TOWARDS A SUSTAINABLE FISHERIES MANAGEMENT

HOW TO ADDRESS UNCERTAINTY IN ORDER TO ACHIEVE A SUSTAINABLE DEVELOPMENT OF REGIONAL FISHERIES MANAGEMENT

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Preface

This Master’s thesis is Malin Folkesson’s degree project in Environmental Science and Physical Planning, at the Department of Physical Geography and Quaternary Geology, Stockholm University. The Master’s thesis comprises 45 HECs (one and a half term of full-time studies).

Supervisors have been Peter Schlyter at the Department of Physical Geography and Quaternary Geology, Stockholm University and Beatrice Crona, Stockholm Resilience Centre, Stockholm University. Examiner has been Ingrid Stjernquist, at the Department of Physical Geography and Quaternary Geology, Stockholm University.

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Abstract

Fisheries management is not only about managing the resource fish, but also includes managing the social system. Aquatic ecosystems and the social system are both complex and change continuously. It is important to address what types of uncertainty the combination of both systems, complex socio-ecological systems leads to, their consequences and how these should be dealt with. Successful or unsuccessful management outcomes are difficult to address whether or not they are due to management efforts or natural changes. In addition, uncertainties often lead to a short-term management, since lack of knowledge makes it difficult to act in a long-term perspective. This thesis conceptualizes how to address different types of uncertainty prevalent in fisheries management, with focus on natural process uncertainty, measurement and estimation uncertainty, decision and implementation uncertainty, and institutional and regime uncertainty. This was done by analyzing how three theoretical approaches, namely co-management, adaptive management and adaptive co-management address these uncertainties. In order to highlight how different types of uncertainty have been dealt with in practice, a case study on the fishery management in Lake Vättern has been made.

A comparison between the literature study and this thesis’ case study shows that hypothesis-testing, cooperation, communication and transparency are corresponding factors on how to deal with uncertainties in fisheries management and that institutional and regime uncertainty is inadequately addressed in Sweden.

Keywords: co-management, adaptive, Sweden and Lake Vättern
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<tr>
<td>CAB</td>
<td>County Administrative Board (“Länsstyrelsen”)</td>
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<td>Common Fisheries Policy</td>
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<td>CMI</td>
<td>Co-Management Initiative (“Samförvaltningsinitiativet”)</td>
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<td>CPR</td>
<td>Common Pool Resource</td>
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<td>EEA</td>
<td>European Environment Agency</td>
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<td>Swedish Board of Fisheries (“Fiskeriverket”)</td>
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1. Introduction

In the early 1990s, the cod population outside the coast of Newfoundland, Canada collapsed (Charles, 2007, p. 90). A closer examination of this incident showed that the collapse had foregoing signals pointing towards a problematic decrease in cod, but measures for stabilizing the population were not taken on time (EEA, 2001). The main cause for inaction was that the information about the population’s development had high levels of uncertainty. In order for politicians to recognize the decline as a fact and to change the regulations accordingly they needed proof based on certainty. (Wilson, 2002, p. 351; Charles, 2007, pp. 90-96). Jeopardizing the locally important fishing industry was not an option, unless the decline was a certain fact. Noteworthy in this context is that the actors involved (e.g. environmentalists and the fishing industry) all aimed for the same goal – to have a sea rich in fish and to assure a stable future fish population. As of today, the cod population has still not recovered in Newfoundland. (Charles, 2007, p. 96; EEA, 2001). How is it possible to allow a fish population to collapse if all actors connected to fish or fishing activities share the same goal contrary to a collapse?

The collapse of cod in Canada – which could be seen as a worst case scenario – was a result of a combination of different types of uncertainty and this current study examines how to deal with these uncertainties in fisheries management. Aquatic ecosystems, like all ecosystems are dynamic and are continuously changing (Berkes, 2007). These changes are drivers of uncertainties in fisheries management. This is because this dynamic context leads to prediction difficulties, difficulties to build an understanding about the natural preconditions and complex interactions within the ecosystem. Moreover, uncertainty leaves room for interpretation and, in turn, this results in differing world views between actors because natural processes and trends are interpreted differently. For this reason, changing conditions create an uncertain management context (Wilson, 2002, p. 10). Uncertainties have often led to a short-term management structure as lack of information makes it difficult to act in a long-term perspective (Wilson, 2002, p. 335). Different types of uncertainty exist, such as uncertainty connected to the ecosystem, and uncertainty connected to the social system. These will be described in more detail in this thesis.

Sweden’s Environmental Objectives Council states in their report from 2009 that there is a risk of sudden and irreversible changes especially in Swedish marine and aquatic environments (Nilsson & Hellberg, 2009). The Council stresses that fisheries management in Sweden is unsustainable today and that it needs to be addressed together with biodiversity issues in order to be able to adapt to changing conditions (Nilsson & Hellberg, 2009). This general statement is not valid in all areas in Sweden, but as a mean to address issues like these, co-management arrangements with an adaptive approach have been applied to both marine and freshwater environments in Sweden. It was the
Swedish Board of Fisheries that implemented these co-management arrangements in Sweden and it was called the Co-Management Initiative (CMI). This Initiative has been applied to six areas in Sweden (see Fig. 1), whereof one is examined in this current study. The Swedish CMI has focused on developing a sustainable fisheries management by building a system that can incorporate changing conditions on a continuous basis (Píriz, 2005). Co-management is a decentralized institutional design where actors related to fish or fishing activities become involved in the management process (Armitage, Berkes, & Doubleday, 2007, p. 1). In natural resource management, management with an adaptive approach is sometimes assumed to best incorporate uncertainty (Berkes, 2007). This is because it explicitly embraces uncertainty as a way to build understanding by using system monitoring and evaluation of results to adjust actions and decisions. Since uncertainty in fisheries management can only be reduced by some degree, it is important to recognize and highlight its existence instead of treating uncertainty as noise. (Steneck & Wilson, 2010).

Limited literature exists on how uncertainty has been included in practice in Sweden. The goal of this thesis is to address this gap. This current study will examine a Swedish fishery co-management arrangement and how participating actors have dealt with different types of uncertainty. These findings will then be compared to the theoretical approaches on how to deal with uncertainties.

1.2. Aim of Study and Research Questions

As a first step in this study, different types of uncertainty are categorized and with this as a foundation it is assessed how different types of uncertainty in fisheries management are addressed in the scientific debate. This is done through a literature study. Secondly, a case study will demonstrate how these types of uncertainty have been included in the management process of a fishery co-management in Sweden – Lake Vättern. The Co-Management Initiative (henceforth CMI) Vättern is interesting to study because conflicts were prevalent before the implementation of the CMI in this area and there is a broad base of involved actors. Most importantly, the CMI Vättern still proceeds today whereas the management processes in other CMI areas were abandoned. In fact, the CMI Vättern resulted in an ambitious management plan. The theoretical approaches on how to address uncertainty are compared with the fishing area of Lake Vättern and how uncertainties have been addressed in practice.

The hypothesis posed by literature:

- If uncertainty is not included in the fisheries management process, then aquatic resources cannot be managed in a sustainable manner.

Therefore, the central questions of this thesis are:

- Are different types of uncertainty in a Swedish fishery co-management explicitly included in the management process, and to what extent does this project have a capacity to adaptively address uncertainties?
- Is co-management a suitable institutional design to deal with uncertainties?

Adaptive management is a theoretical approach that directly aims to deal with uncertainty and is the reason for why the capacity to adaptively address uncertainties is examined. Co-management is another theoretical approach on e.g. how to create legitimacy among involved actors and is seen to have a conflict resolving mechanism. A comparison between the theoretical approaches and practice on how uncertainties have been addressed is made by analyzing and comparing literature about uncertainties in
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fisheries management and the results of the case study. For this reason, the reader will be given a thorough theoretical background to this subject, which is later compared to the case study’s approach to address different types of uncertainty.

Fig. 2 Outline of thesis

Figure 2. This model shows the structure of this thesis. The literature study will outline how science addresses uncertainties and the case study will highlight how co-management participants have dealt with different types of uncertainty in practice in Sweden.

2. Method of Literature Study

The literature study has been executed in two steps, first by an identification of different types of uncertainty that exist in fisheries and secondly by examining how different approaches address these types of uncertainty in fisheries management. The first step resulted in a categorization of uncertainty based on commonalities in fisheries literature, which is shown in section 3.2.

The theoretical framework is a synthesized representation of main arguments and key features. The literature study in general consisted of an identification of key authors and references, to further on identify main general assumptions within different theoretical approaches. This process is called snowball sampling (Krippendorff, 2004, p. 118). Main databases used in this current study are Science Direct, Elsevier, and

In this thesis uncertainty is referred to as incomplete knowledge about a system and/or its parameters. The system here can be both the ecological system and the social system.

Box 1. Definition of uncertainty
Google Scholar and frequently used search words have been uncertainty, fisheries, co-management and adaptive. The literature study has been delimited to adaptive management, co-management and adaptive co-management arrangements and thus excludes other types of local and regional arrangements that can be applied to fisheries management, such as e.g. integrated coastal zone management (see e.g. Cicin-Sain, Knecht, Jang, & Fisk, 1998). Literature on uncertainty has been delimited to uncertainties prevailing in fisheries and excludes other types of literature topics about uncertainty, such as economic uncertainties in business. Technical aspects, such as examination of uncertainty inherent in different models have also been excluded. This thesis’ definition of uncertainty can be found in Box 1, while co-management, adaptive management and adaptive co-management are defined and described in section 3.3.

The goal of the literature study is the identification of key features required for a successful fisheries management and how to deal with uncertainties.

2.1. Criticism of Literature Sources

The literature study is an identification of key authors and references, which have been chosen by this thesis’ author. This means that there might be other references and authors that have not been detected and included in this thesis. Furthermore, the categorization of uncertainty prevalent in fisheries, which is outlined in section 3.2., is based on commonalities in the literature and there might be other types of uncertainty that are not included in this thesis.

3. The Theoretical Framework of Fisheries Management and How to Address Uncertainty

This chapter accentuates the complexity of aquatic environments and uncertainties prevailing in fisheries. It further demonstrates theoretical approaches applied in fisheries management and how these address different types of uncertainty.

3.1. Complex Socio-Ecological Systems: The context of fisheries management

As described in the introduction, fisheries management is about dealing with a dynamic environment, where both the social and the ecological system are continuously changing. This affects the predictability of these systems and as an attempt to gain control over such situations humans have since a long time used command and control as a problem-solving approach. This means that a problem is identified and a solution to control the problem can be implemented. This approach has been insufficient for addressing problems connected to complex socio-ecological systems, and in order to explain why, examples where the command and control approach has been successful, need to be given. For instance, problems connected to human parasites and pathogens are controlled by medicine and good hygiene, and problems associated to food variation are controlled by growing and storing agricultural products (Holling & Meffe, 1996). This command and control approach requires a direct relationship between cause and effect: problem x can be solved by solution y in any given situation. Aquatic ecosystems, on the other hand are non-linear, dynamic and complex systems. When the command and control approach is applied under these non-linear and complex circumstances it is often followed by a negative social, ecological and economic impact, because a similar level of predictability is assumed but seldom achieved (Holling & Meffe, 1996). Within the context of fisheries management, this means that a
management strategy for instance can have different outcomes when applied under seemingly similar circumstances. This is because relationships between different species and environmental conditions in aquatic ecosystems are vast and have unknown connections and feedbacks. Therefore, dynamics in aquatic ecosystems create a changing management environment where uncertainty is predominant (Berkes, 2007). Although scientific research constantly aims to reduce uncertainties and knowledge gaps, a level of scientific uncertainty will always remain (FAO, 2009). According to Wilson (2002) the command and control approach assumes that it is possible to control complex systems, which has lead to the misconception that science can obtain almost complete knowledge about the aquatic ecosystems to make well-working management decisions (Wilson, 2002, p. 327). This is not possible in complex socio-ecological systems.

Fisheries management is about managing a so called common-pool resource (henceforth CPR). Dietz et al (2002, p.18) define this as:

... a valued natural or human-made resource or facility that is available to more than one person and subject to degradation as a result of overuse. Common-pool resources are ones for which exclusion from the resource is costly and one person's use subtracts from what is available to others.

Two issues are connected to a CPR: the problem of overuse and the free-rider problem. Overuse is a consequence of subtractability, meaning that the negative outcomes of overfishing are paid by the collective, while the gain and profit of fishing is given to the individual. (Dietz et al, 2002, pp. 18-20). This phenomenon is also known as the Tragedy of the commons, which means that there are no incentives from an individual perspective to be moderate about the extraction because others will continue using the resource (Hardin, 1968). The free-rider problem originates from difficulties to exclude unauthorized users from these CPRs. (Dietz et al, 2002, pp. 18-20). In fisheries, illegal fishing is an example of this. Moreover, beside the Tragedy of the commons, another game situation, the Prisoner’s dilemma can be valid within fisheries management. The prisoner’s dilemma illustrates that two actors may chose not to cooperate even if this would maximize the gain for both. This is because of rational self-interest, which means that both prisoners will act in their best self-interest, instead of acting most beneficial in terms of the group. This situation is valid, given there is no communication between the actors. (Lesourne, Orléan, & Walliser, 2006). Put in the context of fisheries management, this situation can be applied to fisheries where resource users have a limited level of communication. In international fisheries for instance, resource users will distrust each other because of the lack of communication, even though fishermen from different countries all share same goals and objectives: to maintain the ability to fish in the future. However, it is also important to point out that this situation can also be valid in seemingly small defined waters where communication between resource users is limited. To not reveal the real catch size may for instance be a cultural behaviour (Forman, 1967).

It becomes important to point out that people do not always act in a rational manner, as these game theories imply and for this reason these game theories may under some circumstances be invalid.

Fish is a moving resource, and is therefore neither limited to regional administrative boarders, nor countries. The level at which management is put at becomes important for a successful fisheries management. This mobility also creates a situation where it is difficult to achieve a stable resource flow, seen from a fisherman’s perspective (Schlager, Blomquist, & Yan Tang, 1994). Consequently, when dynamics in aquatic
ecosystems interact with the two issues connected to CPR (overuse and free-rider problem), complex dynamics are created. As a result, uncertainty becomes predominant and may result in difficult and inaccurate predictions of the resources’ characteristics (Walters, Is Adaptive Management Helping to Solve Fisheries Problems?, 2007).

Schlager et al (1994) describe additional difficulties associated with a CPR that fishermen encounter due to the subtractability issue when harvesting a CPR with mobile flows:

In order to address appropriation externalities [subtractability], resource users must possess information on the size of the population, the population dynamics of the flow units, the number of units being harvested, and the effect of each resource user's harvest upon every other resource user's harvests; and from this information determine the optimal harvest level.
(Schlager, Blomquist, & Yan Tang, 1994, p. 297)

This type of information can be difficult to obtain due to the unpredictable and complex characteristics of aquatic resources. For instance, should fluctuations be seen as a natural phenomenon or as a consequence of external factors and is this development a short variation or a part of a long-term trend? For instance, information about harvest levels are affected by the extent of illegal fishing and unreported and unregistered catches which make this information incomplete. Moreover, in quota-based fisheries, “high-grading” is another factor affecting attempts to get information about the real harvest level (Tidwell & Allan, 2001). This is a phenomenon where fishermen discard small fish individuals and continue harvesting in order to replace them by larger individuals with the intention to increase the economic catch value. Additionally, bycatch is another negative consequence of the quota system, which is yet another factor affecting the ability to estimate the real harvest level. Bycatch is the catch of non-targeted species in a quota based fishery (Tidwell & Allan, 2001), i.e. within the same catch individuals of non-target species are caught. These individuals are discarded with a high mortality rate as a consequence. Selective gear is an ongoing research field for addressing this issue. However, selective fishing can be difficult to achieve in some fisheries because different species live in the same area, which makes fishing even with selective gear difficult (e.g. juvenile fish of a non-target species may be caught even when fishing aims to catch only full-grown individuals of a targeted species).
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Fisheries management

Natural dynamics (examples)
- Environmental conditions
- Population dynamics

Social dynamics (examples)
- Market demands
- Political changes

Level of (examples):
- Cooperation
- Competition
- Communication
- Trust
- Group size
- Free-rider problem

Figure 3 shows a conceptual model of the complexity in fisheries management. The left circle represents natural dynamics and changes in aquatic ecosystems and the right circle highlights social dynamics, where both affect the ability to predictability of the resource. The third circle represents factors that influence the level of management success in a CPR and the combination of the three circles represents fisheries management.

As mentioned above, natural systems change non-linearly, thus creating difficult management contexts. In addition to ecological changes, the social system can also change and react in uncertain ways due to e.g. market demands and political systems (see Fig.3). Moreover, differences in social motives (maximization of gains, competition and cooperation), the social structure (e.g. group size, power, status, and the ability to communicate) and the pay-off structure (e.g. risks associated with different choices and what types of pay-offs that are associated with cooperation) affect the management (Kopelman, Weber, & Messick, 2002, pp. 117-122). Environmental uncertainty makes these social differences difficult to solve and may reduce cooperation (Kopelman, Weber, & Messick, 2002, pp. 126-127). To give an example, when there is uncertainty about the pool size, fishermen tend to overestimate the pool size and request more fish for themselves. They will also assume that other fishermen will act in similar ways. For this reason, environmental uncertainty, especially regarding the size of the resource pool tends to lead to overharvesting. (Kopelman, Weber, & Messick, 2002, p. 126).
3.2. Different Types of Uncertainty in Fisheries Management

Uncertainty can be defined differently depending on its context. The Technical Consultation on the Precautionary Approach to Capture Fisheries (1995) defines uncertainty from an ecological perspective as “the incompleteness of knowledge about the state or process of nature” (Caddy & Mahon, 1995, p. 36), while Milliken (1987) defines uncertainty from an individual perspective as “an individual’s perceived inability to predict something accurately” (Milliken, 1987, p. 136). The term uncertainty can also be divided differently. For instance, the European Environment Agency (EEA) focuses in their environmental issue report on early warnings, risk reduction and the precautionary approach based on case studies from around the world (EEA, 2001). In the EEA report it is stressed that the term 'uncertainty' needs to be wider and distinguish between a) risk: when possible outcomes can be assessed by using probabilities; b) uncertainty: when probabilities cannot be assigned to different outcomes due to an inadequate theoretical or empirical foundation; and c) ignorance: when other types of possibilities or outcomes are completely unaddressed. (EEA, 2001).

In uncertainty literature, many categorizations of this term regarding fisheries management exist, as well as the usage of different terminology. When assessing uncertainty literature, four categorizations emerge that different authors have in common; natural process uncertainty, measurement and estimation uncertainty, implementation and decision uncertainty and institutional and regime uncertainty. Following categorizations are a synthesized result of the literature study and are the basis on which scientific approaches and the case study are assessed.

Natural process uncertainty
This category refers to uncertainty connected to the dynamics in natural systems. Insufficient and inadequate information about the relationships within an ecosystem create this type of uncertainty. (Henriksen, 2007, pp. 154-155). Examples of such are multi-species interactions, predator-prey effects (by both fish species as well as by other species), migration patterns, stock concentrations, spatial heterogeneity and how environmental conditions (e.g. climate) affect different fish species (Henriksen, 2007, pp. 154-155; Charles, 1998). Process uncertainty also refers to ignorance about any of these relationships in fisheries management (Henriksen, 2007, pp. 154-155). Randomness can also be included in this category and refers to uncertainty connected to stochastic dynamics (Charles, 1998).

Measurement and estimation uncertainty
Measurement uncertainty arises due to inadequate measurement of catches, insufficient and/or lacking scientific data as well as inadequate attempts to measure effort (e.g. the length of nets in use in relation to the catch) (Henriksen, 2007, pp. 154-155) (Francis & Shotton, 1997). Estimation uncertainty covers non-measurable variables such as recruitment, survival rate and total stock size, which have to be estimated based on assumptions (Henriksen, 2007, pp. 154-155; Charles, 1998; Francis & Shotton, 1997). These variables are often used in models about e.g. stock assessment and are simplifications of the reality. Whether or not a model reflects the real dynamics in the ecosystems, stocks, species relationships etc., is a part of this type of uncertainty (Henriksen, 2007, pp. 154-155; Francis & Shotton, 1997).

Implementation and decision uncertainty
Implementation uncertainty refers to the implementation of different management measures and their effects, how effective they will be, the compliance with fishermen
and how fishermen will respond to regulations (Henriksen, 2007, pp. 154-155; Charles, 1998; Francis & Shotton, 1997). Decision uncertainty refers to the extent to which decisions are based on scientific information (Henriksen, 2007, pp. 154-155). It is also connected to social motives of both the management itself such as domination of certain societal goals, and of the fishermen’s goals and motives in the decision-making process (Kopelman, Weber, & Messick, 2002, pp. 117-120; Charles, 1998).

Institutional and regime uncertainty
This type of uncertainty refers to the level of communication between participants, people’s willingness to compromise, how decisions are made (Francis & Shotton, 1997), compliance regarding the decision-making process and how fishermen adapt to new institutional arrangements (Charles, 1998). This type of uncertainty is also connected to the institutional ability to address social differences and issues connected to a CPR and different game situations (e.g., the prisoner’s dilemma) (Kopelman, Weber, & Messick, 2002, pp. 117-122). In addition, the extents to which the institutions are perceived as legitimate and fair (Jentoft, 2003, p. 8). Moreover, the ability to integrate information, both scientific and experience based.

In order to achieve well working fisheries management and to create a sustainable development, it is important to address the uncertainties mentioned above and issues associated with complex socio-ecological systems. Main goals of fisheries management are to reduce conflicts, to learn from management mistakes, to have a sustainable harvest level of fish and to ensure the ability to fish in the future. For this purpose, different approaches have been applied on fisheries management: co-management, adaptive management and the combination of the two, adaptive co-management. How do these approaches address these uncertainties and issues?

3.3. The Scientific Development on How to Create Sustainability in Fisheries Management

3.3.1. Co-Management: An institutional design challenging top-down management
As mentioned above, the command and control approach have been applied to fisheries resulting in negative outcomes. This problem-solving approach has also lead to an inappropriate institutional design for dealing with this resource. In mid 20th century it was accepted biological knowledge that fish populations are open populations, which drove managers to seek an institutional design that appropriately could address these open, nonlocal populations (Steneck & Wilson, 2010). This mobility of fish leads to the fact that conservation efforts in one area can become insufficient and irrational when species migrate from one area to another where it is affected by other regulations and where there is a risk that the fish is caught by someone else. (Acheson, Wilson, & Steneck, 1998, p. 391). For this reason, national governmental agencies were perceived as the best and most rational form of authority to manage transboundary resources and to establish relationships between other states concerning the resource (Wilson, 2002, p. 345; Acheson, Wilson, & Steneck, 1998, p. 392). According to Tropp (1997), the states have failed in this matter and the management of transboundary resources has resulted in crisis governance. This is because fisheries management at a national level was not able to respond to the dynamics within the socio-ecological systems and as a result, the legitimacy of the state has decreased, since it has not fulfilled the expectations (Tropp, 1997, p. 70).
To address the problems connected to a CPR (overuse and free-rider problem) and in order to be able to manage fisheries sustainably, the theoretical discourse in fisheries management is now emphasizing the importance of decentralization. Local and regional arrangements, where local participants have an important decision-making role tend to make decisions that are of a more adaptive and flexible character, and more appropriate to local situations than central agencies can accomplish with their decisions that are of a more generic character (Pinkerton, 1999). Therefore, since a centralized, top-down resource management is inadequate when it comes to respond to dynamic and changing circumstances, a decentralized management has developed as a response to this (Armitage, Berkes, & Doubleday, 2007, p. 1). Different local arrangements have been applied to fisheries management, for instance community-based management, integrated coastal zone management (ICZM) and collaborative management. Collaborative management or co-management, stresses the importance of decentralization in fisheries management which enables resource users to become involved in the decision-making process. Berkes et al (1991) define co-management as “the sharing of power and responsibility between the government and local resource users” (Berkes, George, & Preston, 1991, p. 12).

A controversial issue in fisheries management is connected to scientific uncertainty, which often makes fishermen question the reliability of this information (Jentoft, 2000). For this reason, science and local knowledge play an important part in co-management. (Jentoft, 2000). In co-management arrangements local knowledge and experience are just as important as expert knowledge. Co-management aims to combine three disciplines in fisheries management: ecology, economy and social sciences. (Armitage, Berkes, & Doubleday, 2007, p. 4). Moreover, Jentoft (2000) stress that in order for management institutions to be regarded as legitimate by involved parties they must provide a foundation where regulations, processes and means can be communicated and deliberated (Jentoft, 2000) and that the system must be perceived as reasonable, rational and just by involved users in order to be regarded as legitimate (Kooiman et al, 2005, p. 280). Legitimacy is a core factor in co-management and several authors stress that in fisheries management, co-management is therefore perceived as the most suitable management form for creating legitimate agreements (Kooiman et al, 2005, p. 281; Jentoft, McCay, & Wilson, 1998). Additionally, the representation of different stakeholders in co-management arrangements should be perceived as fair by participants and the involvement of these should be perceived as democratic in the decision-making process. (Jentoft, 2003, p. 8).

### 3.3.2. Limitations of Co-Management

Co-management has received some criticisms, e.g. for its rigidity, path dependency and lack of accountability. These criticisms lead to a changing view, from that co-management were seen as a management model that could be applied on specific areas to that co-management is a process with emphasis on adaptation.

Pascual-Fernández et al (2005) argue that co-management arrangements have often been initiated as cooperation between the government and institutions of science. These arrangements are often based on information provided by the science institutions which set the foundation in the decision-making process. This knowledge is often created at a national level and communicated to local levels. Even though these arrangements are of local character, this proceeding leads to a reinforcement of an institutional design that is hierarchal with top-down control. Consequently, this leads to an insufficient incorporation of local knowledge. (Pascual-Fernández et al, 2005, p. 226).

A comment on Pascual-Fernández’s et al (2005) conclusion is that even though research is provided by institutions of science (national level), this does not
automatically exclude an incorporation of local knowledge. Since one of the main features of co-management is deliberation, an incorporation of local knowledge can still be achieved. Furthermore, sometimes, especially in fisheries, there are tensions and conflicts between different local actors. If co-management arrangements would be initiated by local actors, this might, depending on who the initiator(s) is and despite a bottom-up approach, may be perceived as biased or imposed.

In order to make it possible to involve all parties with a connection to the fish resource, co-management often leads to a complex institutional design. A side effect of this is that such a complex institutional design can sometimes become too complex for being understood by resource users and thus affect the legitimacy and feasibility of the co-management arrangement (Jentoft & Mikalsen, 2004). By aiming for a fair management system (creating legitimacy), the tendency goes towards more regulations which lead to a more complex system. In turn, this also affects the flexibility of the system and reduces the ability to adopt to change (Jentoft & Mikalsen, 2004). Jentoft and Mikalsen (2004) showed that once a strategy system has been set, for instance the quota system, it may become very difficult to change to other strategies. This is because of large investments in e.g. fishing gear and fishing vessels, and because agreements are based on the current system and the cooperation might be at risk when implementing a new strategy. Instead of leaving an insufficient strategy, more fine-tuned regulations and rules will be created and applied in order to address the limitations of the chosen strategy. Therefore, once a strategy has been applied, future challenges tend to be regulated in the same way. (Jentoft & Mikalsen, 2004).

However, this tendency towards more fine-tuned regulations described by Jentoft and Mikalsen (2004) was not studied in a co-management setting. For this reason, it becomes important to point out that in a co-management arrangement, issues connected to compliance and legal framework understanding can be discussed and highlighted before rules are implemented and may counteract this tendency.

The core feature of co-management is the sharing of power and responsibility between resource users and the government. However, Jentoft and Mikalsen (2004) stress that another limitation of co-management arrangements is that fishermen do not have to take responsibility for the outcome of the fisheries management. They do have power in the decision-making process and ability to create and alter rules and regulations, but the responsibility is sometimes put on the government or governmental agencies alone. In these cases, the involved fishermen have no incentives to take the effects of the management system as a whole into consideration (Jentoft & Mikalsen, 2004). According to Jentoft and Mikalsen (2004), the separation of responsibility and power is the core limitation of co-management.

3.3.3. Dealing with Complex Socio-Ecological Systems: Recognizing adaptive management

Adaptive management was developed parallel to and independently from co-management. While advocates of co-management focused on the institutional design, advocates of adaptive management sought to develop a strategy on how to manage complex socio-ecological systems in the notion of uncertainty (Armitage, Marschke, & Plummer, 2008). Adaptive management was developed as managers kept finding large knowledge gaps in the ecological processes – information that was needed to produce more reliable models. These knowledge gaps where often large-scale processes, both temporal and spatial, which were too costly for science to address (would require research covering large areas and during long time spans). As a result, politicians’ need to make policy comparisons drove scientists to seek a different approach: planned
experimental management. The only way to detect the effects of different management strategies is to compare them and their feedbacks directly in the field. (Walters, Is Adaptive Management Helping to Solve Fisheries Problems?, 2007). Adaptive management aims to deal with uncertainty, because the experimental approach leads to feedback loops of information (McLain & Lee, 1996). Through this approach, action can be taken regardless of uncertainty by incorporating scientific knowledge and by testing assumptions in order to learn and adapt through experiences (Salafsky, Margoluis, & Redford, 2001). Charles (1998) defines the meaning of adaptive management as “to continue learning about the fishery system over time, through suitable monitoring, and to adopt in a timely manner to unexpected circumstances, so that conservation goals are not compromised.” (Charles, 1998, p. 42). Adaptive management focuses on how to manage such complex systems as aquatic ecosystems by having a learning-by-doing approach that highlights feedback mechanisms, networks and relationships (Armitage, Berkes, & Doubleday, 2007, pp. 4-7). This learning process based on feedbacks can be distinguished between single-loop and double-loop learning (see Figure 3). Single-loop learning is when the management encounters a number of problems and in order to solve them alternative strategies and actions are identified and implemented, but the mental model remains the same (Armitage, Marschke, & Plummer, 2008). In double-loop learning, instead of changing and altering actions, the bottom line foundations, norms and values are challenged by promoting change (Armitage, Berkes, & Doubleday, 2007, p. 9). This learning loop has no static mental model; instead it leads to a learning process recognizing dynamics and change.

![Figure 4. Shows two types of learning processes: single-loop and double-loop learning. This model is a modification of Armitage, Marschke and Plummer's (2008) model.](image)

This learning approach means that managers establish qualified hypotheses which are implemented and tested in practice. Learning is a back-loop which means that these acts or strategies create feedbacks of information, which in turn result in learning and even more qualified hypotheses (Armitage, Marschke, & Plummer, 2008). Feedbacks are in this context referred to data provided by monitoring and research and resource users’ observations and experience in the field, i.e. both science and experience based knowledge. These feedbacks are the foundation of learning. (Steneck & Wilson, 2010).

### 3.3.4. Limitations of Adaptive Management

Adaptive management has also received criticisms, such as the validity of the learning-by-doing approach, failure to embrace uncertainty connected to the social system, funding issues, lack of strong leadership, and that the experimental approach does not include the social system. The learning-by-doing approach has received some criticism because uncertainty combined with non-linear environments does not necessarily make experience and past events valid in the future (Nadasdy, 2007, p. 210). To get around
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this problem, promoters for adaptive management emphasize the importance of resilience. The management of natural resources needs to take resilience into consideration in order to assure the function of natural systems, which means that instead of managing stability and basing management attempts on an equilibrium state management focuses on managing for resilience (Nadasdy, 2007, p. 209). Berkes (2007) describes this as (Berkes, 2007, p. 288):

*Learning to live with uncertainty requires building a memory of past events, abandoning the notion of stability, expecting the unexpected, and increasing the capability to learn from crisis.*

Moreover, another critique related to learning and feedbacks is that a fisherman is often licensed to harvest specific species. Experience based feedbacks by fishermen regarding cross-species or small scale developments will not be provided to managers since this type of info is irrelevant to licensed fishermen (Steneck & Wilson, 2010).

Walters (2007) has studied cases during three decades where adaptive management has been applied. Unfortunately, the majority of these cases have been failures. He concludes that these are three main reasons for this: (a) decision-makers’ unwillingness to embrace uncertainty. Here, Walters et al (2008) give an example from fisheries in Gulf of Mexico where bycatch was a main problem. A policy choice to reduce the bycatch was implemented, but soon indications arose that this policy was beneficial to another species which seemed to counteract the survival of the targeted species (the one the policy was implemented to help in the first place). However, inadequate data existed of this non-commercial species. Decision-makers then called for new data. Since this was uncertain information decision-makers tend to trust simpler intuitive predictions and solve more difficult management decisions by calling for more research (Walters et al, 2008); (b) difficulties to fund the increased monitoring needed to be able to compare different management strategies successfully, and; (c) lack of strong leadership willing to do all hard work that is required for an adaptive management approach. (Walters, 2007).

Adaptive management promotes change and a criticism related to this is that a changing environment requires changes in regulations on a continuous basis. Jentoft and Mikalsen (2004) emphasize the need of a foundation where interest conflicts over e.g. gear types and restrictions can be discussed and deliberated (Jentoft & Mikalsen, 2004), which adaptive management does not address.

### 3.3.5. Adaptive Co-Management: Addressing limitations of co-management and adaptive management

The two narratives, co-management and adaptive management are now combined in a new constellation called *adaptive co-management*. Here, the ability to learn and the linkage of different management levels, where responsibility is shared are combined (Armitage, Berkes, & Doubleday, 2007, p. 5). Folke et al (2005) define adaptive co-management as (Folke et al, 2005, p. 448):

*...flexible community-based systems of resource management tailored to specific places and situations, and they are supported by and work with various organizations at different levels. The flexible structure allows for learning and ways to respond to and shape change.*

A key concept in adaptive co-management is the importance of knowledge and learning (Armitage, Berkes, & Doubleday, 2007, p. 9). It is of importance to create a common foundation of knowledge through collaboration involving multiple stakeholders, creating systematic learning. This learning process aims to modify management strategies on a continuous basis. (Armitage, Berkes, & Doubleday, 2007, p. 9).
By combining co-management and adaptive management a resource management that promotes collaboration between organizations at different scales and is flexible and tailored to specific situations and places emerges (Armitage, et al., 2009). Double-loop learning is essential in adaptive co-management (Armitage, Berkes, & Doubleday, 2007, p. 9).

In adaptive co-management, focus should be drawn to long-term dynamics instead of setting total allowable catch levels and determining the amounts of fishing vessels and boats. Long-termed patterns can for instance be age structure in a population and migration patterns. These long-termed, relatively stable patterns can be detected through experience. According to Wilson (2002), an ecosystem’s detectable long-term and stable patterns have to be recognized in order to keep the functionality of ecosystems. (Wilson, 2002, p. 240).

Moreover, an adaptive co-management arrangement is rarely an all-or-nothing concept; instead, the extent of responsibility and power sharing between resource users and governmental agencies varies. For instance resource users may be involved in decisions concerning operational matters (management plans), but less involved in policy decisions, such as use rights. (Charles, 2007, p. 84)

3.3.6. Limitations of Adaptive Co-Management

Also adaptive co-management has received criticisms, e.g. institutional limitations, lack of transparency, unequal influences by resource user groups and unwillingness to highlight uncertainty. Yaffee (1997) has presented three key limitations of governmental agencies (Yaffee, 1997), which, according to Pinkerton (2007) all contradict adaptive co-management arrangements:

1) Governmental agencies have a short-termed operational process, where short-termed rationality is preferred before long-termed rationality (Yaffee, 1997). This short-termed operational process leads to missed opportunities to learn and properly deal with problems, because agency leaders tend to solve disagreements and disputes within the range of already existing organizational procedures. In addition, past behavior tends to be rationalized and as a result, innovation, effectiveness and adaptation decrease over time. (Pinkerton, 2007, p. 158) Moreover, this short-termed structure creates a situation where immediate results are preferred, often at expense of long-term results. In addition, resource managers’ do not have to take responsibility over poor decisions, since the outcomes are not immediately apparent. (Pinkerton, 2007, p. 159; Yaffee, 1997);

2) Governmental control over power is resulting in a biased favoring of their information and counteracts cooperation (Yaffee, 1997). Government agencies tend deal with power-sharing as a zero-sum game, where the power that is shared will result in exactly this much less to enjoy. This leads to a competitive situation about power resulting in less cooperation. Within a co-management arrangement this would mean that different scales of local and traditional knowledge would be incorporated inadequately because these types of knowledge would be perceived by conventional agencies to compete with their knowledge and power which often has a more large-scale character. In order to address insufficient control, the tendency goes towards more regulatory stringency. Hence, there is no creation of a feedback-loop to create an adaptive approach to the governmental agencies’ governmental policies. (Pinkerton, 2007, p. 159; Yaffee, 1997);

3) Fragmentation of interests (Yaffee, 1997). Governmental agencies tend to fail when it comes to create common visions between different interest groups. The better interest
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groups are at lobbying the more influence they tend to have. An agency’s response to this may be to institutionalize formal consultative mechanisms to the most powerful interest group. A result of this can be that interests of the most powerful interest group have larger policy influence and consequently have an unproportionate representation in comparison to the general public’s benefit of these activities. In situations where several conflicting interests exist, conflicts may arise between different stakeholders as well as between positions within the agency. As a result, communication or cooperation between actors within same geographical territory is less likely to occur – the level required for being able to deal with fragmented interests and to create common visions. These conflicts will instead be transferred higher in the governmental levels in order to get addressed. (Pinkerton, 1999, pp. 159-160; Yaffee, 1997).

Pinkerton (1999) highlights these institutional issues and connects them to uncertainty. The author states that there is an unwillingness of governmental agencies to give free access to data. If they would share data, the governmental agencies would provide access to and information about the degree of uncertainty in their results, estimations and harvest levels. In other words, data sharing could cause political risks (Pinkerton, 1999). To overcome this, Pinkerton (1999) emphasizes the need for partnerships and shared databases in order to be able to highlight the uncertainties and to add transparency to the system. Here, everyone can contribute with information or different types of support (e.g., financial and logistical) and consequently everyone would share the risk and collectively decide the acceptable degree of uncertainty (Pinkerton, 1999). This also gives room for critiques which can have an alarming effect if the fish stock is believed to be in danger or close to a collapse. Moreover, an involvement of a third party, e.g. a university can overcome barriers between parties with distrust. (Pinkerton, 1999).

Major client groups within the fishing industry that are commercially valuable, e.g. large vessels, large investment groups and groups with a long history, tend to have the highest influence on fish harvesting policies. Besides these commercial important groups, the sport fishing industry holds another dominant position. These large client groups counteract co-management and adaptive management. (Pinkerton, 1999). When the influence of different industry groups is uneven, creating a situation where rules and regulations tend to favor certain groups, the system will be perceived as imposed by higher governmental agencies by the others. Hence, the representativeness and legitimacy of such a system decreases (Jentoft & Mikalsen, 2004). To prevent this, Pinkerton (1999) suggests the establishment of issue networks in order to create a forum of innovation (Pinkerton, 1999).

Adaptive co-management promotes change on a continuous basis, but changes might not be promoted by those who have made large investments. Powerful investment companies and industries do not have the luxury to manage a natural resource at the expense of short-term stability. The production industries need to take demand into consideration and need to have short-term stability in order to make future investments (Nadasdy, 2007, p. 217).

3.4. The Theoretical Approaches’ way of Addressing Uncertainties

Different characteristics of co-management, adaptive management and adaptive co-management address different types of uncertainty. This section accentuates how uncertainties are addressed by the theoretical approaches mentioned above and follows
the categorization of uncertainty in fisheries management as outlined in section 3.2. Table 1 is a summary of how these approaches address different types of uncertainty.

<table>
<thead>
<tr>
<th>Uncertainty Type</th>
<th>Co-management</th>
<th>Adaptive management</th>
<th>Adaptive co-management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural process uncertainty</td>
<td>Focuses on conflict resolution (social system), rather as a result of process uncertainty (ecological system) than addressing natural process uncertainty directly</td>
<td>Addresses natural process uncertainty directly by having a learning-by-doing approach and by recognizing feedbacks</td>
<td>A flexible management structure to deal with socio-ecological change with emphasis on double-loop learning</td>
</tr>
<tr>
<td>Measurement and estimation uncertainty</td>
<td>Involvement of different actors in the decision-making process in order to highlight differing points of view</td>
<td>Incorporates new scientific knowledge on a continuous basis</td>
<td>Incorporates new knowledge, both experience based and scientific</td>
</tr>
<tr>
<td>Decision and implementation uncertainty</td>
<td>Addresses this type of uncertainty directly by characteristics such as participation and transparency</td>
<td>Do not address the social system, but actively aims to implement new strategies and measures as a mean to address natural change</td>
<td>A flexible management structure to deal with socio-ecological change, with emphasis on participation, legitimacy and management portfolio</td>
</tr>
<tr>
<td>Institutional and regime uncertainty</td>
<td>Addresses this type of uncertainty with emphasis on legitimacy and transparency</td>
<td>Focus is put on natural changes and to create institutions that can deal with these. Do not address the social system</td>
<td>A flexible management structure to deal with socio-ecological change, with emphasis on networks at different institutional levels</td>
</tr>
</tbody>
</table>

Table 1. A summary of how theoretical approaches address uncertainties

3.4.1. Natural process uncertainty

Natural process uncertainty can be decreased to some degree by scientific research. However, aquatic ecosystems can never be fully understood. Therefore, adaptive management addresses this type of uncertainty by having an experimental learning-by-doing approach with emphasis on feedbacks in order to address ecological knowledge gaps. Jentoft and Mikalsen (2004) suggest that managers should challenge existing assumptions and aim for a reform. Without doing this, the learning process tends to be short and create an ineffective management system (Jentoft & Mikalsen, 2004). This is the notion of double-loop learning, which is the essential part of adaptive management and adaptive co-management.

Natural process uncertainty can result in different interpretations and opinions among different actors, which can lead to disagreements. The process of co-management deals with the social system and tends to include conflict resolution abilities, while adaptive management addresses uncertainty connected to the ecological system. However, since
aquatic ecosystems are dynamic and changing continuously these changing conditions affect cooperation and agreements. For instance, Brandt and Kronbak (2010) have studied the stability of joint agreements when they encounter changing conditions, mainly driven by climate change. They stress that climate change can alter well-working management attempts to become ineffective by creating increased scientific uncertainty, i.e. change the settings on which collaborative agreements are based on (Brandt & Kronbak, 2010). Their results show that it is mainly changes in biomass that change the foundation on which stable joint agreements rely, because it reduces the set of possible joint agreements and consequently collaborative outcomes becomes less likely (Brandt & Kronbak, 2010). To overcome these issues Brandt and Kronbak (2010) emphasize the need for improved information and a management structure that incorporates changing environmental conditions (Brandt & Kronbak, 2010). This is the notion of adaptive co-management. Adaptive co-management aims to combine different sectors with connections to fish or fishing activities while basing decisions on science, experience and uncertainties.

Another characteristic of adaptive co-management also addresses this category of uncertainty because local and regional arrangements tend to lead to decisions that are more adaptive and flexible and is also more appropriate to local conditions (Pinkerton, 1999). They are also better suited to deal with uncertainty and are more flexible than central bureaucracies when it comes to respond to socio-ecological change (Armitage, et al., 2009).

3.4.2. Measurement and estimation uncertainty
Measurement uncertainty can be addressed quantitatively (analytical approach), just as randomness (Flaaten et al, 1998). Estimation uncertainty (which is based on measurement uncertainty) needs to be addressed by a continuous incorporation of new information (Flaaten et al, 1998). An institutional design that favors collaboration can help addressing measurement and estimation uncertainty concerning catch reporting, because methods and estimations can be discussed. Inadequate knowledge and inadequate catch reporting can be addressed by a combination of an adaptive and a collaborative approach. If managers keep finding knowledge gaps an experimental learning-by-doing approach is needed, since waiting for information should not be a reason for inaction. Co-management enables the involvement of resource users and thus the incorporation of their knowledge. This knowledge is often of a practical character and based on experience. Resource users are good field observers which can detect changes in an early state. The combination of expert knowledge and observations is a suitable way to deal with estimation uncertainty, which is addressed by co-management.

3.4.3. Implementation and decision uncertainty
Charles (2007) emphasizes that in order to deal with uncertainty that is connected to complex environmental systems a management approach should not rely on a single management strategy. Instead, advocators of adaptive co-management stress that each strategy, for instance the quota system or area preservation, has its positive and negative consequences. Each system is connected to different types and levels of uncertainty. Charles (2007) stresses that in order to decrease the uncertainty connected to each strategy different management approaches should be combined – strategies whose advantages counteract other strategies’ disadvantages (Charles, 2007, pp. 84-85). In the approach of adaptive co-management a management portfolio is important to deal with uncertainty.

Moreover, changes in natural ecosystems are causing prediction difficulties and, as a result create uncertainties regarding what effects different management measures will
have (Flaaten, Salvanes, Schweder, & Ulltang, 1998). According to Flaaten et al (1998) many management issues are not due to lack of knowledge, but rather due to conflicting objectives and interests. To address this category of uncertainty more emphasis should be put on creating functional management strategies (Flaaten et al, 1998).

In order to be able to create functional management strategies and a management portfolio, experiences show that an implementation of different strategies and other types of decisions tend to be more successful in a co-management arrangement. This is because decisions must be able to be deliberated and communicated in order to have a process that is perceived as legitimate (Jentoft, 2000). Participation and communication equip involved parties better in order to deal with change and uncertain outcomes, which gives them a sense of control (Locke & Schweiger, 1979). In governance, both social and ecological uncertainty is inherent to the system and can best be addressed by a adaptive co-management process, by incorporating different types of knowledge and sources of knowledge in order to have an optimal problem-solving approach (Armitage, et al., 2009).

### 3.4.4. Institutional and regime uncertainty

A controversial issue in fisheries management is connected to scientific uncertainty, which often makes fishermen question the reliability of this information (Jentoft, 2000). According to Jentoft (2005) one way to address this type of uncertainty and controversies is to establish institutions. Social actors tend to trust institutions more than individuals. Institutions can therefore have a validating effect on knowledge in certain situations. For instance, institutions of science can reduce some of the political pressure on agencies. When controversial management measures are implemented, the validated knowledge by research institutions can help creating a more stable and believable situation. (Jentoft, 2005, p. 149). However, institutions can also be perceived as having limited legitimacy, which means that institutions of science sometimes can be perceived as a biased actor. Institutional and regime uncertainty is mainly addressed by co-management, because in order for management institutions to be regarded as legitimate by involved actors they must provide a foundation where regulation, processes and means can be communicated (Jentoft, 2000). Moreover, in order to be able to deal with the above mentioned types of uncertainty the institutional design needs to enable such solutions. For instance, the degree to which science and experience based knowledge can be incorporated.

### 4. Case Study Methods

This chapter outlines the process by which the central research questions were addressed. It describes the chosen research method followed by a discussion of source criticisms.

#### 4.1. Data Collection and Analysis

Lake Vättern has been chosen because it was a part of the Swedish CMI, because actors involved in this co-management process created meeting minutes and because this process resulted in a management plan. Meeting minutes from the management process from between 2004 to 2010 have been analyzed. The analysis of consecutive minutes allowed the assessment of the management process of the CMI. Furthermore, the meeting minutes were compared with the final management plan in order to trace trade-offs during the development process. Management plans are interesting subjects to assess because they represent the final guidelines elaborated during the management
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process. These guidelines are supposed to be followed by all actors involved and can be seen as the final compromise between participants.

This thesis has a qualitative approach, and aims towards an understanding of co-management as a process and of how respondents have dealt with different types of uncertainty. The method of grounded theory has been used when analyzing the gathering material (Bryman, 2001). First, the meeting minutes were examined and all topics and questions where involved actors expressed disagreements and uncertainty were collected. These uncertainties were then coded and categorized. In addition to this, interviews with involved parties in the CMI Vättern have been conducted. The interviews were based on these codes, together with key features from the literature study (see Appendix for commonly discussed interview topics). These codes were later compared with the categorizations of uncertainty in fisheries management synthesized in this thesis’ literature study (section 3.2). The main goal of the interviews was that respondents could explain the management process from their perspective. The interviews have been semi-structured with main themes such as the implementation of CMI, consequences of different types of uncertainty and pros and cons of the management structure. Interviews were conducted by telephone, and lasted between 30 minutes – 2h, between Mars until December, 2010. The interviews were recorded and later transcribed in order to avoid interpretations made by the interviewer. Materials from another scientific (ongoing) study have been used, such as unedited meetings minutes and recorded interviews. These interviews were also transcribed. In addition, documents, such as the SBF’s assessment report of the Swedish CMI have been used.

Respondents in this case study have been people involved in the co-management process, where two CAB representatives, three SBF representatives, three CAB representatives, two resource user group representatives, one municipality representative and one scientist have been interviewed. Used sampling method has been to contact those who frequently have attended CMI meetings, which means that people that are not actively involved in this process or indirectly involved have been excluded. See section below for comments on how this may have affected the results.

4.2. Criticism of the Sources
Involved actors in CMI Vättern are representing their organization. Not all commercial fishermen in Lake Vättern are members of an organization, which means that opinions from these fishermen have not been included in this thesis. There is probably a reason (maybe disagreements) for their exclusion of this organization. These opinions probably differ from the respondents in this thesis’ case study.

The examination of meeting minutes can have been interpreted wrongly, since none of these meetings were attended by the author. In addition, there might be topics or disagreements that were not written down in these meeting minutes, which mean that this is information not provided to the examiner. All participants in the CMI process have not been interviewed, only active members. Once again, this might have skewed the results of this case study, since there might be other reasons for why these people have not been as active.

5. Case Description
This section includes a case description and a description of the organizational structure of the studied area.
5.1. The Co-Management Initiative in Lake Vättern

5.1.1. The Study Area
In 2004, the Swedish government gave the Swedish Board of Fisheries (henceforth SBF) the mission to implement six local and regional co-management pilot projects in Sweden. This initiative was called the Co-Management Initiative (CMI). In this case study, one out of six projects within the CMI is examined - Lake Vättern. The main goal of the SBF regarding the implementation of this type of local and regional arrangement was to suggest possible collaborative arrangements and decision-making processes regarding fisheries and to investigate what segments of the organizational process that is possible to be involved and transferred to a co-management arrangement. (Fiskeriverket, 2007). The SBF has defined the CMI as a co-management arrangement with an adaptive approach. (Fiskeriverket, 2007).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>1 912 km²</td>
</tr>
<tr>
<td>Average depth</td>
<td>39,8 m</td>
</tr>
<tr>
<td>Maximum depth</td>
<td>128 m</td>
</tr>
<tr>
<td>Average yearly lake temperature</td>
<td>7,8 °C</td>
</tr>
<tr>
<td>Maximum length</td>
<td>135 km</td>
</tr>
<tr>
<td>Maximum width</td>
<td>31 km</td>
</tr>
<tr>
<td>Residence time</td>
<td>60 years</td>
</tr>
</tbody>
</table>

Table 2. General information about Lake Vättern (Norrgård, 2010).

The CMI lasted from 2004 and 2006, but the co-management arrangement in Lake Vättern continued after this period. A more detailed description of the organizational structure of CMI Vättern will be given in next section.

Lake Vättern is Sweden’s second largest lake (Länsstyrelsen Östergötland et al, 2005) (see Table 2, for general information), and is to be found in the southern part of Sweden (see Figure 5). The recreational fishing is extensive (SBF). Lake Vättern has both public and private waters (Fiskeriverket, 2007). Private water can in general be described as all water within 300 meters from inland and around islands longer than 100 meters. (Fiskeriverket, 2007).

Commercial fishermen have a license to fish and are obligated to report their catches to the SBF. Lake Vättern 19 commercial fishermen have fishing as their main income. Only commercial fishermen are obligated to report their catches to the SBF (Fiskeriverket a, 2010), hence the total catches of sport and recreational fishing etc are unknown.
Species that are of highest economic value in Lake Vättern are signal crayfish (*Pacifastacus leniusculus*), char (*Salvelinus umbla*), grayling (*Thymallus thymallus*) and common whitefish (*Coregonus lavaretus*). During recent decades the population of char and grayling, both salmonoid species, have decreased in Lake Vättern. Char has decreased to the extent that it is now considered to be an endangered species in southern Sweden. (Hammar, 2005). A reversal of the population decrease for char has been, and still remains one of the main challenges for the fishery management in Vättern. This was one of the main reasons for why a co-management arrangement was implemented. Besides declining fish populations, illegal fishing has become an issue in Lake Vättern, mainly of signal crayfish. Signal crayfish is currently the most economic valuable species for commercial fishermen. In addition, the general public and owners of private waters also fish signal crayfish.

In 2005 three protected areas at the spawning sites of char were implemented (Fiskeriverket b, 2010). Within these areas all types of fishing is prohibited, except for crayfish fishing. In addition to this, minimum catch size and other restrictions were implemented. Test-fishing from 2006-2010 has shown an increase of char (Fiskeriverket b, 2010).

### 5.1.2. The Organizational Structure

Legal regulations regarding fisheries in Sweden can be found in statutes of the European Union’s Common Fisheries Policy (CFP) and in Sweden’s fisheries legislation. Since Lake Vättern is inland water it is regulated by the Swedish legislation. European Fisheries Fund is the financial part of CFP and aims to fulfill the objectives of CFP (European Commission, 2009). The CMI in Sweden was funded by the European Fisheries Fund, the SBF and CABs. (Fiskeriverket, 2007). The SBF cannot delegate...
exercise of authority regarding e.g. license requests, and conditions for protected areas, minimum catch sizes etc. In other words, the SBF cannot delegate the responsibility of fisheries management and can therefore not delegate this to a co-management arrangement as the Swedish legislation looks like today (Fiskeriverket, 2007). This means that a co-management cannot be decisive in Sweden, unless there is a change in the Swedish legislation. In Sweden, the SBF and county administrative boards (CABs) make decisions regarding licenses and dispensations (Länsstyrelsen et al, 2005). Figure 6, shows the administrative boarders around the lake.

In 2004, as a response to the SBF task to implement a co-management initiative in Sweden, an organization that deals with the environmental protection and water quality in Lake Vättern, the VVF set up a meeting and invited all resource user groups, CABs and municipalities with a connection to Vättern (Norrgård, 2010). The CMI Vättern was an ongoing project from 2004 until 2006. After this period the participants of the CMI Vättern were positive to this arrangement and applied for European funding in order to enable a continuing of co-management. In 2007 the VVF decided to make the co-management arrangement permanent by becoming an organ in the VVF named Co-Management Fishing. (Norrgård, 2010). Even though the CMI has ended, the co-management arrangement has continued. In this thesis the period after 2006, when Lake Vättern was not a pilot project within the CMI anymore, will regardless of this be referred to as the CMI.

There has been an involvement of different types of actors in this CMI process: resource users (commercial fishermen, recreational fishermen, sport fishermen, domestic fishermen and water owners), indirect actors (tourism fishing entrepreneurs, municipalities and other local actors), authorities (SBF, CAB, the Swedish Coast Guard, the Swedish Environmental Protection Agency etc), and experts (Fiskeriverket, 2007). The work was divided into different workgroups. Each work group had a representative from each organization:

- **Legal framework**: Discusses rules and regulation modifications and license and disputation questions.
- **Surveillance**: One meeting per year. Discusses previous year and guidelines for the following year and emphasize prioritized areas.
- **Research and studies**: Aiming for a better coordination between different studies and monitoring programs in Lake Vättern.
- **Information**: Produces informative material about the lake, fish species and fishing activities. E.g. has made a folder to the general public where rules and regulations are describes.
- **Signal crayfish and signal crayfish fishing**
- **Fishing protection in Lake Vättern’s affluents**

Additional actors have been invited to these meetings depending on the topic (Fiskeriverket, 2007). Meetings were held at different locations around the lake where results were presented and discussed. If a decision could not be made, the question became a matter for the responsible work group where it was discussed further. The work group solved these issues by creating different alternative solutions which were presented at the next meeting. When consensus could not be achieved decisions were made by majority decisions. Suggestions of changes in regulations were sent to the SBF (the decision-makers) for authorization.

For managers of Lake Vättern, the purpose with the co-management implementation was to create an organized cooperation regarding fish and fishing activities, to reverse the declining char population and to find solutions on how to give access to the
resource. They wanted to accomplish a management plan and an acceptance and understanding about the regulations regarding fish and fishing activities in Lake Vättern. The function of the CMI Vättern is to be a policy-making and advisory organ (Norrgård, 2010).

Figure 6 shows the hierarchal structure of the governance system in the fishery of Lake Vättern
Malin Folkesson

Swedish Board of Fisheries

- Institutions of Science
  - Sötvattens-laboratoriet
- Universities
- Four County Administrative Boards (CAB)
- Eight Municipalities
- VVF

- Environment
- Fishing (The CMI)

- Sport Fishing
- Recreational Fishing
- Domestic Fishing
- Commercial Fishing
- Tourism Fishing Entrepreneurs
6. Results, Analysis and Discussion

The first section in this chapter demonstrates experienced uncertainties in the CMI Vättern and how these have been addressed. This section is based on interviews with respondents and meeting minutes from the CMI process and follows the categorization of uncertainty as outlined in section 3.2. It further highlights experienced pros and cons of the co-management process. In the second section the literature study and the case study are assessed and discussed.

6.1. Participants’ Perceptions

6.1.1. Natural process uncertainty

Addressing natural process uncertainty was initially essential in the CMI Vättern because it led to tensions between different resource user groups (municipality, 2010; scientist, 2010). An example of this type of uncertainty addressed in the CMI Vättern was the decline in the char population. Six main possible explanations arose (VVF, 2010; municipality, 2010):

- Overfishing
- Signal crayfish eat the roe of char
- Reduced nutrient loads as a consequence of effective water treatment, creating less primary production (less food) and thus less fish
- Climate change affecting the reproduction cycle of char
- Ice-free winters
- Pollution

Owing to the number of possible explanations for the char decline, resource user groups put the blame on each other: recreational and sport fishermen blamed commercial fishermen for fishing too much and vice versa. A respondent explained why this situation can occur (VVF, 2010):

*The largest differences of opinion are due to lack of facts and figures. This makes it possible to claim this or that and when you have such poor knowledge base it is not too hard to continue to claim anything no matter what anyone else says.*

In the CMI Vättern these disagreements were addressed by conducting experiments and further research. The goal was to generate basic information, to gather local and regional knowledge and to identify reasonable explanations for the decline (VVF, 2010). When managing a changing resource it is important not to draw too wide conclusions from single experiments and research results must be compared against each other (resource user, 2010). Previously, a respondent felt that too many uncertainties were connected to some decisions, where someone explained something as being a fact, and it later turned out not to be true. (resource user, 2010).

Respondents expressed that uncertainties led to communication difficulties. This was clearly apparent when natural science was communicated to the legal professionals and politicians. For instance, in biology, it is often easier to dismiss a certain theory as an explanation for a certain circumstance than it is to proof a theory as being the only possible explanation (VVF, 2010). Politicians and jurisdiction, on the other hand rely on facts beyond all reasonable doubt. This level of certainty can often not be achieved in natural science (VVF, 2010). A respondent explained:
I have to tell these people ‘Yes, the crayfish is the main threat for char right now’, even though it is only correct to some degree. Although we have a good documentation and basic facts about the ecosystem in Vättern, which is a lot compared to other lakes, it is not difficult to find reasonable arguments against this. (VVF, 2010)

When dealing with natural process uncertainty, respondents expressed that it is important to work with the concept of the antithesis, where the range of hypothesis is narrowed down by discarding hypotheses that are proven to be irrelevant. The hypotheses that are supported by the results of the tests remain (critical thinking). To only test the most obvious explanations for a phenomenon is too simplistic (VVF, 2010). A respondent stressed that it is important to keep an “openness” and not to stick to one model of explanation or a single opinion, which can be very treacherous when dealing with uncertainty (municipality, 2010). A respondent describes the situation like this:

*We have tested different possible explanations by investing different efforts [km nets], different fishing pressures and different temperatures etc. We have done hatching experiments indoor under controlled circumstances, but they [char] hatch like they were supposed to, so the reproduction itself works and is not the reason why we have a mass death of embryos. It is something in the lake, can be temperature, ice, fish, crayfish or that they don’t get big enough in order to get big. We only find more or less likely explanations. So we try to agree upon that it is coexisting factors. (VVF, 2010)*

A respondent stressed that explaining the decline by coexisting factors is not easy to accept for some participants, because resource users tend to blame others for problems without recognizing their own contribution (VVF, 2010; VVF, 2010). In order to create an understanding about this system and to agree on that variations are caused by coexisting factors, representatives from CABs stressed that one aim of the CMI has been to establish a systems understanding, especially among resource user groups (municipality, 2010). In the case of Lake Vättern, myths existed as a result of natural process uncertainty and lacking communication (municipality, 2010). The CMI has made it possible to spread new knowledge and to discuss these myths and rumours, which were impossible before (CAB, 2010; VVF, 2010). The process of acquiring new information was also required in order to establish a common agreement on the current state of the lake, which was needed in order to create a management plan. Without the discussion that the CMI enabled, unanswered questions would have continued to circulate as rumours (VVF, 2010).

Another example of natural process uncertainty that CMI participants have encountered is connected to the signal crayfish population; its affect on the ecosystem and its future development. Signal crayfish is an introduced species in Lake Vättern and therefore the knowledge about the ecosystem is limited. Gathering more information requires a monitoring of the signal crayfish population development in order to be able to detect changes and effects within the ecosystem at an early stage (CAB, 2010; resource user, 2010). In order to do this cooperation with a local university has been established. The development of the signal crayfish population is also uncertain. In other lakes, where signal crayfish was introduced, the population has expanded until it collapses due to food insufficiency. Some respondents believe that this decrease has already started (resource user, 2010), other believe that the population is still in a expansive phase (CAB, 2010), while others feel uncertain if the population will collapse at all (scientist, 2010).

There has been indications on that the spawning period for a sub-population of char seems to be negatively affected by climate change and as a response to this managers have implemented a prolonging of prohibited fishing activities during autumn as a precautionary
measure. A respondent expressed that this implementation would not have been done without the CMI (VVF, 2010).

Previously, the commercial fishermen’s main income was generated by char fishing while today; char has been replaced by signal crayfish as the source of main income. If/when a collapse of the signal crayfish population occurs commercial fishermen need to be able to return to catching fish instead of signal crayfish (SBF, 2010). However, since the char population was threatened, different restrictions (protected areas, mesh sizes, minimum catch sizes, depth restrictions) have been implemented (SBF, 2010). Consequently, commercial fishermen will not be able to fish char to the same extent as before (SBF, 2010). As a solution to this problem commercial fishermen suggest to fish common whitefish instead (resource user, 2010). However, juvenile char and common whitefish seem to live within the same depth range and the implementation of depth and gear restrictions on char prevent commercial fishermen from fishing common whitefish before it is certain that the gear in use does not catch juvenile char (CAB, 2010). A collapsing signal crayfish population will, according to some respondents, be the end of commercial fishery in Lake Vättern (SBF, 2010):

... we cannot live of fishing fish. The SBF has changed the rules, we are no longer allowed to fish where the fish is. We are not allowed to fish with the gear that gives us fish. If something happens with the crayfish population, then there will not be many commercial fishermen left. (resource user, 2010)

Natural process uncertainty has in the CMI Vättern been addressed by hypothesis-testing, deliberation and by spreading information in order to address rumours. As a result of this process, an understanding about the ecosystem and other actors arose.

6.1.2. Measurement and estimation uncertainty

In Lake Vättern, 19 commercial fishermen are registered and obligated to report their catches (SBF, 2010: VVF, 2010). The interest group of recreational fishing on the other hand, consists of several thousand people and recreational fishing is carried out by the general public which have no duty to report their catches. (CAB, 2010). This has resulted in difficulties estimating the extent of the recreational fishing (CAB, 2010). When managing a system like Lake Vättern it is important to have information and figures (CAB, 2010). Consequently, respondents feel that they no longer have control over the resource management (CAB, 2010). Managers have to rely on the recreational fishermen’s own networks, newspapers, and forums in order to estimate their catches (VVF, 2010). National surveys have been conducted as an attempt to address this uncertainty associated with to the recreational fishing, but it is still difficult to know if these surveys targeted the people fishing in Lake Vättern (CAB, 2010). Managers of Lake Vättern are now complementing this information by conducting own surveys in order to get more realistic numbers. It is not difficult to estimate amount of catch per effort, but the difficulty is to estimate how many they are (VVF, 2010). Moreover, illegal activities also affect figures on how much fish and signal crayfish that actually are caught in Lake Vättern. (CAB, 2010)

There have been disagreements within the CMI Vättern regarding the SBF’s choice of method to make estimations about the status of different populations. To give an example, the SBF has used a method based on commercial fishermen’s fish catches as a measure to estimate the char population in the lake (resource user, 2010). But today, the majority of the catches consist of signal crayfish and not of fish (resource user, 2010). A respondent stressed that estimations based on the commercial fishermen’s catches do not represent the reality (resource user, 2010). Another critique regarding the SBF’s method to do estimations and calculations based on catches is concerning the estimation of the signal crayfish population. A respondent stressed that the SBF only base their estimations on catches and do not take effort
into consideration. In addition, the SBF uses these estimations as a base when approving new cages for signal crayfish fishing (resource user, 2010).

Within the CMI, participant cannot affect the SBF’s chosen method regarding estimations, but can instead influence and discuss interpretations of certain results. Methods shall follow national and international standards in order to allow comparisons between different areas, and are therefore difficult to change. (scientist, 2010). The data that existed on Lake Vättern has until 2006 been fishery dependent, meaning that estimations were solely based on commercial fishermen’s catches. (scientist, 2010; VVF, 2010). Due to the decline in the char population, different measures were implemented by the SBF. These measures needed to be monitored and data that are less fishery dependent exist on Lake Vättern today.

One respondent stressed that sometimes absolute priorities are suggested based on material which is too uncertain in itself (municipality, 2010). When uncertain estimations are combined, the result is a further increase in uncertainty and the final result is a theoretical model with high degrees of uncertainty. One respondent believes that the instinctive feeling and experience-based knowledge, which is based on other factors than the theoretical model, should be incorporated in a better way (municipality, 2010). In addition to this, this respondent stressed that a sufficient monitoring of some protective measures is missing, as well as a strategy on how to save and structure this information. This respondent wants a plan on how to use the monitoring information in order to successively reduce the data uncertainty (municipality, 2010).

Measurement and estimation uncertainty have been addressed by communication and by using existing networks in order to address uncertain figures. As a result of this process, a discussion about acceptable methods and figures has occurred, and the implementation of different measures and their monitoring need have led to less fishery dependent data and that participants feel that estimations are closer to reality today.

6.1.3. Decision and implementation uncertainty
The involvement in the CMI Vättern and the goal of this arrangement differs between participants. According to representatives of CABs, the goal of the CMI was to establish an ecosystem approach to fisheries management and to create a management plan that is accepted by all involved actors (VVF, 2010; CAB, 2010). The management plan supposes to explain the current situation in Lake Vättern, possibilities, problems, and the development (CAB, 2010). This ambition required the involvement of a broad base of actors with connection to fish or fishing activities. (municipality, 2010; CAB, 2010). The goal of the CMI was described differently by respondents representing resource user groups:

If something like this starts, a project where you can make your opinions heard, you have to be involved. Otherwise we can be completely neglected. Now, we can be involved, even though it does not lead up to much we can still influence this process. But if you do not participate you cannot influence at all. If we had not been there, then the recreational fishermen would have taken over everything. (resource user, 2010)

Before the CMI, according to one respondent, the commercial fishermen had more influence than other resource user groups and stakeholders, and the SBF together with the organization of commercial fishermen shared the power (resource user, 2010). Furthermore, this respondent felt that some information was not shared with other resource user groups and that “fishy” decisions were made (resource user, 2010). The CMI led to an open dialogue with the decision-makers - the SBF - and the management process now focuses on the resource’s state instead of favouring certain resource user groups (resource user, 2010). Moreover, several respondents feel that their opinions are now heard by the SBF (resource user, 2010). The engagement has therefore increased locally compared to before the CMI (resource user,
2010), when decisions were perceived as more or less imposed. Through the CMI a forum for discussing different suggestions has been created (resource user, 2010; resource user, 2010).

In the CMI, rules are discussed and altered before they are implemented (VVF, 2010). This speeds up the decision-making process and assures that opinions of all CMI participants are considered (CAB, 2010). As a result of this, participants feel that the e.g. surveillance of fishing activities is better and that rules are followed and are better conforming to reality (VVF, 2010).

The management of the CMI Vättern have sent many suggestions of changes in rules and regulations concerning the fishery in Lake Vättern. One suggestion was that it should be prohibited to catch red (breeding) coloured char during their spawning period. This suggestion was dismissed by the SBF because this rule was not possible to implement legally, owing to the perception that it was too difficult to be understood by the general public, and therefore difficult to avoid violations (VVF, 2010). In addition, brochures have been created within the CMI process to inform the general public and recreational fishermen about the lake, species and rules in Lake Vättern.

It is important to have a clear agenda for every meeting and to document the process and result (VVF, 2010). Writing meeting minutes is important to secure transparency and accountability as well as quality of the management process as such. This allows the participants to perceive the process as democratic (VVF, 2010). It is also important that the resource user groups receive answers from scientists and not from CABs, because CABs’ opinions are perceived as biased by some actors (CAB, 2010). It was perceived as positive, that a decision-maker from the SBF was present at several meetings regarding the protected areas. This allowed the decision-maker to explain the reasons why these closed areas needed to be implemented. Before this, most participants did not agree on the SBF’s decision on closed areas, but their opinion changed after meeting the decision-maker. (VVF, 2010)

In addition, one respondent stressed that the largest uncertainty is the long-term development of the resource (VVF, 2010). This respondent believes that there should be a 20-year monitoring plan on the protected areas. When these areas were implemented in 2005, there was no actual monitoring plan, but the ambition existed (VVF, 2010). However, these areas have regardless been monitored, but on a yearly basis (VVF, 2010).

Participants in the CMI Vättern have encountered problems associated with the large differences between different stakeholders with regard to organizational capacity. Commercial fishermen are well organized, while the sport and recreational fishermen, tourist fishing entrepreneurs and private water owners were less organized (resource user, 2010; scientist, 2010). The representative of low organized user groups might not have anyone to deliberate with and thus has to make decisions on his or her own (resource user, 2010). This person can then be perceived as someone pursuing his or her personal agenda. In addition to this, another problem is that the participants do not represent their organizations properly (scientist, 2010; CAB, 2010). To pursue an interest without having a mandate can have a severe impact, regardless of which organization a person represents, because the representation fails (resource user, 2010). As a consequence of this, members of the organizations have reacted to decisions taken in the CMI (CAB, 2010). Moreover, for a CMI to function even better, representatives need to bring opinions from their organization back to the CMI (CAB, 2010). However, a respondent explained that this is sometimes difficult, because before every meeting, material and reports are sent out to participants and this material is in some cases sent out with too short notice for being discussed with the organization (resource user, 2010). These questions need to be discussed and deliberated within the organization, in order to avoid that the representative’s opinion is presented as the organization’s opinion (resource user, 2010).
The VVF, together with the leader of the CMI have been perceived as neutral, at least by scientists (scientist, 2010). VVF’s main focus has been the environment and water issues and this organization is therefore perceived as relatively neutral regarding fish and fishing activities (scientist, 2010). Some respondents feel that the VVF does not have an own agenda, whereas another respondent expressed that CABs agenda is to have the overall responsibility concerning the lake, trough the tool of the VVF. (resource user, 2010). This respondent wants that the overall responsibility should stay at the SBF, because they are the decision-makers and can act more unbiased than actors with local connections (resource user, 2010).

Another uncertainty on Lake Vättern is concerning surveillance. Since there is no business trade on Lake Vättern, the Swedish Coast Guard is not mandated to perform surveillance on this lake. This means that the surveillance is put on CABs, but these do not have a legal responsibility to take on this responsibility. Consequently, no obvious authority for the surveillance exists. However, CABs do survey the public water in Lake Vättern, with SBF funding that is supposed to be for fishing protection. CABs apply for this type of funding on a yearly basis. (VVF, 2010).

6.1.4. Institutional and regime uncertainty
Within this CMI arrangement, participants have built an increased understanding of other organizations’ interests (CAB, 2010; resource user, 2010; municipality, 2010). As a result, respondents believe that they manage to solve conflicts in the field of fisheries management better today (resource user, 2010; resource user, 2010). Some respondents stressed that participants are reminded about other stakeholder’s reality and perspectives, and are therefore forced to see the bigger picture in a CMI arrangement (resource user, 2010; resource user, 2010). As a result of better communication, the trust in and respect for each other have increased (municipality, 2010; CAB, 2010; resource user, 2010; scientist, 2010; resource user, 2010). Representatives of CABs stressed that a forum like the CMI allows the inclusion of other actors’ opinions in a better way than in the usual management process, where this is commonly done by a circulation for comments (CAB, 2010).

Before the CMI, the dialogue between authorities such as CABs and the SBF, between commercial fishermen and recreational fishermen (VVF, 2010), as well as between authorities and different resource user groups was inadequate. The discussions and the local engagement that the CMI has led to, have resulted in a more responsive SBF compared to previously when CABs managed this resource (CAB, 2010). Respondents of the SBF emphasized that it is easier for them to respond to and collect opinions from the local level, information that would not have been recognized without the implementation of the CMI. The relationship between resource user groups and decision-makers became through the CMI process closer and decision-makers also stressed that this makes it possible for them to respond to critiques and ideas faster than before the CMI implementation (SBF, 2010). Managers of the CMI Vättern have tried to include resources and competency from the SBF to Vättern, and done this successfully, which has not been done previously (CAB, 2010).

A respondent is annoyed that research and research results are perceived as a biased account (scientist, 2010). This is most common among resource users, but cemented opinions that are not based on facts also exist at authorities (scientist, 2010). According to this respondent, this is a trend that can be reversed when actors meet (scientist, 2010). When researches were perceived as a biased account VVF sometimes had to bring basic data that was not from the SBF, but from VVF, because some representatives distrusted the SFB and CABs, (VVF, 2010). A reason for this may be because VVF has a good reputation among resource users (scientist, 2010) and has always been strict about basing decisions and reports on facts and raw data and to quality check results in order to avoid rumours (VVF, 2010).

The CMI has led to many experiments and research results in order to acquire more information and knowledge about the lake and this process requires funding (CAB, 2010). To
apply for funding is perceived as complicated (scientist, 2010). This has to be done by authorities and economists (scientist, 2010; CAB, 2010). No resource user organization would have taken this responsibility, and maybe no one could because CMI has to be put on an unbiased part (VVF, 2010). In addition, it is not the resource user groups’ work to produce figures and reports (VVF, 2010). Every representative category stressed that resource user groups cannot do this by themselves, but also that to have a CMI on a purely voluntary basis would not be likely to work (scientist, 2010; CAB, 2010; resource user, 2010; resource user, 2010). It is therefore important in a process like this that a platform of continuity exists, such as VVF, with people that can work (resource user, 2010). The future of CMI is uncertain because of the financial part is uncertain (resource user, 2010; scientist, 2010; resource user, 2010).

Another factor affecting the representativeness is the cooperation between different governmental agencies. A respondent expressed that some municipalities are more active than other and this person felt that he or she does not know the municipalities’ collective opinions when attending these meetings (municipality, 2010). This respondent would like to have a better coordination within each municipality where different organizations with interest in e.g. tourism, technology, nature, recreational activities are gathered. The communication regarding these topics needs to be improved between all municipalities around Lake Vättern (municipality, 2010). This would allow spreading information and exchanging knowledge between the municipalities, so that the learning process becomes more effective (municipality, 2010).

Future focus will be put on creating job opportunities and employment and a partly European Union funded project has been initiated. A respondent states that in order to avoid competitive conditions between actors it is of importance to extend the cooperation to include this economic development as well (municipality, 2010). Only organizations are allowed to participate in the CMI regime (CAB, 2010; scientist, 2010; VVF, 2010; CAB, 2010). However, there is no organization behind the general public (and not supposed to either) and some resource user groups are less organized (CAB, 2010), which means that some perspectives are not represented. This has been discussed at meetings but this issue has, in reality, not been adequately resolved. There is a strong resistance to include individuals instead of organizations because this erodes an important incentive to be a member of an organization, which allows the participation in the CMI (scientist, 2010).

A respondent stated that not everything is ventilated in the CMI and that decisions on some topics are still solely discussed and made by authorities. (resource user, 2010). An authority respondent stressed that this is because of the insufficient organization of different resource user groups. They have to bring almost completed suggested in to the CMI, because this cannot be done by organizations with such low organizational level. Clarifying the limits of the influence the CMI can have on the legal framework is important, because there is a risk that resource user groups will not attend future meetings if they do not perceive their participation as influential (CAB, 2010; CAB, 2010; SBF, 2010). A critical point in this CMI process was when participants discussed the boundaries of the protected areas. There were disagreements about this, and after approximately a year of discussions back and forth, the CMI Vättern sent two suggestions on changes of these boundaries. The SBF dismissed these suggestions because it was not possible to implement due to legal restrictions. CMI participants got upset about why the representative of the SBF had not informed them about this at an earlier stage. The SBF stressed that they did not want to affect this bottom-up perspective and wanted the CMI to have its course (VVF, 2010).
6.2. Analysis and Discussion

6.2.1. Co-management with an adaptive approach

Before the implementation of the CMI in Lake Vättern the management process was usually based on expertise and science. This has now changed to a fishery management that more frequently combines science with experience based knowledge (resource users). This strengthens the regional and local management of this natural resource and is, according to adaptive management and adaptive co-management, a proper way to deal with natural process uncertainty, implementation and decision uncertainty and institutional and regime uncertainty connected to the local and regional level. This is because the institutional design of co-management is better suited for addressing issues at the local and regional level and creating flexibility in order to better respond to local and regional socio-ecological dynamics. The previously operational process contained a higher degree of central governance with rules and regulations with a general character, sometimes inappropriate for local conditions. Put differently, the implementation of co-management has changed the previous fisheries management consisting of a collaborative relationship between the SBF and central interest groups, to collaboration between the SBF and central interest groups and with groups specialized on local and regional conditions. This has lead to a shorter communication distance between the decision-makers and local actors and issues and suggestions on the local level can be heard much faster at the central level than previously. According to the EEA report the term uncertainty also includes ignorance (EEA, 2001). This thesis’ case study shows that the communication distance between decision-makers and local actors has become shorter and that the central level is more responsive to local conditions today than before the CMI implementation. This means that a form of institutional ignorance, where information exists in the society but not provided to the decision-makers, can be addressed by a co-management arrangement. This type of institutional design also leads to a more flexible and responsive management system.

Another result of the CMI process in Lake Vättern is that participants gathered local knowledge, which had not been done previously. This type of information is essential when dealing with natural process uncertainty, since knowledge about local conditions is used more appropriately. This information gathering was important when CMI participants tried to establish an understanding about the biological and ecological processes in the lake, but also for creating an understanding about why the char population has decreased to a critical level. In order to find a reasonable explanation for this decline, CMI participants tested different hypothesis. According to many researchers the theoretical approaches of adaptive management and adaptive co-management hypothesis-testing leads to more qualified hypotheses and thus a more appropriate management approach (Armitage, Marschke, & Plummer, 2008). Managers in Lake Vättern did this because participants in the CMI Vättern initially disagreed about the reason for the decline. Resource user groups perceived each other as enemies and blamed other actors for this. In order to manage this resource properly, participants needed to find the actual reason for this decline. The lack of trust in and legitimacy of other resource user groups as well as authorities led to that information from certain actors was perceived as biased and thus untrustworthy. The participants of the CMI Vättern were in need for a strategically generation of new information – information that was seen as unbiased in order to be accepted by all participants. By generating new information and testing different hypotheses, participants started to understand that some hypothesis could not solely explain the char population decline. This working approach is an example of double-loop learning, because through this process participants challenged and altered their fundamental ideas and norms. Double-loop learning is according to the theoretical approaches of adaptive management and adaptive co-management an appropriate approach in order to
deal with uncertainty (Armitage, Marschke, & Plummer, 2008; Armitage, Berkes, & Doubleday, 2007, p. 9). Since this thesis distinguishes between different types of uncertainty, a more appropriate way to describe this is that double-loop learning is a tool to address natural process uncertainty, just as participants did in the CMI Vättern when they tried to find out the reason for the char population decline.

In the CMI Vättern, the hypothesis-testing has resulted in two improvements; one related to the ecological system and one related to the social system. The first improvement is that participants of CMI Vättern have agreed upon that co-existing factors are resulting in the char population decline and not a single component or that it is a certain resource user group’s fault. In order to agree upon this, participants needed to establish an ecosystem understanding. This is fundamental in order to be able to establish a management with an ecosystem approach and to appropriately deal with natural process uncertainty. The achievement of an ecosystem understanding is a consequence of the CMI’s ability to spread system knowledge. The second improvement as a result of the hypothesis-testing is that the dialogue between different resource user groups, resource user groups and authorities at different levels and between different authorities at different levels is today better than in the past. Several respondents expressed that before the CMI started they perceived each other as enemies. In a CMI process, participants are forced to look beyond their own interests and views and to acknowledge other actors’ points of view.

A hypothesis-testing aiming to increase the understanding about the processes in the lake would probably have taken place even if the CMI would not have been implemented, as authorities still would be in need of increased information. However, this thesis’ case study shows that disagreements and rumours exist as a consequence of natural process uncertainty and limited communication. Respondents emphasized that communication is needed in order to address these rumours, and this would not have been done easily without the CMI. The distrust and disagreements among different resource user groups, in combination with the distrust of authorities would not have been sufficiently addressed without a forum that enabled communication. This further strengthens the impossibility to treat the ecological system separately from the social system. Moreover, if the authorities would have managed this resource by themselves there may have been other hypothesis that would not have been tested, as a result of fewer involved actors in this management process.

Even though participants is the CMI Vättern have had a hypothesis-testing approach in order to deal with natural process uncertainty, other possible explanations for e.g. the char decline might still exist, which were not considered in the process of the CMI Vättern. Although CMI participants have different backgrounds, there might be approaches and hypothesis not presented in this collective body of knowledge, which is a type of institutional and regime uncertainty or ignorance. In the CMI Vättern, a respondent emphasized that it is important to test antitheses and to exclude unlikely explanations instead of searching for evidence to fit in a particular theory. This may be a good approach to deal with this type of uncertainty. However, these rejected hypotheses can in combination with each other have a significant effect or as a consequence of the dynamic ecosystem may be valid in the future.

The case study shows that this form of adaptive approach (hypothesis-testing) was more frequent in the beginning of this CMI process, when managers felt they had insufficient data about the lake. If this adaptive ability tends to reduce over time, this might lead to a fishery management that inadequately responds to natural changes.

The theoretical approaches of co-management and adaptive co-management aim to create a complex institutional design in order to involve all actors with a connection to the fish resource (Armitage, et al., 2009). The CMI Vättern did also aim for a broad base of actors connected to the resource, because managers of Lake Vättern wanted to create an ecosystem approach. For this reason it became important to involve all actors with a connection to fish or
fishing activities in Lake Vättern, because an ecosystem approach could not have been achieved if not everybody had an ecosystem understanding. However, according to Jentoft and Mikalsen (2004) aiming for a complex institutional design can sometimes lead to an institutional design being too complex for resource users to understand, because there is a tendency towards more fined-tuned rules in order to address shortcomings of the existing system. To avoid these problems, participants in the CMI Vättern have used different strategies such as the spreading of information (brochures) among the general public. They have also discussed what types of rules and regulations that can be demanded by the general public to understand in order to avoid violations of rules and regulations. The fishery management in Lake Vättern is aware of the importance of building a flexible management system. As mentioned above, participants of the CMI Vättern have established an understanding of other participants’ points of view. This might also ease the understanding about the complex institutional design that is needed in order to involve multiple actors.

Moreover, respondents emphasize the importance of having openness, and not to regulate too specific measures. A main reason for this is because of the uncertainty connected to the system. If wrong measures are applied, then this might have contrary results. This can also counteract the creation of a too complex institutional system, as Jentoft and Mikalsen (2004) describe. Also the SBF is aware of not creating too complicated rules and wants to remain a general character of the rules concerning all inland water in Sweden. This is the main reason for why several suggestions made by the CMI management have been dismissed by the SBF; because the suggestions are too specific and cannot be included in the legal legislation due to that they are inapplicable on other areas. On the one hand, local actors are cooperating and suggest rules that are beneficial for the fishery on the local level. On the other hand, the central level (the SBF) aims to create a general and easy system of rules that does not require too much enforcement.

6.2.2. Participation and cooperation

Brandt and Kronbak (2010) stress that climate change will alter collaborative agreements, especially those connected to biomass changes because it reduces possible collaborative outcomes. To apply what Brandt and Kronbak (2010) describes on the CMI Vättern, a changed biomass is evident if/when there is a collapse in the signal crayfish population and this may challenge the cooperation within the CMI Vättern in the future. If there is a decline this would mean that cooperative alternatives are reduced, according to Brandt and Kronbak (2010). This is because the resource will then not be able to hold the same fishing pressure as today and resource users will have to reduce their fishing activities. A collapse will lead to a situation where some resource users have to stop fishing. A question that needs to be addressed will be who has to leave in this case. This uncertain future, especially evident for commercial fishermen who have fishing as a main income, can to some degree be addressed in a co-management arrangement, because, as Locke and Schweiger (1979) describe, participation and communication equip involved parties better for dealing with change and uncertain outcomes and give them a sense of control. In the CMI Vättern, a respondent expressed that CMI enables a discussion about what uncertain factors that exist and this prepares involved actors better for future changes. As a result of the hypothesis-testing, participants have received more information about current processes in the lake. Participants are now aware of that future changes are inevitable. For this reason the institutional design of co-management enables a necessary discussion about possible outcomes, trends, interpretations of observations, and future challenges. This makes participants more secure and feel that they have a sense of control over their own situation. This is consistent with the description by Locke and Schweiger (1979). A good tool to use in the CMI Vättern has been the creation of a management plan. The management plan, and the process to create it, aimed
to create a common vision about the lake and its resources and an understanding on what should be improved. It gives an understanding about future changes that must occur. How the end document will help the practical management of the fishery is unclear, but the process to create it seems to have had a positive effect in order to establish a common vision among participants. According to Yaffee (1997) there is often a fragmentation of interests within fisheries and that institutions tend to fail to create common visions between different groups. In the CMI Vättern the process of creating a management plan, which means they discussed visions and objectives, led to that the participants needed to agree upon the current situation in the lake. Before the implementation of the CMI the institutional design did not sufficiently address this limitation. According to Pinkerton (1999) and Yaffee (1997) disagreements between actors tend to be transferred higher in the governmental levels in order to get addressed, when they instead need to be addressed on the level disagreements exist. This thesis’ case study shows that co-management is an institutional design that addresses disagreements on the local level (where they exist) and enables different actors to meet.

Participants of the CMI Vättern have given suggestions on modifications of rules and regulations and this process has led to that involved parties have made trade-offs between perceived pros and cons connected to different suggestions. This has led to a better understanding of new regulations and increased compliance. This may lead to a decreased need of enforcement compared to if the SBF would do this by their usual operational approach; to send submission of comments. Seen in a longer perspective, this might lead to fewer rules and regulations because of better social control and compliance. In addition, according to Jentoft and Mikalsen (2004) the institutional design can become too complex for resource users to understand and this would be addressed if participating actors can communicate with each other.

According to Charles (2007), an advocate of adaptive co-management, a management portfolio is needed in order to deal with uncertainty connected to the outcomes of different measures. This is important because measures’ disadvantages can be addressed by other measures’ advantages. In Lake Vättern decision-makers did implement a management portfolio consisting of different measures. They implemented for instance protected areas, mesh size restrictions, increased minimum catch size (of individuals), prolonged time when fishing is prohibited and depth restrictions. Some of these measures were discussed in the CMI, such as the prolonging of the prohibited fishing activities during autumn as a precaution since a consequence of climate change seemed to be a changed spawning period for char. This is another example of a capacity to adaptively deal with change and uncertainty and a respondent stated that this rule alteration would not have been implemented without the CMI. However, feedbacks can be achieved by monitoring and research on the one hand, and by users’ observations and experience on the other hand (Steneck and Wilson 2010). Without monitoring and follow-ups this may lead to a situation where there is a resistance towards new management implementations, because implemented measures are not followed up and evaluated and therefore never taken away once implemented. This may lead to a fisheries management too complex to be effective and loosing in flexible as the system becomes too rigid and the capacity for learning becomes lost.

Jentoft (2000) stresses that an implementation of different strategies and decisions tend to be more successful in co-management arrangements because they can then be deliberated and communicated. Same situation can be seen in the CMI Vättern when decision-makers attended a meeting concerning the implementation of the protected areas, where they explained why this is of importance and enabled that participants could ask questions. Respondents expressed that the majority of the participants were against the implementation of the protected areas at first, but after this meeting the majority realized that they are necessary. Furthermore, on Lake Vättern, the responsibility of the surveillance and its funding
are uncertain. Without surveillance the illegal fishing activities will be even more troublesome and difficult to comprehend.

6.2.3. Horizontal and vertical relationships combined with transparency

A controversial issue in fisheries management is that fishermen often have grave doubts about the reliability of scientific research (Jentoft, 2000). This was evident in the fishery of Lake Vättern as well. According to Jentoft (2005), the appropriate way to address this is to establish institutions, because people tend to trust institutions more than individuals (Jentoft, 2005, p. 149). However, this thesis’ case study shows that information from institutions is still perceived as biased, because the institution in itself is perceived as biased and untrustworthy, i.e. lacking in legitimacy. It seems to be more important that information is created by institutions that are perceived as unbiased regarding fish and fishing activities. Most importantly, a dialogue between resource users and institutions is needed in order for resource users not to perceive certain institutions as biased. Without communication, creating institutions is not enough in order to address this issue, because the information itself will still be questioned owing to the uncertainty inherent in this information. In the CMI Vättern, information provided by the SBF and institutions of science has at times been perceived as biased by certain resource user groups and for this reason the VVF has provided new information and initiated experiments in order to gather information that were perceived as more unbiased. For this reason, communication and deliberation is needed at the local and regional level with emphasis on transparency in order to address this issue. In addition to this, it is important to be clear about the degree of uncertainty in this information. It is also important to be clear when presenting scientific results about what is known, not known and what is uncertain. This is today difficult in the decision-making process and in politics, since decisions need to be based on facts in order to be implemented. Respondents of the CMI Vättern also expressed difficulties communicating uncertainty. An adaptive approach applied here would mean that different measures can be implemented regardless of a level of uncertainty, because this learning-by-doing approach does not have to be based on certainty (Walters C. J., 2007). But still, an implementation of these measures will still require a motivation for why these are needed to decision-makers. This is difficult since communicating uncertainty is problematic. Moreover, an adaptive approach requires monitoring in order to learn from feedbacks (Steneck & Wilson, 2010; Armitage, Marschke, & Plummer, 2008) and monitoring requires funding and resources, which might not always be as large as required for an explicit learning process. Wilson (2007) also found in his case study that monitoring is a commonly occurring lacking factor for a successful adaptive approach.

The CMI has been seen as an excellent forum to present and call for new information, both from scientists, authorities and resource user groups. To be able to incorporate new information on a continuous basis is one of the main features of adaptive co-management and is essential in order to deal with different types of uncertainty sufficiently.

When the influence of different industry groups is uneven, rules tend to favour certain groups. When this occurs Pinkerton (1999) stresses that the system will be perceived as imposed by higher governmental agencies. Hence the representativeness and legitimacy decrease according to Jentoft and Mikalsen (2004). Pinkerton’s (1999) solution to this is issue networks. In Lake Vättern this was the case before the implementation of the CMI; a respondent described that the SBF favoured commercial fishermen and that there was a biased cooperation between commercial fishermen and the SBF. Today, respondents feel that the CMI has addressed this biased situation, by being transparent, by having everybody’s voices heard and by having a closer cooperation and relationship with the decision-makers, without feeling that the management favours a certain resource user group. In this case, the CMI has
worked as an issue network, where issues have been deliberated and discussed, just as Pinkerton (1999) suggests as a solution to this problem. A horizontal management system as adaptive co-management, leads to more equal influence, compared to a vertical (central-regional-local) management system.

Pascual-Fernández et al. (2005) stress that a limitation of co-management is that although it is a local and regional institutional arrangement it still has a hierarchal structure because the information that is provided is from institutions of science and communicated to local levels, which lead to less incorporation of local knowledge. This view that information from a central level leads to less incorporation of local knowledge is to perceive this system as a zero-sum game. One type of information does not exclude the other. In fact, sometimes national information is the only information existing and funding on the local level might not exist in order to address certain knowledge gaps. Local and regional knowledge can instead use this information and translate it to the local and regional level. As in the CMI Vättern, a national survey has been done regarding the extent of the recreational fishing. This national survey will be complemented with local surveys. Moreover, sometimes conflicts exist on the local and regional level and even though information would be provided by this level, it does not automatically mean that this approach would not be seen as imposed or biased.

Authorities initiated the CMI Vättern and are also dominating representatives. Respondents stated that this process would probably have failed if it had been initiated by a resource user group (due to the disagreements and tensions that existed between these resource user groups previous to the CMI implementation). Even though authorities can be perceived as biased, they were in this case perceived as more unbiased than other competitive resource users.

A limitation of adaptive management can be lack of strong leadership that is willing to sustain all the hard work needed for a successful adaptive approach (Walters 2007). In CMI Vättern they did have a strong leadership and representatives of authorities were willing to make the effort required for the continuation of this process, which was based on resource users’ requests. Respondents pointed out that this was one of the reasons why this CMI was successful. However, what Walters (2007) does not mention in his study is what will happen if this strong leadership would disappear. If a strong leadership would disappear it could lead to a reduced willingness and engagement among other participants for this co-management. To reduce this vulnerability, delegation of responsibility among different participants in order to increase the legitimacy could be seen as an example to solve this issue.

In addition, if this work is supposed to be long-termed, different actors have to be involved under long time spans. For this reason, it becomes important to integrate new members, without losing learning experiences and generated knowledge, trust etc. It becomes important to stress that time, willingness and funding in order to keep documentation of these learning experiences and knowledge become important. If not, this knowledge may be lost. In addition, different learning processes needs to be combined, which further require resources. This makes it even more important to emphasize the need for a stable institutional foundation of co-management and a stable duration of such, one that can deal with these fluctuations. This stable institutional foundation does not exist today, because there is an uncertain funding and future existence of this arrangement. However, replacing members can also be positive especially regarding hypothesis-testing and when dealing with natural process uncertainty. It can counteract that double-loop learning tends to decrease over time. It can however have a negative consequence regarding implementation and decision uncertainty because generated trust might disappear members leave. As Jentoft (2005) describes, the fact that people tend to trust institutions more than individuals could counteract this limitation.
6.2.4. Representation issues and communication channels

When an individual within a CMI arrangement is representing an organization with a limited organizational capacity this person tends to be perceived as an individual pursuing a personal agenda. Hence individuals representing a less organized organization tend to have limited legitimacy as an organization and as a resource user group. Therefore, it is concluded that less structured and time invariant organizations tend to project, and consequently get, problems with external legitimacy while highly structured stable organizations gain more influence. This in itself is a democracy problem; marginalised groups tend to remain marginal or further loose out in the process, whereas powerful actors maintain or strengthen their positions. This uncertainty does not become sufficiently addressed in the Swedish co-management arrangement, since actors with the most influence still are the most powerful actors in this setting. Even though the institutional design of co-management should counteract this it does not, because less structured organizations suffer from legitimacy problems, which enable local strong actors to be able to pursue their interests. Since there tend to be unevenness between different local actors, it becomes important that the responsibility of management is put on different levels – local, regional and central, which is the notion of adaptive co-management. If not, a local and regional arrangement like this might lose its meaning and resource user groups, or representatives of less structured organizations might find a process like this to be meaningless. One way to address this might be, just as the participants in CMI Vättern have done – to work towards an ecosystem and social understanding. A result of the CMI process is that participants have built an understanding of other participants’ reality and points of view. This leads to a better system understanding and a common vision among participants would enable a more holistic management approach.

Jentoft and Mikalsen (2004) discuss that a limitation of co-management is that the formal responsibility is often put on a higher governmental authority which leads to an absence of responsibility among participants. Jentoft and Mikalsen (2004) argue that the formal responsibility needs to be put on these groups in order for participants to feel recognised and to suggest measures and strategies that are beneficial for the overall resource instead of pursuing personal agendas. However, as this thesis’ case study shows, a socio-ecological system understanding might counteract this type of institutional limitation and would address this problem without a formal responsibility put on local actors. In addition, it becomes important to ask the question if a formal responsibility and power put on local resource users is preferable in natural resource management. Local resource users might not always be interested in managing the resource seen from the best public perspective, which would make it important to keep the formal responsibility put on a more general level.

Another important aspect to take into consideration within an institutional design that is based on representation is that results and decisions need to be brought forward on to the central organizations. This is especially important within organizations that have transient representatives (e.g. sport fishermen) and this information flow needs to be distributed at different levels. When resource users are more limited to the local surroundings emphasis should instead be put on the cooperation and communication between the local and central level (e.g. commercial fishermen and recreational fishermen).

Yet another important aspect regarding representation is that the information is well-established in the organizations because if the representative (person) changes, this information risks becoming lost. Factors such as trust, legitimacy and conflict resolution, which are a result of co-management, may not be seen among actors outside the group involved in the co-management arrangement if the information and decisions created here is not forwarded and linked to the central organizations.

Wilson (2002) claims that long-term patterns may be detected through experience. Here, it might be worth questioning the influence resource users actually have. As an example,
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consider e.g. statements about an alleged change in age structure. If these observations are not verified by science, will and should this type of information really have the same weight as science? These types of knowledge should be seen as equally important according to Armitage et al (2007), but there seems to be difficulties achieving this. It seems that adaptive co-management have difficulties addressing this type of uncertainty which in turn can lead to an unwillingness to embrace uncertainty — the factor this approach aims to address. A critique made by advocates of adaptive co-management is that decision-makers “only” call for new information and not include uncertainty to a sufficient extent (Walters C. J., 2007). According to the theoretical claims by many advocates of adaptive co-management, science and experience based knowledge should be seen as equally important (Armitage et al, 2007). The critique made by advocates of adaptive management, might not be possible to implement. Experience based knowledge and observations will most certainly not be seen as “proven” results, until science has verified them. This is because it is uncertainty inherent in experience based knowledge, which makes it difficult to embrace. This is one critique that advocates of adaptive management have towards traditional fisheries management and adaptive management, which might not be addressed in an adaptive co-management arrangement either. These two types of knowledge will probably not be perceived as equally important, but can instead be useful in different stages in the management process. It becomes important to develop tools on how to incorporate experience based knowledge and establish communication channels that reach from the local level to the central. However, communication channels cannot be established in organizations that are not organized, which means that these representatives may still be perceived as persons pursuing personal interests. This issue is not addressed by a co-management arrangement. Furthermore, experience based knowledge and science is not independent from each other. Few fishermen exist that solely have generated their knowledge from experience (fishing). The connection with scientists and e.g. newspapers makes this experience based knowledge not as different from science, as much literature on this subject make it sound.

In terms of feedbacks, which are essential in adaptive management and adaptive co-management, there is a tendency that observers see what they want to see, and discard observations that do not fit in a particular theory. Moreover, a critique proposed in the literature study is related to learning and feedbacks and is that a fisherman is often licensed to harvest specific species. Experienced feedbacks by fishermen regarding cross-species or small scale developments are, according to Steneck and Wilson (2010) not provided to managers since this type of info is irrelevant to licensed fishermen. (Steneck & Wilson, 2010). Furthermore, opposing interests among involved actors exist and observations, especially those made by resource users might be skewed in order to “prove” certain hypotheses. The critique that fishermen are licensed to harvest specific species and thus miss cross-species developments can be seen as a potentially misleading critique. The incorporation of experience based knowledge in the usual science dominated management process is not supposed to replace science, but to be incorporated better. However, this critique made by Steneck and Wilson (2010) further strengthens the conclusion that there is difficult to embrace experience based knowledge due to the inherent uncertainty, because of the discussion of what fishermen are interested in affects their perceptions and observations.

Furthermore, cooperation with other organizations was initiated in order to address specific problems and in accordance with adaptive co-management networks and relationships is seen as a proper management approach and is not sufficient without a co-management structure. This local and regional cooperation was not as coordinated before the CMI.

A co-management arrangement can involve different actors depending on the area where co-management is applied. It can for instance include commercial fishermen or have a more pluralistic approach with a broad base of involved actors, such as the CMI Vättern. The
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initiators of co-management set the standard and guidelines of the fisheries management. If commercial fishermen are the initiators, or authorities with e.g. a commercial fishing focus, other interests may become included inadequately. If only e.g. commercial fishermen would be included, it becomes important to establish a link to other resource user groups and other affected actors in order to create transparency at the local and regional level.

As a result of the involvement of the VVF (with main goal to secure a good water quality and environment in Lake Vättern) means that environmental aspects are included in the fishery management process. However, the connection between environmental aspects and fishing objective might be difficult to achieve in co-management that does not have this natural connection. Environmental organizations for instance, are usually not active in every area. This might mean that there is a risk of an insufficient connection between environmental aspects and fishing activities. However, in this context it becomes important to stress that in cases where both environmental objectives and fishing objectives are incorporated, it is important not to lose focus – on fish and fishing activities. If the management approach becomes too wide, resource users might feel less engaged to be involved in a process like this because the focus and reason for their involvement have been lost in the attempt to establish a broad management approach. Instead, this work should be put on different organizational levels. This delineation also needs to be discussed within the co-management, to avoid suspiciousness and unwillingness to be involved in this process.

A future challenge is to connect the work with co-management and its more local management and measures with long-term environmental objectives, regional, national and international. If these are combined, the co-management will be working in line with policies and guidelines (national and international) and thus towards a sustainable development of this regional fishery. It is also important that local organizational representatives and their work are connected to the national level within the organizations.

The biggest uncertainty in the Swedish context is the role of co-management and what it is mandated to decide and what it can influence. The somewhat unclear goal of the SBF regarding this type of arrangement leads to less opportunities for legitimizing the work of co-management. It is important to be clear about what co-management arrangements can influence in order to not lose legitimacy and transparency. Also this delineation needs to be discussed in the co-management, in order to avoid a reduced willingness of being involved in this process. Thus, this is a type of decision uncertainty and institutional and regime uncertainty that is not sufficiently addressed in the Swedish co-management setting.

In the future, to make co-management arrangements less vulnerable the SBF or equivalent could ease the administrative work regarding financial support (how to raise funding), the organizational structure, what co-management can affect and not affect (legal rights to influence), what types of knowledge and competency is needed, active involvement by the decision-makers, or at least an active dialogue and be a support base for the leaders of co-management arrangements regarding conflict resolution etc. This would ease the work connected to co-management and also an implementation of such design.

7. Conclusions

- Is uncertainty in this example of Swedish fishery co-management explicitly included in the management process, and to what extent does this project have a capacity to adaptively address uncertainty?
- Is co-management a suitable institutional design to deal with uncertainties?

Co-management arrangements tend to have an adaptive approach in order to address different types of uncertainty, in particular with regard to natural process uncertainty. The institutional
design of co-management addresses mainly implementation and decision uncertainty, and institutional and regime uncertainty through features such as communication, transparency, and democracy, which address distrust and legitimacy issues.

Co-management incorporates both science and experience based knowledge. This enables an appropriate use of local information, which is needed in order to appropriately deal with natural process uncertainty. Moreover, the institutional design of co-management it better suited to respond to socio-ecological dynamics connected to the local and regional level, in comparison with a central management. However, there seems to be difficult to embrace experience based knowledge as equal important as science due to the inherent uncertainty in this type of knowledge.

The involvement of resource user groups in the hypothesis-testing process resulted in an ecosystem understanding and an understanding of other actors’ points of view. Trust, legitimacy, transparency and a reduction of rumors are features affecting implementation and decision uncertainty as well as institutional and regime uncertainty and are a consequence of co-management. However, the hypothesis-testing tends to decrease over time, as new information is gathered and might as a result lead to a future management system that inadequately responds to new socio-ecological changes.

However, representation issues are insufficiently addressed in the Swedish co-management arrangement and lack of communication channels within organizations increase the vulnerability of co-management regime. To decrease this vulnerability, fisheries management should be put on different levels – local, regional and central. Further research should be put on establishing solutions on how to make this type of institutional arrangements less vulnerable and on how to solve representation issues.

To conclude:

- Co-management does address different types of uncertainty, and have an adaptive approach to deal with, in particular, natural process uncertainty but also with regard to other types of uncertainty. However, this adaptive ability might decrease over time.
- Institutional or regime instability makes co-management arrangements vulnerable with doubtful long-term sustainability given the current management approach. This is because co-management is vulnerable to the turn-over of representatives and the vulnerability of established communication channels and personal networks within organizations. This vulnerability together with representation issues are insufficiently addressed within the current co-management regime.
- Institutional instability and permanence with regard to regime robustness and the uncertain long-term funding are clearly issues that need to be addressed if current promising arrangements are to develop into any form of more mature governance regime.

As of today, two different trends can be detected in fisheries; one towards a centralized level and another trend is towards a more local management approach, just as co-management. The Common Fisheries Policy of the European Union is an example of a centralization of fisheries management. It becomes important to keep and further develop the connection to local and regional areas, in order for fisheries to be managed in a sustainable manner, just as the result of this thesis shows.
8. Bibliography


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To see published meeting minutes from the CMI Vättern process, visit the webpage of the CAB of Jönköping: http://www.lansstyrelsen.se/_jonkoping/projektwebbar/fiskaivattern/Samforvaltning+Vattern/Mote_sprotokoll.htm

Unpublished and unedited meeting minutes have been used.
9. **Appendix**

**Commonly discussed topics during interviews**

- The relationship between different actors before and after the implementation of the CMI
- Consequences of different types of uncertainty, e.g. if there will be a collapse in the signal crayfish population, funding and surveillance.
- The reason for the char population decline
- The role of science and experience based knowledge
- Pros and cons of the co-management process
- Monitoring
- Representation