bobwill/ssm.pdf> (accessed on 28 March 2011).

Woods, P. (2006), *Qualitative research*. Available online: <http://www.edu.plymouth.ac.uk/resined/qualitative%20methods%202/qualrshm.htm#Interviews> (accessed 28 April 2011).

WWF (2001), *The Status of Wild Atlantic Salmon: A River by River Assessment*. Available online: assets.panda.org/downloads/salmon2.pdf (accessed on 25 march 2011).

Yin, R.K. (2003), *Applications of case study research*. London: Sage.

Zexian, Y. & Xuhui, Y. (2010) *A revolution in the field of systems thinking—a review of Checkland's systems thinking*. In *Systems Research and Behavioral Science* 27(2): 140-155.

APPENDIX A: DRYZEK'S DISCOURSE ANALYSIS

Discourse analysis of survivalism

Basic entities recognized or constructed	<ul style="list-style-type: none"> • Finite stocks of resources • Carrying capacity of ecosystems • Population • Elites
Assumptions about natural relationships	<ul style="list-style-type: none"> • Conflicts • Hierarchy and control
Agents and their motives	<ul style="list-style-type: none"> • Elites, motivation is up for grabs
Key metaphors and other rhetorical devices	<ul style="list-style-type: none"> • Overshoot and collapse • Commons • Spaceship Earth • Lily pond • Cancer • Virus • Computers • Images of doom and redemption

The promethean discourse

Basic entities recognized or constructed	<ul style="list-style-type: none"> • Nature as only brute matter • Markets • Prices • Energy • Technology • People
Assumptions about natural relationships	<ul style="list-style-type: none"> • Hierarchy of humans over everything else • Competition
Agents and their motives	<ul style="list-style-type: none"> • Everyone; motivation is up for grabs
Key metaphors and other rhetorical devices	<ul style="list-style-type: none"> • Mechanistic • Trends

Discourse of administrative rationalism

Basic entities recognized or constructed	<ul style="list-style-type: none"> • Liberal capitalism • Administrative state • Experts • Managers
Assumptions about natural relationships	<ul style="list-style-type: none"> • Nature subordinate to human problem solving • People subordinate to state • Experts and managers control state
Agents and their motives	<ul style="list-style-type: none"> • Experts and managers • Motivated by public interest
Key metaphors and other rhetorical devices	<ul style="list-style-type: none"> • Mixture of concern and reassurance • The administrative mind

Discourse of democratic pragmatism

Basic entities recognized or constructed	<ul style="list-style-type: none"> • Liberal capitalism • Citizens
Assumptions about natural relationships	<ul style="list-style-type: none"> • Equality among citizens • Interactive political relationships, mixing competition and cooperation
Agents and their motives	<ul style="list-style-type: none"> • Many different agents • Motivation a mix of material self-interest and multiple conceptions of public interest
Key metaphors and other rhetorical devices	<ul style="list-style-type: none"> • Public policy as a resultant of forces • Policy like scientific experimentation • Thermostat • Network

Discourse of economic rationalism

Basic entities recognized or constructed	<ul style="list-style-type: none"> • Homo economicus • Markets • Prices • Property • Government
Assumptions about natural relationships	<ul style="list-style-type: none"> • Competition • Hierarchy based on expertise • Subordination of nature
Agents and their motives	<ul style="list-style-type: none"> • Homo-economicus: self-interested • Some government officials must be motivated by public interest
Key metaphors and other rhetorical devices	<ul style="list-style-type: none"> • Mechanistic • Stigmatizing regulation as 'command and control' • Connection with freedom • Horror stories

Sustainability discourse

Basic entities recognized or constructed	<ul style="list-style-type: none"> • Nested and networked social and ecological systems • Capitalist economy • Ambiguity concerning the existence of limits
Assumptions about natural relationships	<ul style="list-style-type: none"> • Cooperation • Nature subordinate • Economic growth, environmental protection, distributive justice and long-term sustainability go together
Agents and their motives	<ul style="list-style-type: none"> • Many different agents at different levels, transnational and local as well as the state; motivated by the public good
Key metaphors and other rhetorical devices	<ul style="list-style-type: none"> • Nature as natural capital • Connection to progress • Reassurance

APPENDIX B: QUESTIONNAIRE

1. Hvorfor har du involvert deg i Vossolaugget prosjektet?
2. Hva blir konsekvensene hvis Vossos laksebestand blir utryddet?
3. Har ditt standpunkt mhp. situasjonen til Vossos laksebestand endret seg gjennom årene?
4. Hvilke krav er nødvendig for at villaks og fiskeoppdrett skal kunne sameksistere?
5. Hvilken tilleggs kunnskap trenger du for å kunne forstå bedre situasjonen til Vossos laksebestand?
6. Har oppstarten av Vossoprojektet ført til noen endringer i din forvaltningspraksis?
7. Forklar samspillet mellom prosjektdeltakere i Vosso laksefredningsprosjektet.

	Helt uenig	Uenig	Verken enig eller uenig	Enig	Helt enig
Uenigheter mellom prosjektdeltakere blir løst på en tilfredstillende måte	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Det er tilstrekkelig mye dialog mellom prosjektdeltakere	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dialogen mellom de involverte aktørene har økt med årene	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
En enkeltperson eller gruppe dominerer debatten.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enkeltpersoner eller grupper savnes i prosjektet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8. Hva er ditt standpunkt når det gjelder verdien til Vossos laksebestand for tidligere og kommende generasjoner?
 - Pragmatisk – fortiden er fortiden og de kommende generasjonene vil bare vite det de selv kan erfare
 - Bærekraftig – kommende generasjoner fortjener de samme forutsetningene som tidligere generasjoner
 - Biodiversitet – det er en egenverdi i alle arter og Vossos laksebestand må ikke utryddes
 - Vekst – matbehovet for fremtiden er viktigere enn eksistens av noen enkeltarter
 - "Laissez-faire" – la Vossos laksebestand tilpasse seg på en naturlig måte til de endrende forholdene i elven
9. Hvordan vil du beskrive din innflytelse på resultatene av prosjektet (i forhold til andre aktører)?
10. Hvem er ansvarlig for å bestemme over fremtiden til Vossos laksebestand? Flere valgalternativer er mulige.
 - De offentlige styresmaktene – Direktoratet for naturforvaltning o.l.
 - De offentlige styresmaktene og industri – f.eks. kommune og BKK
 - Elveiere
 - Det lokale samfundet – demokratisk prosess
 - Fiskeoppdrettsnæring
 - Forskere

The questionnaire can be found online on the following link:

<http://www.surveymonkey.com/s/BVD8SKK>

APPENDIX C: INTERVIEWS WITH STAKEHOLDERS

River owner A

Why are you involved in the Vosso salmon rescue project?
I am one of the 24 owners of Bolstad, the lowest part of the river. I have worked as a guide since I was fifteen or sixteen years old, mainly for English and German tourists. It was around 1985/1986. I finished this job when the salmon was not open for fishing anymore, around 1990/1991. The river is now only open for the fishing of trout and escaped farmed salmon. The river owners do not get an economic income. The income is around 25.000 NOK in summertime, not enough to pay to each owner. I have been the leader of the hatchery for 12 years.
Why should the wild salmon be saved?
It is a national obligation. Other countries are expecting that of us, like we are expecting that the elephant will be preserved. It is a big salmon and has been around for 100.000 of years. But it has disappeared in just a few years. Not having the wild salmon also has an economic impact and impact on our community. It is a small village and now most people are moving to towns to get an income. It has become a very quiet place.
What are the biggest threats to the survival of the wild salmon according to you?
Sea lice and escaped farmed salmon are the biggest threats.
Are there any conflicts in the project?
There are no big conflicts. But there are different platforms that have been on quite a distance. This project may be building a bridge. I have good faith. There are people with different interests, but now they understand each other better. There are actually two projects: one from 2010-2020 and Vossolaugget, which lasts 5 years.
Why does the other project have a shorter time period?
Because of the money available. After 5 years we will see further.
How would you describe the interactions between the participants in the project to rescue the Vosso salmon population?
The cooperation is quite good, but there are a lot of people involved. It is a challenge to have everybody working for the same cause.
What (if anything) should be changed in the practices of the rescue project (participants) so that the salmon will be saved?
We have some threats for small salmon. The government should buy the big farms out. They should do everything to control sea lice. But fighting against a big business is a challenge.
How would you describe the importance of saving the salmon compared to other salmon populations in Norway?
I think it is equal to other rivers. There is not a big difference. The biggest difference is that other rivers have a shorter distance from the river to the sea. This makes rescuing the salmon a bigger challenge

River owner B

Why are you involved in the Vosso salmon rescue project?
I am not directly involved in it. But I live nearby the river. And have done that for almost all my life. So I have been fishing myself and have seen the development of this salmon situation. So I have no direct economic interest towards it. I know that the river and the fishing have been very important for the people living in Bolstadøyri, because it has meant a lot to them, some economic, but also there are people from different countries and so on. So social life has changed since the salmon disappeared.
Why should the salmon be saved?
I think that, as you have certainly heard many times before, you can compare it to the tiger or the wild big animals. It's a very special salmon, due to the big size of the fish as you certainly know. I think wild salmon fishing should be saved everywhere, but this Vosso salmon is special.
What are the consequences if the Vosso salmon population becomes extinct?
Well, I think it would be a big loss for people living by the river, but also for humanity.
What are the biggest threats to the survival of the wild salmon?
I think it must be the lice, the 'lakselus' from the fish farms as you know. But also fish escaping and mixing with the wild fish. Because, as you know, then we won't have the special fish in Vosso anymore, if it's mixed with the escaped fish from the fish farm.
What conditions would be necessary to make the wild salmon and the farmed salmon coexist?
I think that the fish farms should be on land. In a newspaper in Bergen two days ago, they tried to make some arrangements based on concrete. It would be on the water. But it would make it much more difficult for the fish to escape. And to make it close so that the sea lice threat would not be so big they say. What I think is that there are two problems. This one and another: there is also a pollution problem in fjords. I know a diver from England, and he has been working in these fish farms. What's beneath there, he said, is horrible. So there is also a problem there. Not only to the salmon, but to the life in the fjords.
What additional knowledge do you need to better understand the Vosso salmon state?
I think we know enough. The problem is to do something about the situation. There the authorities have to work harder, because there is a lot of money in the fish farm industry. It is very important for the economic situation in the country. So I think that's the biggest problem.
How would you describe the interaction between the participants in the Vosso project?
I know too little about that to say anything special.
Are there any individuals or groups that are not included in the project, but should have been included?
No, I don't think so.
What is the most important value of the salmon for past and future generations?
Well, it's part of the biological diversity. We would survive without this special salmon. But it is a loss.
Who should be responsible for managing the Vosso salmon?
I think that the politicians on a national level should be. They should have the responsibility for this. It is a national task. It is not for the river owners to lead this. And I think also that the government understands this responsibility. As I said: it's a lot about money. Fish farms are a big industry. It is something to think about that most of the fish farms are here on the western coast of Norway. Near the capital, in Oslo, there are no fish farms and there the salmon is healthy and there are a lot of them I have seen on television. We don't like this situation here.

What, if anything, should be changed in the practices of the rescue project?

I think the whole sea farm industry is a threat, not only to the salmon, but to the life in the fjords in general, because of pollution. So I think they should stop to have the fish farms in the fjords, or in open water. I certainly know that it's very expensive as they say. But what I read in the paper, I think it is interesting what they try to develop now. Because as I understood, it would not be so expensive. And the fish farm owners, they understand they have to do something. Because the population in Norway, in general, they will not allow this to continue.

Do you think they do enough now?

No, I don't think they do enough. In Vosso, they have spent a lot of money and they are trying to find solutions. But I think the big problem is these fish farms and as long as they are in these fjords, the problem will continue.

River owner C

Can you first introduce yourself shortly?

I'm born here. It has been 73 years since. I have lived here most of my time. My father had this farm before but he had an office job for the post in addition, and I have somehow inherited both the farm and the post job. So that's what I have been doing. And the farming earlier days were mixed with the cows and the sheep, but from what I can remember, we delivered the milk to a dairy in Voss, transported it with a train then. Because we first got a road connection to the village in 1975. Before that we had just a train. Compared to many places in Norway that's not so bad, because there were trains running in both directions. The islands had hopefully one ferry a day, so we were privileged in that way. But there were a lot of difficulties to, because when you had to bring in something, you had to load it on a train and load it off and things like that. But besides that it was a good place. So we kept on milking cows almost until the road came. In 1970 we jumped out, because then I took over the post and it was a bit difficult, milking in the morning and catch up the post and the train. So we changed to sheep mostly.

How have you become involved in protecting the Vosso salmon?

I have somehow be working with the salmon all my days almost. My father was very keen on fishing. And in his young days we had what they popularly called salmon lords, coming from England to do the sports fishing. These English people were almost the first tourists in Norway, both for salmon fishing and for things like mountain climbing and things like that. Because here it was not know as a sport. They do some fishing, mostly netting I think. They also had a kind of trap installation to catch them. There was a limit how much salmon they could consume. And the only way they had to preserve it was salting. I have never eaten salted salmon, but I suppose that was not what you would like to have every day. In the earlier days, we were a bit overpopulated so in a bad year, people were quite hungry. And then I suppose I could have a lot of salmon to eat. The farm work was very different from today. Down here were we have our fields now, they used to grow things like potatoes and grains, things to supply themselves.

And were they fishing a lot also?

They were not fishing a lot. They fished for what they could consume. Because after the railroad came in Bergen in 1885, they could perhaps deliver to Bergen. But before that the fish would not last. It was a summer season, so I think that was not that actual. What they could do was salt it, but I'm not sure how much it was worth, salted. Because Bergen also had fish coming from the sea, so they were not so interested. So that didn't make it so important. But what makes it important was that they could live mainly from the products produced from the farm. But there was a lack of cash. If they want to buy something, then they have to sell something. Or rent something away. And they rented away the sport fishing. I think it was quite important. Because I know in Bergen city, there were mostly wooden buildings. But a lot of people lived in Bergen. It was an important city in Norway, more than today. It was a Hansa city. But sometimes the house took fire. And if they had a little wind and different circumstances, they burn out a part of the city. And after a while they needed timber. And they had chopped of the timber in the surroundings, so they had to move in here. And they got transport to here. They had some possibilities for getting a little money, but I think it was very welcome, these English people coming. And I understand that it seems to be a great deal of money today, but the value of the money was so different before. We know that these English people started coming here around 1850. In 1901 one of these Englishmen rented the most of the river and this farm here was on sale then, so he bought it. They come here every summer. And my father was very keen on fishing, he started to be a guide probably in 1915 or a little later and became almost the right hand for the Englishman, when there were things to do here. So when the Englishman got old, he sold the farm to my father. But the family still comes back for fishing every summer and we more or less live together with them in the house. That was not so uncommon in those days so we moved out of a few rooms and things like that in the season. Anyway, when the war came they could not come anymore. But they came back after the war. I can just remember them coming back. But in 1952 or something, they got problems. They had the money for coming, it was a rich family, but the restriction of the money after the war in England, they were forbidden to take the money out of the country and they had to stop coming.

But there was still a lot of fish?

There was still a lot of fish, yes. But the river had never been impressing because of the number of the fish, but because of the size of it. That was just as worthy in this trophy fishing. And in 1965 we got a travel agent firm in Oslo, and they stayed for twenty years. They build their own house for housing the people coming. But still there were jobs for guide. So I had such a job myself from 1955 and we have three sons and they also had that that job. And this was very good, because this was happening in the summer and they had a summer job to come back here. And they could live at home and do this. And earn money, so they more or less made it though. It has been a good part of the village, especially for the farmers. Some could have a job with it and others would have money from the rent.

And when did you notice that there started to be fewer fish?

The 1960s were good years and the 1970s almost the same. We had always had up and down years, bad years in between. I think what makes the bad years was that you had high water in the river after spawning time and they used to spawn at a certain depth. And when the winter came and the river dropped down, then they dropped on dry land. But still the roe can survive in wet sand. But if you got a frost in addition, then it would kill it off. And I think that was happening some years and then six years after, you would have a bad year coming in, but you have the three generations in the river, might be four sometimes. And three other years in the sea. So it comes up again, automatically. So in 1987 which was a good year, that was the last one. Then it dropped down very suddenly and did not rise again.

What did the people do then when they saw that the fish were not coming back anymore?

We should probably have stopped doing any fishing in 1990 or 1991 because there were too few of them coming. So we should have been warned then, but we have had seen a bad year so many times, and it was coming back, so it could have been done better. But otherwise there were so many things happening at the same time. Around 1990 they were building the road and they dumped a lot of soil and so on in the water. And before that they were building the power station in Evanger. That's a big one, and they did a lot of things they shouldn't do. There was a mountain valley north from here and the tunnels from this power station go almost to the Sognefjord. So that's a lot of land they have gathered the water from. And when they build one of the dams, they had to clean up the ground to the solid mountain rock, before they could start building the dam. And the river in the other valley, north of here is a much smaller one. So they didn't dare to drop the soil in that river. So instead they dropped it in the tunnel and it came out here. So the river was like cacao for a couple of years. You couldn't see that much then in the water. But we had fish. So it didn't do any harm right down and we had a case with the power station who built them afterwards. And we couldn't put the finger on anything because the salmon were coming back. But in 1989 or 1990 they decided to do a regulation of the lake, the Voss lake. And they had done it absolutely the wrong way. This has to be done in winter when the river is very low. And they closed the river for a short time to do the work. And then all the dirt from the work came into a small amount of water. And they killed probably the small fish in the river and a lot of insects living on the bottom of the water which is the food for the small fish. So they reduced very much. And at the same time the fish farms and their problems, in the end of the 1980s and 1990 really took speed and build much more and bigger farms. So what did most of it is difficult to say and they have been researching twenty years to try to find it out and they still haven't got a good answer, so it isn't easy. Whether we will have more salmon coming, I don't know.

What do you think?

I should think it is possible, but we must find out what the reason is. And I'm not absolutely sure of that because these parasites, which we call salmon lice, have been there all the time. But we think that the farmed salmon are magnifying them. Anyway they have had a lot of problems with them in the farm, and maybe they magnified them, because they are there all through the year. And the sea trout has been in the system all the year, also before. So it's not that easy. But there is something there. And how much the genetic, how much they damaged that part with the farmed fish we don't know. But when they started doing the fish farming, at least in this part of the country, they mostly started up using this breed of fish because they wanted fish who grow rapidly. So they are the grand grandfathers to most of the farmed fish. But you know, I have been farming on a small scale. But we know when you grow animals, it's not so easy to change the breed. Different things you can change easily, but most of it is well protected, so it takes a long time. So how much they can have damaged it in, well it's almost forty years now, but since they really took speed it's not more than 25, 30 years. So how much they can have damaged it in such a short time is not easy to say, for me anyway. They have to find their way to the ocean, and find their way back again, and maybe things like chemicals can have an effect, I don't know.

What do you think of the role of the government? Have they been doing enough to protect the salmon?

No they haven't because they like to start things, because then they will be elected again. That's the problem. And these fish farmers, they get their permits. And there are things they should do and should not do to get the permit. And if they have not been doing anything illegal, they haven't done anything wrong as I see it. Decisions have been made from the government. And they should have been more careful when they started such a big thing as the fish farming, do some researching first and at least do it on a smaller scale and so on. But they haven't done that. And that's also the same with these power plant buildings and things like that. Also, they have got their restrictions, but they should have had different in addition and also I think they have to choose well when they are building more stations, so they don't damage the possibilities for tourism. That's also quite a big business in Norway and we like to keep it that way. If we have no more waterfall it's not so good. We have been doing this with the tourists for a long time, 40, 45 years. And they have been reading about the highest water fall in Northern Europe, in Eidfjord, and they have been reading that it was nice to see it. But what I did not tell is that it is not switched on every day. We get many things like that.

What do you think about the cooperation between all those different people that are trying to save the salmon? Do you think there is enough cooperation?

I hope so. But the atmosphere between the fish farmers and the DN, they have been a bit unwilling to cooperate. But of course the people in Trondheim have got their job there. But I think the fish farmers have done a lot of work which we can use, especially in a situation like now, because my opinion is that they are a lot better on breeding artificially than the other ones. They are very much aware now that they are getting unpopular. Because of this. So I think that they do what they can. But also they, as the other ones, like to show that they can. They want to be mentioned doing that. But that's how we are. We must allow them to do that. So I have been representing the river owners for the last couple of years and I find it very interesting. And I think we also need fish farmers in the organization. And of course they have got a lot of money, and if they are willing they can make things happen. And I think they are aware now that things must happen. I saw in the news paper yesterday that they were talking about making big installations of concrete, floating on the water and put the farm in there so they could lock it and take uninfected water and things like that, because this parasites they are very costly for them and they can't use very much things like chemicals or penicillin because their market will disappear. So I think we can cooperate with them. I think so.

Fresh water fish manager from Directorate of Nature and Hordaland commune

1. Can you tell me something about your function?

Normally I'm a fresh water fish manager for the Hordaland county. From one year ago I have been working at the Directorate for Nature in Trondheim. I still work a lot with Vosso and you can say that I'm leading the work. I'm managing the rescue project.

2. How are you managing the project?

Well, it is both the county governor and the Directorate of Nature Management that have the responsibility for the wild salmon. But the DN is on the national level and the county governor on a regional level. So because the DN has a whole responsibility, I am managing the project on behalf of DN. We have a board of four persons that are leading the project, the leading board. And I am leading this board.

3. What would you say about the cooperation between you and the other members?
The cooperation is very good. The leader of the research project, is a member. The representative from Hordaland commune is also a member. She is working half the time here and half the time on the hatchery in Voss. And we have a representative of the community of Voss. And we have a very good cooperation.
4. How would you describe the cooperation with other actors that are involved in the project?
We have contact with other scientists through the research leader. Sometimes we have these research meetings. At least once a year in December in Voss, where we are meeting lots of other scientists. The fish farmers did not take part in this work at all, until two years ago. They started just a couple of years ago. And now they are taking a lot of responsibility. As you know, they have started this salmon production in Evangervatn. And they paid lot of money for that. So now there is quite a good cooperation. It was hard in the start because as you might know there has been a good dialogue between the fish farmers and the environmental management. So the Vosso project has been a good example on how it can be. There are very few of those examples, maybe Vosso is the best example in Norway on cooperation between fish farmers and nature management. It has been a tough time to get there. But it's improving.
5. Do you think there should be some other actors involved in the project?
We are trying to get those experts at any time we need. If we know of any experts that could be useful we always try to contact them. So we have had contact with a whole lot of experts. There is not a lack of experts. There will always be different opinions on what to do and so on. So that's why we had a lot of experts in these yearly meetings, to get another opinion.
6. And the sports fishermen that used to fish there, are they in any way involved?
In some way. They are involved as they take part in the fishing for escaped salmon in the autumn. And they also take part in the work at the hatchery. When the hatchery needs an extra hand, or something like that. They are also taking part in an organization that we took the initiative to start. It's an organization for those who own the land. Those who own the land near the river and those who own the right to fish. They and the community and the anglers are together in one group that have meetings three to five times a year. And they are again represented in one group that we have, so we meet them somehow. And they are also invited to the yearly meeting in summer at Voss, the anglers. So we meet very many of those anglers each year in the summer at Voss.
7. And is the Fishers and Hunters organization involved?
Not much, but it might not be needed, because we have a very good contact. And the leader of that organization is meeting me at least once a month to talk about everything. And we meet him quite often at other places. So we have a very good contact and discuss this all the time. So I don't feel that they feel a lack of influence at all.
8. Why do you think that the salmon should be saved?
We have international obligations for taking care of all of our salmon stocks. And this is one of them, and this may be one of the most important, because it is the biggest in the world. So it's very important to protect salmon. So I think we should spend a whole lot of money to try to get it back. And the other reason is that, economically it can be very important. It can give a good income for the landowners and for the community. So we should spend a whole lot of money now to get good income for the local community later.
9. What, if anything, should be changed in the project to make it more successful?
We have a good organization, and it works. One of the main reasons for why we are not succeeding that well is lack of money. We should have more money to work faster.

10. And who do you think should be responsible for giving a larger amount of money?

I think the fish farmers, they can still improve. They have improved a whole lot and given more money than ever. But maybe they can improve more. And of course this is responsibility for the Norwegian state, so the Norwegian state should spend more money on this.

11. Can you tell me more about the concept of river owners?

The river owners are mostly the farmers along the rivers. There are also some that a long time ago bought some rights to fish in the river, even an, at that time, rich English family has bought quite a bit of Vosso and the right to fish. But mostly it's the farmers and earlier they rented out the right to fish for quite a lot of money and today the fish angler industry in Norway has become big and there should have been quite a high amount of money for the land owners to get for fishing if the Vosso salmon had returned as it should.

12. What do you think are the biggest threats to the Vosso salmon?

The biggest threat in all our county is the fish farming. There is no doubt about it. We are not sure if there might be another threat that we don't know.

Fisheries anthropologist

1. How have you become involved in the project?

I have been interested in fisheries anthropology, the social science of fisheries. I was also interested in restoration efforts, and in salmon restoration. I grew up in the West coast, and lots of salmon restoration is happening over there. And I wanted to come to Norway to understand whether or not there was interest in salmon restoration in Norway, the place where salmon restoration came from. I was interested if there is interest in salmon restoration and if so, who are they, what are they doing. I searched a lot for a project here and I found the research leader of the project. He helped to facilitate the research project I did. He asked me if I could produce a chapter for the Vosso report. Because I had a year, I had funding. I wanted to do a research project about salmon restoration in Norway. And he had something for me to produce, so it was really the perfect timing.

2. What have your main findings been?

That was an oral history project in a way. I asked the question: how important was the Vosso salmon for your culture, for your economy and for your recreation, previously, currently, and what you think it can be in the future. The people who were involved in the sports fishery had a more positive view towards the future. The people who were involved with commercial fishing among the fjord, using the sitjenot, they were less positive about the future, because they really don't see any chance for the return of what they had, which makes sense. I think they are right about that. Some of them thought that maybe they could maintain their sitjenot and use them for tourism purposes to show people how the fishing happened, but that was only a few people who really had that idea. Mostly the people along the river saw the most future potential for restoring the salmon. But the people who lived along the fjord were still interested. They still cared about it, because it had been so important to them. So I was also interested in who is involved and why. And the people who lived closer to the river, in places near the outlet to the Vosso river, they were a lot more involved than the people further out on the migration route, which makes sense. Out there, there is a mixture of salmon stocks that comes by, so the Vosso salmon is not the only salmon they depended on, but the Vosso salmon was very important culturally and economically to people further in, towards the river.

3. And was the Vosso salmon nationally known?

It was nationally and internationally known. Part of the reason this salmon is getting so much attention is because it has one of the longest migration routes, so it was known to produce the biggest specimen, the largest individual fish. It was prized in sport fishing. So people from America and Britain in the 1800s paid a lot of money to come and rent out houses along the river. And it was a famous fish, compared to other rivers in Norway. So the fact that this particular fish is on the decline, it is an emblematic fish, so the government is concerned about it, the fish farmers are concerned about the loss of the Vosso salmon tarnishing the salmon farming reputation. So the fish farmers want the Vosso salmon not to go extinct either. Also, since the Vosso salmon was the biggest fish, it was used as the genetic starting point for the farmed salmon. So they wanted it to be the biggest, fastest growing fish they could have. So the Vosso salmon was one of the main strains of fish that was used to genetically develop the ones that are now used in farms.

4. But what is then the difference between the farmed and the wild salmon?

They took the wild salmon and they bred it, but they selected it to grow even faster. But they started with the Vosso salmon for one of the primary strains of fish. So Vosso salmon is now in Chile, Vosso salmon is now in British Columbia. The Marine Harvest used the Vosso salmon as a starting point.

5. And what can you say about the cooperation between all those people who are involved in the project?

Well you know, I haven't got updated about it since I left. But when I was here, the salmon the salmon farmers in Hordaland commune, they are helping to finance some of the activities of rearing smolts and setting them out. Three years ago they were involved in financing the Vosso project. And the farmers I have talked to, also don't want the Vosso salmon to go extinct. Also because it would be bad for their business, both because they are people who care and also because it would be bad for their business, they think. It is in their interest to keep the Vosso salmon. That's what they told me.

6. Do you think that this restoration project will be successful in the end?

That's a good question about all these restoration projects. It has been a really long time since the salmon has crashed. A lot of things have changed. There have been changes in ocean, changes in hydroelectric power, changes when the flow of water comes out. There is all these sea lice and issues with salmon farms. It seems kind of unlikely to me that this is going to work.

7. If you compare this project to other projects you know about, for example in America, what can you say?

I don't think it's going to get salmon back in Seattle either. I don't think people and salmon coexist that well. So in Alaska, there are a lot of very pristine watersheds. Watersheds that haven't been developed, that haven't been dammed, that haven't been logged. So there are still the intact watersheds and there are still very productive salmon runs. And it is pretty clear if you look where there has been a lot of development with people, doing other activities in those areas, then that's where you get reduced salmon productivity. In Russia they have created whole salmon rivers, salmon production zones. It is clear that in order to have productive salmon; you need not let other activities disrupt the production. I'm still hopeful, but I don't think it is really that likely that runs that have already gone away are really going to come back all that strongly. But maybe they can be strong enough to not be dead. And I think that an interesting question is whether or not; if you were to get the Vosso salmon back, at least a little bit, whether there would then be more economic benefit up in Voss. Which is part of the reason why people want to work hard to restore this: they would get some economic benefit. I think there is potential to not let it die out, but I don't think there is really that much potential to let it be a money making thing. So if that is what motivates people, then I'm not sure they're going to get what they are looking for. But I still think it's worth it, but whether or not the people financing it think it's worth it, is a question. But if we say, oh now it's not going to work, then maybe the people financing it won't finance it.

8. According to you, who should be responsible for deciding the future of the Vosso

salmon?

Well, policies have to be the government. So the decisions about what actually the management is. The people can't decide that, the government has to decide that. But I assume that the government in Norway, since it is a democracy, should listen to what people want. And if the people want salmon restoration, then they should do it. And It seems like they are valuing salmon with their national fjords, but I think the problem with salmon and a bunch of other environmental issues is that all these activities combine to be the problem, and it is really hard for any one person to effect change. And it's also very hard to decide for one person, I'm not going to do this activity because everyone else is doing other activities that are damaging.

9. A tragedy of the commons?

It is a very good example of a tragedy of the commons. So the government really has to be a facilitator I think.

It is really interesting to see the difference in culture between the wild salmon people and the farmed salmon people in Norway versus in British Columbia. Where I come from, there is a very huge polarization between farmed salmon and wild salmon. I grew up in a place where people have bumper sticks on their cars that say "friends don't let friends eat farmed salmon". Farmed salmon is evil. But the culture I grew up in is hostile to farmed salmon, because it is a wild salmon fishery. And even though people are not necessarily environmentalists, they have learned what are the things that threaten wild salmon and what are the things that we should try to be against, so they know all the reasons why farmed salmon is bad for the environment. Because they don't like it. And all the farmed salmon that is produced makes the price of the wild salmon go down, because it floods the market and it is available all year round and it's just harder for the wild salmon industry to succeed when there is so much of farmed salmon everywhere, so competition. But there really is a threat to wild salmon from farmed salmon, because of all the things that they are studying here, the effects of sea lice and escaped farmed salmon and disease spreading, and all these things. So what I find interesting is, so in Norway there are wild salmon too, is there a similar polarization between farmed salmon and wild salmon, that I experience in BC and Alaska, and here salmon were never the foundational economy for people. So salmon on the west coast of the U.S. was the foundational economy. Everyone had access to it. It is a cultural identity. In Norway maybe cod would be more like that because it was more prevalent, people without other means had access to cod fish, whereas salmon was kind of a a luxury good. So I don't think salmon has the same meaning here, in a way as it does where I'm from. This is my impression. Before farmed salmon came, most people had never eaten salmon. And after farmed salmon came, it suddenly became available to every person. So before it might have been, at Christmas you got a smoked salmon and it was really special food. So when the salmon started crashing in Norway and people started experimenting with farmed salmon, suddenly it became accessible to everyone, suddenly it became part of Norwegian culture even more prevalently and people are more tied to it. People are proud of the farmed industry, and that's what's meaningful to them. And also it is the second largest industry in Norway, and it has a lot of economic power and it's sad, but people would probably choose farmed salmon over wild salmon if they had to say, have the industry or have the wild salmon, they would probably just say the industry. So I think Norwegian salmon industries don't understand why there is so much polarization, why are people so upset about farmed salmon in British Columbia. Why are there all these demonstrations and people against it. It's just a very different background and culture that they came into and so it has been interesting to understand what is the background. There is less hostility, more working together, but there is still a sense among wild salmon advocates that there needs to be salmon farming industry on land, there need to be some solutions, but there is not the same kind of hostility as on the west coast of the US.

Marine biologist

How are you involved in the project?
The point of employing me I think is because they want somebody to work with the marine phase of salmon biology. So I'm going to work with the salmon lice and all the other issues that contribute to the salmon population fluctuation. These are my main tasks.
What is your impression of the salmon situation so far?
For my background I have a bachelor in aquaculture so I have studied salmon somewhat and I'm also a fairly keen fisher. In general of what I've read and my impression of it is that the distribution worldwide is of course much smaller than it was, many years ago. We had so many populations in the US and the world that were large. And we now have the area in the world where we do have healthy salmon populations is in Norway. So in comparison with other places in the world, we are doing quite well. At the same time though, it is under a lot of stress, or pressure from all these kinds of industries or human impacts, not necessarily all from the industry. Just the fact that the human population is growing also creates conflicts so in that respect there are a lot of interactions and pressure on the salmon populations. As a consequence, areas where there is a lot of interaction, you see there is a decline in salmon populations, for example the west coast of Norway.
Do you think there is something unique about this salmon population compared to other salmon populations in Norway?
The Vosso salmon is special in the sense that it's so big and numerous, it was at least. So it is a salmon population that is different, in the sense that it is biologically extreme. That's why it's interesting to keep it. If it wouldn't have been different from other populations, there wouldn't have been so much focus on it. And I mean, biological variance, or biological diversity is also about extremes. And this is definitely an extreme.
Would it be possible to put other salmon populations in the river, would they survive?
Theoretically, yes, I think so. There is restocking of populations in rivers where they have been extinct or where there hasn't been salmon before. So salmon tends to be very adaptive in that sense. But you have to look at it in a longer perspective, in the sense that they have adapted biological or genetic variance, the population has adapted thousands and thousands of years. So to replace it so that it would reproduce by itself is most likely questionable I guess. I mean, there has been lot of rivers where they place out eggs, and then the salmon go out and come back and then they reproduce, but to keep up a healthy population that way is much more difficult and nature does a much, much better job in this.
So do you then think that this project will be successful on a long term?
Well, I'm from Stavanger, I'm always negative. No, I think so, I hope so. But there has to be an alliance of the stars in the sense that a lot of things have to be working at the same time.

What can you say about the results of this project so far?

This is definitely a different kind of project than I have worked for before. It is very focused on getting direct results that are very measurable. So you have an end product that you want to end with. So in comparison with the university, where you explore the realm of the truth and then you try to go in that direction that seems to be correct, but the end result is just getting more knowledge. And in this project, you have end results that you have to come to, which is basically to get the Vosso salmon to reproduce. They have a lot of nice results, saying a lot of different things, everything from the effects of regulation and aluminum. When they migrate out and all these things. But in general biology is extremely complex, so they are working parallel in the sense that they are working both in just getting basic biology knowledge, and they are also working on things that we can use to reintroduce it into the river and just measuring whether or not these effects are working. So there is a parallel of these two things working. And they have come a long way in the sense of biology, and they have come a long way in the sense of doing work to reintroduce the salmon, but the end results will be in the next few years so I think there are a lot of good results here.

And how have the fish farmers helped in the project?

Well, as I understand it, they have taken very much interest in it, because of our focus on it, of a lot of people focus on it. And then they have established this own group, which is called Vossolaug, which is a collaboration of the farmers. And they have been more and more aware of that something needs to be done and they are trying to do something on the basis of the knowledge that has been established from the Vosso project. And that's good. I like to see that we are collaborating more as one unit, rather than them working by themselves, and we working by ourselves. I think that they want to do the same thing, but at the same time it's all about how it looks from the outside, the media and their possibilities of being able to go out and say that they're doing it, or that we're doing it. It's a conflict of interest I guess. But we just have to try to bridge the gaps as much as possible and try in the end not to stand in your corner and scream at each other, but rather try to collaborate in the end result, which is getting the salmon back in the river.

What do you hope that the project will achieve in the end?

It's a fairly easy end product, getting the Vosso salmon back in the river, reproducing by itself. It's that easy. That's the end results we hope for but I think that the side product of that is to see that it works, that that type of reestablishing of the population actually works, that collaboration works, that there is a belief in what researchers do to get things working again.

And the financing, will that be a problem in the future?

It's always a problem. I mean, finance controls everything I guess. And it's unfortunately not always a good correlation between correct results and financing. It also has a lot to do about being in the media and crying about it. I think we should be objective and always say what we find, always do the right thing and not necessarily go out and scream. When we do have results, we present them and we present them objectively. And if we do that consistently, I think people are much more willing to listen to us then if we go out and say that they are the bad guys and we are the good guys.

And is that being done now?

I think that the research leader, who is our face out, is very good at being very objective in a sense that he says that all we need to do is focus on ourselves and our results and not say things that are not based on science, not based on data. Because if we do that, somebody is going to come out and say look what you did and our credibility will fail.

What do you think the main threats are to the salmon?

In general, it's human population growth I guess. That's the main issue. Hadn't we be here, then there would be much more salmon around. And then are things that are not humanly influenced, which is the climate change, which can also affect and will affect ranges of the environment. And then there are very specific things in specific areas, regulation of rivers and stuff and then on the regional basis you have farming industries also, which have been shown to have an effect on rivers, directly through escaped fish and sea lice, but saying that there is one thing that will affect the salmon population is very simplified. So it is very regionally based. There are some things that work on larger scales, and then some things that work on regional scales and some things that work very specifically on one river. In the end though things that we have to focus on is the things where it is possible to do something about, so on a regional scale where we work it is possible to do something about salmon farming and it is possible to do something about river regulation

What would the requirements be for the fish farms and the wild salmon to coexist?

It is very, very difficult to answer. Any industry has an impact, but the question we have to answer is what kind of question are we willing to allow and when it comes for example to Hardanger area, it seems that there is too much farming going on. The areas between them are too small and there seems to be too much farming in general. So in some of these area the farming intensity needs to be lower or not to be increased. And in some of these areas we can try to figure out exactly where the placement is, so if we place them better that there's a better chance of getting areas where the smolts can go out, but at the same time there is a limit to how much open cage farming there can go on. But exactly how you do it, if you have a good answer ... There is a lot of reports and stuff and suggestions on how to do it, like fire gates, so you have areas with the intensive farming, then you have a long area in which there is nothing and. Buffer zones, because then the contagious areas can't contaminate the other areas. But I can't answer this, that's not my area.

Who should then be responsible for this?

The government, there is no sense that they should regulate themselves. Industries they are well intentioned, but because there are some people in each industry that are not. Maybe there are hundreds of farms that are doing great, but then you have a couple that doesn't care. Then that affects everything. So it needs to be controlled, it needs to be regulated somehow. And who should do that? There's setups of which branch should regulate. That's a political question and I am a basic biologist.

Leader of Voss hatchery

How are you involved in the project?

I am the daily leader of the Voss hatchery. We do the cultivation work and take care of the roe from the gene bank. We hatch and start feed small larva and produce Vosso smolt and fry and the fish out in the river.

What is at stake if the Vosso salmon becomes extinct?

For me personally, I will have to find a new job. It is very sad if it this wild salmon dies out as it is a special, big salmon, maybe one of the biggest Atlantic salmon. It would be a shame for the future if it dies out. It has a big economic value. If it would return to its normal situation, it would have a big economic value for Voss and river owners. It would be very sad if it died out.

Do you think that this project will succeed to restore the Vosso salmon?

If we manage to control the known threats to the salmon. We know that Vosso has a good water quality. The fry grow up there every year. The small salmon do well in the river, but they have a very high mortality in the sea.

What are your main reasons why you want to save the wild salmon?
I am interested in nature. I think it's an exciting, interesting job. That's my main reason.
What can you say about the results of the project?
As long as I have been working with salmon, I think it goes well. But there is a high mortality out in the sea, where we don't have control over.
What can you say about the smolt development in the last years?
Vosso is very big. It is very difficult to get exact numbers. But it goes well with the young fish. It goes a little bit up, you can maybe say it is stable in the river.
What can you say about the cooperation between the other people involved in saving the wild salmon?
The hydropower plant is mostly interested in producing electricity. And the same goes for fish farmers: they are mostly interested in farming fish. We need to find a balance. But, I think that the river owners, who work here, have the Vosso salmon as first priority. So there are different interests. If they had to choose, they would protect their own interests and protection.
Have there been any bigger conflicts which have prevented the rescue action?
No, no big conflicts. But we notice that we have different interests, what can I say? Different views.
And if you compare the situation with a few years ago, has it improved, stayed the same or worsened?
The power companies, they have had an understanding of the effects on the fish. There has been a better understanding in the last years. Also in the salmon farm industry. They are going in the same way, but are going a little bit slower. But the last years they have taken a little bit more responsibility, as we have seen. The environmental organizations interested in wild salmon have done a good job to make the society see these problems. It has been more revealed.
Are there any local governmental organizations that are involved?
Local Hunting and Fishing Society, they are part of the national Hunting and fishing organization, so they are part of a larger organization.
Do they also sponsor the hatchery?
Yes, with volunteer work.
Will there be an end to the project?
We don't have any special end date. But until the river reproduces on its own. But there are many threats to the salmon. Farmed salmon, hydropower, the building of new power plants. So I think it is difficult to say when we will have a good production in the river.
And the national gene bank, does it have an unlimited production of eggs?
Maybe there is not an exact limit to the production, because they have the opportunity to take in new fish from the river, and they also have a frozen gene bank, which they can use to create new families.
Who should have the main responsibility for deciding the future of the Vosso salmon?
The highest level has to be the government, the environmental department. But we must not forget the county governor in Hordaland, and they have to cooperate with the more local people, like the fishermen and the river owners and the local hunting and fishing association. They are all in the local advisory board and have meetings here every year to discuss the issues locally.
So the way it is organized now is good?
Yes, I think so. But there is a difference of taking care of the river. We have a lot of experience with that locally and the governments having responsibility for the wild salmon. But there are other departments that have responsibility for some of the problems. For example the power plant industry and the farming industry. So that makes it a little bit more complicated.

Do you have a good overview of what Vossolaugset is doing?
Yes, to some extent. Because I will attend all the board meetings. And I also have a place in the board. So, they seem to have genuine interest in the wild salmon. But, even though we cultivate, and produce a lot of salmon and smolt, they have to do something with their own industry to make it sustainable. So that the salmon will also have a good survival in the sea.
Do they use the same genes for making the wild salmon and farmed salmon?
They started out with the farmed salmon once. But they have been breeding them a lot and they breed them to grow and to grow well in a farming net. So they have removed themselves from the wild salmon. So it's not the same fish anymore. The geneticists also say that this is not the same fish, and you use a lot of genetics from the wild salmon populations. Research has shown that if you get a lot of farmed salmon in the wild salmon stock, then the total production from that river will be reduced. It's not a good thing to get the farmed salmon escapes in the rivers.
Even, for example, if they are bigger than the farmed salmon?
It is very seldom to get a farmed escape larger than ten kilo. The Vosso salmon was traditionally the largest salmon.
Do you have anything more to add, that is important to know?
Both power plants and the farming industry, they have a good economy. They do well, so they should participate in this rescue operation. They do have the resources and the responsibility.
Are they giving the enough money?
No, the farming industry does not give enough money or resources.

Representative from Hordaland commune and Voss hatchery

How are you involved in the project?
I work at both the Voss hatchery and the Directorate of Nature. I have been invited to work at DN due to my expertise at the Voss hatchery. The Voss hatchery plays a very important role for the restoration of the Vosso salmon because of their knowledge about the salmon.
What is special about the Vosso salmon population?
The Atlantic salmon has many diverse populations. The Vosso salmon is internationally recognized due to its size. It is believed to be the biggest salmon population in the world. When comparing the salmon populations in the neighboring rivers, one can notice a remarkable difference in size, with the Vosso salmon being by far the biggest salmon. The loss of the Vosso salmon will lead to a loss of biodiversity.
What are some challenges in the project?
The project can be characterized by the involvement of stakeholders that do not only have divergent interests, but also different responsibilities. There are many different government departments responsible for the restoration of the wild salmon, each with a different responsibility. This leads to a fragmented restoration approach. Another challenge is the fact that so much time has passed since the collapse of the wild salmon. The big salmon is especially valued by those who have seen it in real life. And since the stock collapsed in the late 1980s, it has been quite some time since its abundance in the river. The contemporary politicians possibly have never seen it in real life, which is why they might attribute a smaller value to it. This means that the wild salmon is slowly losing spokespersons. However, there are some young people working for the Voss hatchery.

Are there any knowledge gaps?

There are some gaps in the knowledge of fish farmers. However, in the last few years the knowledge of fish farmers seems to have increased and their approach to restore the wild salmon has widened. First their main goal was to increase the number of smolt in the river. The goal of the Voss hatchery was broader. They were aiming to reach natural reproduction of the salmon. Now fish farmers are involved in more ways. These differences in knowledge lead to slightly different views on how the smolt has to be selected and 'put out' into the river. Voss hatchery wants to encourage natural selection. We set out both 'well fit' fish as well as fish that are less fit and are not encouraging the use of vaccines. This is not good for the process of natural selection and in the end leads to fish with less diversity. Farmers on the contrary, are used to artificial selection of the 'strongest fish', using only the biggest smolt for production. But farmers can contribute to the increase of smolt by making their technology available, as this technology is aimed at maximizing the production of fish, which thus also makes it helpful for the restoration of the wild salmon.

Leader Vosso rescue project, from LFI Unifob

Why was the Vosso project initiated?

The project has started in 2000 with the aim to find what the status is for the wild salmon stock. This knowledge was to be used to define some measures. The local government does not have enough competence alone to identify the threats; they need scientists from the outside to provide them with some information. The project can be divided into two periods. The first period is one in which the goal was to collect as much knowledge as possible about the salmon. The second period is about rescuing the wild salmon. The project is called 'Now or never for the Vosso salmon', because the salmon genes in the gene bank have a limited lifespan. This means that the researchers cannot keep towing the smolt for an indefinite period. It needs to start reproducing naturally.

How will you determine when the stock has reached a sustainable level?

This is based on the spawning stock. We look at how many salmon return. This number should also allow for harvesting to take place.

What are the biggest threats to the salmon?

The environmental conditions of the Vosso river are no longer believed to be a threat to the wild salmon. Some scientists think that predation by trout is a big threat for the salmon. Others think that it is the changing temperature of the sea. But the biggest challenges that have been proved are the sea lice and the interbreeding between wild salmon and farmed salmon. However, scientists need to be open for possible unknown threats as well.

What have the fish farms done to mitigate their negative impacts?

The fish farms acknowledged they were contributing to the threat posed to salmon when the scientists provided them with solid information. This is why they have initiated to join the Vossolaug program. The intention they have taken to fight the sea lice problem is to treat the salmon against salmon lice. A catch net has been developed, but this is mainly suitable for the escaped sea trout and not for salmon. The sea lice on salmon are still far too high. A problem is that the escaped salmon comes from many different farms. It is impossible to trace back to which farm the salmon belongs to.

What is the biggest difference between wild and farmed salmon?

The biggest difference between the farmed and the wild salmon is their morphology. Farmed fish are selected for fast growth. This makes them unnatural. The most important difference is that they are not adapted to the conditions of the river but to the conditions of the fish farm.

Is acidification causing a problem?
A high concentration of aluminum has been found on the gills. It is however not clear to what extent aluminum affects the fish. No significant effects have been proven yet. Acidification comes from industries, mostly from Europe. However, it has improved a lot since the heavy industries in Eastern Europe have shut down.
How has the government kept pace with initiatives from the locals?
As in most projects, the local people raised concern about the fate of the wild salmon which spread to the local government. However, the approach from 1990 until 2000 was quite fragmented. From 2000 on the Vosso project came into existence. This was more coherent and systematic.
What do you consider to be the biggest achievements of the project?
The biggest achievements have been the integration of the stakeholders with different interests. Furthermore, through the project fundamental datasets have been established, with concrete data. Had the scientists not established concrete data, then the second project would not have come into existence.
What are some challenges in the project?
It is difficult to get solid data in the fjords and the seas.

Additional question asked by e-mail:
Are there any (significant) differences in the breeding conditions of the hatchery and that of the construction based in Evanger, e.g temperature, smolt selection etc.?
The main difference is that the Evanger smolts are offered a more natural environment than the smolts kept at the hatchery, i.e. conditions concerning: - light - temperature in Evanger are more natural at Evanger, also the smolts at Evanger have more space than the hatchery smolts. In sum, this means that the Evanger smolts will be more like natural smolts than the hatchery smolts. We have yet to find out whether this influences their sea survival in a significant way, but we expect the Evanger smolts to survive better than the hatchery smolts.

APPENDIX D: TABLE WITH STAKEHOLDER INTERESTS EXPRESSED IN THE MEDIA

Date	Local media outlet	Description of event	Stakeholders involved	Interests and/ or opinions expressed	Main interest category (<i>economic, social, environmental</i>)
14-03-2010	Bergens Tidende	Amount of sea lice is seriously high in Osterfjord. Two of the six surveyed farms have an amount of sea lice that has surpassed the limit. The others have lice around the total allowable limit. Delousing will take place before the wild salmon smolts migrate out	<ul style="list-style-type: none"> • National government 	The high amount of sea lice makes the situation worse for the already endangered Vosso salmon.	environmental
01-07-2010	Bergens Tidende	At the end of May, many sportsmen came to the council meeting in Voss to express dissatisfaction with plans to abolish the protection of the river Raundalen.	<ul style="list-style-type: none"> •sportsmen 	It is not just the power plant that gives incomes to Voss. Income is also gained from the extreme sports event.	economic
16-02-2011	NRK Hordaland	The special Vosso salmon could weigh up to 30 kg. It is the biggest Atlantic salmon. It is being threatened by fish farming and sea lice	<ul style="list-style-type: none"> • National government • Norwegian Fishing and Hunting society 	Erik Solheim, minister of environment and international development: <i>we have seen the salmon and of course it has to be preserved for the coming generations.</i> Lisbeth Berg-Hansen: minister of Fisheries and coastal affairs: <i>the biggest problems are sea lice and fish farming and the pressure that the government is putting is right</i>	environmental, social
14-03-2011	Bergens Tidende	Fish farmers fear 220 people in the industry will lose their job, because of the regulations that would more than halve production in Hardanger	<ul style="list-style-type: none"> • National government •Hardanger Villfisklag • Fish farmers 	Hardanger villfisklag is positive about the regulations, because they will have a positive effect for the wild salmon. Fish farms should not complain, but try out new things such as closed plants	environmental, economic

18-03-2011	Bergens Tidende	Vosso salmon will soon disappear	<ul style="list-style-type: none"> • Fish farmers 	Fish farming and sea lice are to blame most for the disappearance of the large adult fish that came to Osterfjord every year. Also, the great traffic on the bridge can create a sound barrier down in the sea	environmental
22-03-2011		Lerøy Vest AS has recently established a fish farm at Sandvik Sørfjorden, next to Vaksdal, with 750.000 rainbow trout	<ul style="list-style-type: none"> • Fish farmer • Norwegian Fishing and Hunting society (NJFF) 	The Nord-Hordaland Fishing and Hunting and Fishing association and Vaksdal commune are very critical towards the fish farm. The current farming activities have an unacceptable and adverse impact. Wild salmon are more threatened than ever.	environmental
24-03-2011	Bergens Tidende	New regulations require a limit to fish production. But the Fisheries department does not think that farm production in Hardanger will be lowered due to the regulations. Farmers can continue their contemporary business	<ul style="list-style-type: none"> • National government • Fish farmers • Hardanger Villfisklag 	Before the meeting, the ministry warned that a cut in farm productions in Hardanger would result in hundreds of lost jobs and put three fish-processing plants in danger. Farmers were also upset because they believed that the regulation was in conflict with the political message that they did not have to reduce fish production. The members of Hardanger Villfisklag want a reduction of the fish production	economic, environmental

31-03-2011	Bergens Tidende, by chairman of the voss	The Voss council is exploring the possibilities for hydropower in the protected river Raundalen	<ul style="list-style-type: none"> • Local government • BKK 	Renewable energy is needed and there is a desire for local employment and wealth creation. There should be a clarification between the various laws and directives that deal with protected waterways	economic, environmental
05-04-2011	Bergens Tidende, by Cato Lyngøy from, Marine Harvest	Fish farmers on the west coast have never resigned from the rescue action described as ``rescue action for Hardangerfjord`` in the news paper.	<ul style="list-style-type: none"> • Fish farmers • National government 	The main reason to put measures for rescuing the wild salmon on hold is the Hardanger fjord regulation presented recently. There is great uncertainty about what the final outcome of the proposal will be. For now it will mean that the Hardanger Sunhordland loses 600 jobs, annual export revenues of around a billion and a dramatic amount of production	Economic
08-04-2011	Bergens Tidende	The national departments responsible for wild fish have recently put a lot of financial resources in the establishment of a national pilot project for the protection of wild salmon in the Hardangerfjord.	<ul style="list-style-type: none"> • National Government • Norwegian Fishing and Hunting society • Fish farmers 	A public responsibility is needed to find good solutions for the community. No privatization of the management of the environment, fishing, coastal and river systems should take place	environmental
12-04-2011	Bergens Tidende, by Per Olav Stafnes, Osterfjord Villfisklag	Proposal for self-regulation by the community. For each farmed fish that is caught, Kr. 500 -, should be charged. If salmon and sea trout are a fine should be imposed of at least Kr. 3 000 - + confiscation of the equipment, and of course the exclusion of the river for a while. This proposal will require a better control of water systems.	<ul style="list-style-type: none"> • Fishermen • Fish farmers • river owners • scientists 	Why should there be a regulatory framework for sport fishing, when even the control authority is struggling to understand the current regulations? It will maintain interest in the river for the next generation, and can motivate landowners to keep the river clean. And it will break down the monopoly of the scientists	economic, social, environmental
16-04-2011	Bergens Tidende	Before the summer the County will inspect the fish farms in Hordaland. This is part of a nationwide campaign organized by the Norwegian Pollution Control Agency.	<ul style="list-style-type: none"> • Fish farmers • Local government 	The purpose is to ensure through internal control that companies do not produce unacceptable pollution of the fjords.	environmental

18-04-2011	Bergens Tidende	Regulations will be introduced in the Hardangerfjord which put a limit on the amount of farmed fish in the Hardanger area. The regulation will restrict the production.	<ul style="list-style-type: none"> • Fish farmers • local government 	The regulations will lead to a dramatic decline in production. If the stricter regulations are implemented, the participation of the fish farmers in the rescue project will be put in danger	economic
07-05-2011	Bergens Tidende	Some fish farmers wanted to pull out from the project. But after a meeting of the steering group yesterday, both the boycott and the quarrel about the bill were a thing of the past as the fish farmers agreed to pay	<ul style="list-style-type: none"> • Fish farmers • River owners association 	Fish farmers refused to pay an expense of approximately 340,000 million, required by the river owners for efforts to fish out escaped farmed salmon in the river last year	economic
19-05-2011	Bergens Tidende	Fish farming in sensitive areas must be on land. If it is too expensive for fish farmers, they need to get support to build farm systems on land.	<ul style="list-style-type: none"> • Fish farmers 	Land-based farming is extremely important since pollution and farmed salmon escapes are too great.	environmental
30-05-2011	NRK Hordaland	Marine Harvest is planning to introduce a brand new way to engage in aquaculture, revealed in an aquaculture trade show in Trondheim in August, the newspaper Bergens Tidende.	<ul style="list-style-type: none"> • Fish farmers • Government • Norwegian Fishing and Hunting society (NJFF) 	NJFF has long argued for closed facilities. But such plants have been regarded as more expensive to build and operate. The major problems that sea lice, disease and escape have caused, in addition to stringent regulations from the government, has turned the mood.	economic, environmental