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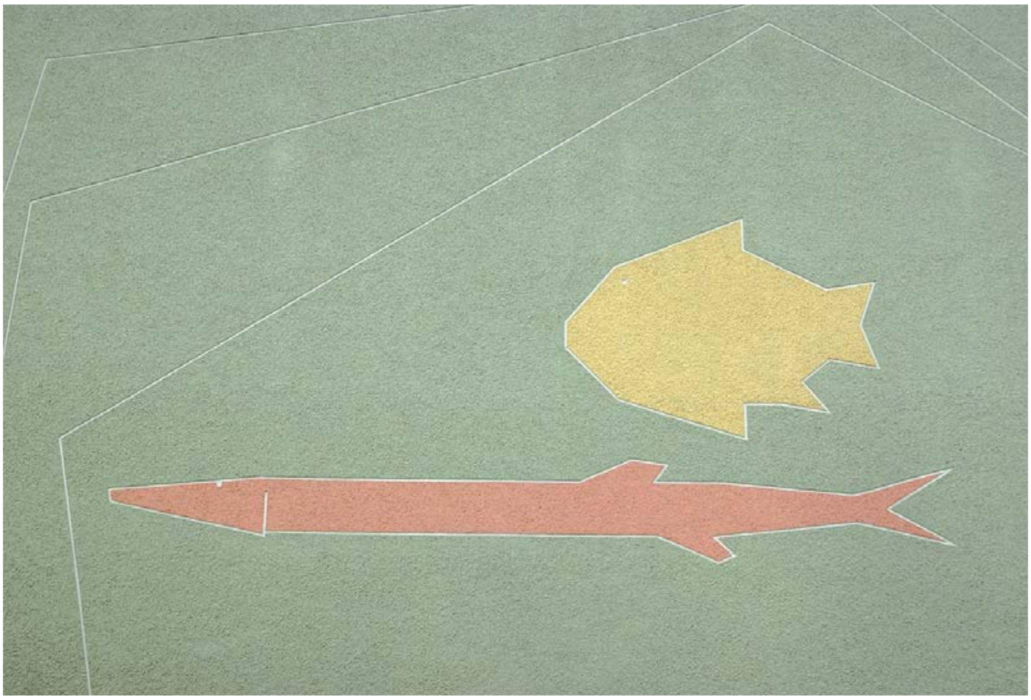
Kari Muje

Sustainability of Interlocked Fishing District -Management Concept for Commercial Fishing in Finnish Lake Fishery



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ABSTRACT

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The Finnish lake fisheries is one of the most extensive commercial inland fishery systems in Europe. It produces a considerable share of fish for domestic human consumption and also for export. Its distinctive feature is that vendace (*Coregonus albula* (L.)) is the overwhelmingly most important target species. The fluctuation of vendace stocks has been a major issue for the persistence and further development of commercial Finnish lake fishery. A number of issues concerning commercial use of the inland fish resources, such as access and fair distribution of environmental goods among interest groups stem from the long history of private ownership of land and from the multi-species and -purpose fishing nearly everywhere on the lakes. In this thesis a novel management approach, interlocked fishing district (IFD), is studied as a solution to the question of improving overall sustainability of developing commercial lake fishery in the context of private ownership of fishing rights. The results indicate that the present institutional and management structure in lake fisheries includes elements that do not comply with sustainability. Within the key interest groups, the landowners and commercial fishers, there is considerable need and readiness to apply IFD-type of resource management for commercial fishing. IFD includes qualities that could advance ecological, socio-economic, community and institutional sustainability in commercial fishing and fisheries management. Applying IFD is possible within the present legislation, yet any application requires case-specific approach. Successful application of IFD would advance resource-based and adaptive management of aquatic resources.

Keywords: Commercial lake fishing; fisheries association; fisheries management; fisheries region; fishing rights; private ownership; sustainability.

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LIST OF ORIGINAL PUBLICATIONS

The thesis is based on following original articles, which will be referred to in the text by their Roman numerals I-VI. The original idea to study IFD concept in relation to the sustainability of the Finnish inland fishery system was introduced by Juha Karjalainen and Timo J. Marjomäki. The planning of the studies for I, II and III were done by me and the co-authors. The idea of focus-group study for V was presented by professor Ilkka Alanen and the idea of economic case study in VI by me. Timo J. Marjomäki introduced the idea for IV, and conducted the modelling. Co-authors contributed in the choice of the tested allocation patterns and in writing the conclusions. In I the empirical data was analysed by me and Marko Lindroos conducted the economic modelling. In II the data was collected and analysed jointly by me and Timo J. Marjomäki. In III the survey was conducted by me and data was analysed jointly by Matti Sipponen and I. In article V I conducted the whole study. In VI Marko Lindroos contributed in the definition of the subject of the case-study and of the economic approach. All jointly written manuscripts were completed together with the co-authors.

I Muje K., Lindroos M., Marjomäki T.J. & Karjalainen, J. 2004. Interlocked sustainable use of multiple fish stocks – modelling biological and socio-economic conditions in Finnish vendace (*Coregonus albula* (L.)) fisheries. *Annales Zoologici Fennici* 41: 375–390.

II Muje K. & Marjomäki T.J. 2005: Sustainability-related concepts and practices in Finnish lake fisheries. *University of Helsinki, Department of Forest Ecology Publications* 34: 249–267.

III Sipponen M., Muje K., Marjomäki T.J., Valkeajärvi P. & Karjalainen J. 2006. Interlocked use of inland fish resources: a new management strategy under private property rights. *Fisheries Management and Ecology* 13: 299–307.

IV Marjomäki T.J., Lindroos M., Muje K., Sipponen M. & Karjalainen J. 2004. Comparison of policies for spatial allocation of annual fishing effort between multiple stocks of vendace, *Coregonus albula* (L.). *Advances in Limnology* 60: 405–418.

V Muje K. 2012. Sustainability of commercial fisheries management by interlocked fishing districts on Finnish lakes – a focus-group study. Manuscript.

VI Muje K. & Lindroos. M. 2012. Economic feasibility and sustainability of an interlocked fishing district in commercial vendace lake fishery. Manuscript.

1 INTRODUCTION

Fisheries all over the world face difficulties caused by overutilization of resources (Hilborn & Walters 1992, Repetto 2001, Worm et al. 2009), uncertainty and lack of up to date -information (Hilborn et al. 2001), and competition from other sources of nutrition (e.g. Anon. 2011a). Many of these problems stem from inadequacies in governance and conflicts over the use of resources (Anon. 2012a). Lake fisheries are further challenged by multiple deep-rooted interests in aquatic environment. The Finnish lake fisheries, which is one of the major commercial inland fishery systems in Europe (Sipponen et al. 2010) produces a considerable share of fish for domestic human consumption and also for export (Anon. 2010, 2011b). Its distinctive feature is that vendace (*Coregonus albula* (L.)) is the overwhelmingly most important target species. The fluctuation of vendace stocks has been a major issue for the existence and development of commercial Finnish lake fishing (Turunen et al. 1998, Karjalainen et al. 2000).

Considering the relatively large total area of lakes suitable for commercial fishing and small number of fishers (III), one could assume that the coexistence of commercial fishing and other uses of lake environments would not be a major issue for Finnish fisheries management. There is a number of issues (eg. Varjopuro & Salmi 1999) concerning commercial use of the resources, such as access and fair distribution of environmental goods, that stem from the long history of private ownership of land and from multi-species and -purpose fishing nearly everywhere on the lakes. Fishing grounds are located near to very popular and continuously growing summer cottage culture. This is a phenomenon where local and non-local environmental interest meet, closely tied to ownership of fishing rights (Muje 1995a, Lappalainen 1998, Salmi & Muje 2001).

The challenge of developing commercial lake fishing – or keeping it on the surface – is thereby complex, touching a range of issues from fish population dynamics and stock conservation to regulation of fishing and related economic issues, and further to interest groups' attitudes on the use of environment. Thus, the research and developmental tasks call for a multi-disciplinary approach (e.g. Andersen 1978, Pollnac & Littlefield 1983). Fishery research has achieved progress in terms of methods and models for sustainable use of fish resources (e.g. Pitcher at al. 1998), yet local or regional resource management systems remain the critical issue in sustainability. Sustainability is widely understood to be at the core of efforts to develop inland fisheries, yet often lacking an integrated view of social, economic and ecological aspects (Cowx & Van Anrooy 2010).

In this study an effort is made to evaluate a novel management approach, interlocked fishing district (IFD, I), as a solution to the question of developing sustainability of commercial lake fishing in the context of private ownership of fishing rights. As a management strategy IFD aims at utilization of the fish stocks in the IFD area according to the ecological state of stocks. In order to understand requirements of this approach in the context of fishery based on privately owned fishing rights, one needs to look at the theoretical and conceptual basis of sustainability, private ownership of natural resources and fishery management.

2 OBJECTIVES

2.1 Interlocked Fishing District (IFD) – a tool for resource-based fisheries management

In this thesis a novel management approach for commercial lake fishery interlocked fishing district, (IFD, refers to the geographical area where the lakes or their parts and stocks under exploitation are located) is studied in order to analyze its potential for sustainability of lake fisheries compared to the present management practices. As the fishery management institutions, both legislation and private ownership -based management structure have developed over a long period of time, the second main objective is to find out how IFD is applicable in the Finnish lake fishery system.

2.2 Measuring sustainability-effects of the management system

In this study, the criteria applied for assessing the sustainability of interlocked fishing district (IFD) and the set of measurable sustainability indicators, are divided according to sustainability components (see chapter 3.2):

Ecological sustainability:
The issues of ecological sustainability are studied in articles I and IV from the point of view of IFD's effect on individual fishers and the management system. Could the IFD enhance ecological sustainability by increasing fishers' access to resources with higher abundance than at present? Can the management system develop towards ecologically defined units?

Indicators: Increase of yield per unit effort (YPUE) in the case of interlocked fishery (I); required increase in fishing effort (for economic sustainability) in the case-study (VI); IFD's effect on risk of stock collapse (IV).

Socio-economic sustainability:
The analysis of socio-economic sustainability of the proposed system seeks to answer the following questions: how the management system at present provides access for the commercial fishers and how this responds to the needs of developing the profession (III)? The management system incorporates a wide range of interest-groups and therefore the socio-economic analysis includes the effects on the groups that are most closely and in the case of Finnish lake fishery also very extensively connected to the fishery: the private fishing rights owners of shareholders associations (V); How they view economic utilization and the IFD in their area?

Economic sustainability of commercial fishing is studied as a separate issue, linking the interlocked use of fish stocks to the theory of economics (I) and demonstrating what economic effects the IFD would have at the local level in the Finnish inland fishery system (IV).

Indicators: Availability of lakes (stocks) for increased fishing effort within an IFD over a long period of time; Profit and yield gains of interlocked fishery (I, III, IV); Fishers' willingness to increase their mobility within a proposed IFD (III); Economic point of productivity in the case-study (VI) and IFD's effect of variation of inter-annual yield for individual fishers (IV).

Community sustainability:
Key interest groups' attitudes towards commercial use of lakes and local management bodies' readiness and ability to apply the IFD (V). The Finnish inland fisheries management system is fundamentally based on local communities and land-ownership therein.

Indicators: Key interest groups' attitudes towards commercial fishing and readiness to apply IFD (III, V), Fishers' willingness to increase their mobility within a proposed IFD (III).

Institutional sustainability:
The institutional sustainability is studied concerning lake fisheries management aiming to cover the central concepts of management and ownership structure, fisheries legislation and the practices pursued institutionally and in the management (V). The aim is to describe the present status of lake fishery system concerning sustainability, and its institutional readiness for enhancing sustainability through the IFD.

Indicators: Applications of sustainability related concepts in Finnish lake fisheries, including management and legislation; institutional readiness (II) and local management bodies' readiness to apply the IFD (V).

Overall sustainability:
Overall sustainability of the fishery can be seen to require simultaneous achievement of all four components. Aggregates of sustainability indicators for forming indices are not applied in this study due to incommensurability of many sustainability indicators. Overall sustainability is assessed through the components′ indicators as their potential to exceed the present pattern of geographically tightly limited utilization and management of fish stocks.

3 THEORETICAL BACKGROUND

3.1 Sustainability and natural resources

The origin of the idea of sustainability can be traced back to the development of the relation of nature and culture from ancient to modern times. Gradually the prevailing ideas developed from 'the Earth designed for man' to 'influence of the environment on man' and finally to 'man's influence on the environment' (Glacken 1962). Man's relation to nature and natural resources has a long history from conservation to exhaustion, with the striking examples of overutilization evident in many fields (e.g. Marsh 1864). The concept of sustainability is based on the requirement of sustenance, survival or flourishing of a process, an organism or a resource. In science, efforts are made to identify and explain factors that are crucial for the entity under study, but scientific theories do not designate which entities should be sustained. For the justification of use of resources, an array of arguments is used from biodiversity to the needs of human societies (e.g. Pietarinen 2000, Loukola & Kyllönen 2005).

The way how sustainability is conceptualized is constantly changing, along with empirical circumstances. The most common arguments used in environmental issues can be categorized into three broad groups of conceptions, or philosophies of sustainability. The groups of conceptions are (Dobson 1998):

a. Critical natural capital where natural resources have only an instrumental role in the world, and the main goal of sustainability is human (present and future) well-being.
b. Irreversible nature where certain aspects or properties of nature cannot be substituted, and should be sustained whether or not they are regarded as critical to human well-being.
c. The value of nature which expands the intrinsic value (b) to concern nature more generally.

For conceptions a. and c. man's relation to nature can be clearly defined, the latter incorporating "*the recognition that nature, and its various component events and processes, is a particular historical phenomenon and should be valued as such*" (Holland 1994), whereas b. allows some degree of anthropogenetic alteration of nature. In the study of natural resources, these conceptions attempt to reconstruct the key elements of sustainability in order to make them meaningful, coherent and rational. In the broad meaning of the concept, natural resources overlap, resulting in intrigue connections concerning their use. Thus, when decisions on the use of the natural resources are made, following questions become important:

1. What are we to sustain?
2. Why should it be sustained?
3. How do we sustain it?

Within these conceptions man's relation to nature is understood so that a. represents purely anthropocentric stand and c. represents purely ecocentric stand (Loukola & Kyllönen 2005). These contrasting views are also referred to as weak and strong conceptions of sustainability respectively (e.g. Costanza & Daly 1992).

When anthropocentric and ecocentric stands are being implemented in practical situations, the arguments concerning e.g. some specific element of a broad question on the "use of aquatic environment", may range through all of the conceptions. This is reflected also in Finnish legislation (Fisheries Act 1982/286, e.g. 1§). It has been claimed that it does not make a difference in practice whether the reasons are anthropocentric or ecocentric, once we take the interests of future generations of human beings into account (Norton 1991). Norton's view is that the interest of future generations is protected by protection of biodiversity and the maintenance of ecosystem health. Policies that serve the interest of human beings can in the long run also serve the 'interests' of nature. Ecosystem health has an important role in the Water Framework Directive (WFD) of the European Union (Anon. 2000). At present a reformation of the fisheries legislation in Finland is under way, with "ecologically, economically and socially sustainable use and maintenance of fish resources, by securing sustainable and diverse yield, natural life-cycle of fish stocks and diversity of fish resources and other parts of nature" (Anon. 2012b, transl. K.M.).

Implementing sustainability in human systems inevitably requires efforts from the society, such as funds, resources and institutions. This leads to two questions: How much resources we are willing to invest in sustainability, and how do we justify the use of society's resources and institutions for sustaining one entity in preference to another? (Loukola & Kyllönen 2005). In this context, the political decision-making becomes crucial. It steers the distribution of society's resources at the level of institutions (e.g. legislation and institutional structure) as well as in the practices of management bodies at all levels of management, governmental or non-governmental. Consequently, political interests concerning social justice or fair distribution of environmental goods, or how these could be achieved, are joined with the natural resource-oriented view of sustainability (Low & Gleeson 1998).

The human system and man's effect on the natural environment drew more attention when the concept of *sustainable development* was introduced. According to Charles (2001), the concept was popularized by the Brundtland report (Anon. 1987) and subsequently by the United Nations' Conference on Environment and Development in 1992. Since then the pursuit of sustainable development has become a *de facto* requirement for public policy. Sustainability, that had long been recognized as fundamental to human societies around the world, took a major role in public debate internationally (Charles 2001).

In the effort trying to broadly cover the human–nature-interaction, definitions of sustainable development have taken multiple forms. The best known of these is the one of the World Commission on Environment and Development (Anon. 1987). With no single agreed definition, there is wide recognition to view sustainable development broadly (e.g. Robinson et al. 1990, Pezzey 1992). In the case of fisheries, the present discussion adopts this integrated view of sustainability, focusing on the sustainability of the fishery system as a whole. Adopting this perspective is helpful in providing us with a better view of the problem of sustainability, yet it does not lead to easy solutions (Charles 2001).

Covering sustainability requires both qualitative approaches (management approaches and policy directions) that might serve to promote sustainability, and quantitative approaches (assessing and predicting sustainability) (Charles 2001). These themes have been examined by various authors (e.g. Kuik & Verbruggen 1991, Munasinghe & Shearer 1995, Atkinson et al. 1997). Recently there has been an increase in fishery-specific applications (e.g. McClanahan & Castilla 2007).

3.2 Sustainability and fisheries

The need for emphasizing sustainability in the fishery system as a whole was presented by Charles (1998) in the context of marine fisheries. He presented three classes of 'fishery world views', with which fishery conflicts and policy questions can be analysed: conservation, rationalization, social/community paradigm (Charles 1992). As various combinations, these paradigms are the basis of the development of the goals in the theory and practice of fisheries.

The fundamental goal of fisheries theory and practice is determining the *sustainable yield,* i.e. harvest that can be taken today without being detrimental to the resource available in future years (Charles 2001). In many types of fisheries worldwide, the focus has been on determining a sustainable yield (Schaefer 1954, Beverton & Holt 1957, Ricker 1975, Gulland 1977). In the effort to determine a sustainable yield one can seek the maximum sustainable yield (MSY), i.e. the most fish that can be caught each year, or a lower yield level that balances the multiplicity of objectives in the fishery system (Charles 1994). While aiming to reach this goal, according to Charles (2001) "*fishery science has evolved as essentially a science of sustainability*", in which the emphasis has been on the determination of sustainable yields.

In the past few decades focusing on sustainable yield has turned out to be insufficient. While the balancing of present and future catches is important, it has become evident that focusing on the *output* requires also attention to sustaining the processes underlying the fishery (Charles 2001). This realization has led to the need to pursue *sustainable fisheries* in fishery discussions (e.g. Anon. 1999). This typically implies attention to the health of the aquatic ecosystem (e.g. Anon 2000) and to the integrity of ecological interactions (Charles 2001).

Despite the abundance of discussion on how sustainability can be measured, very little has been applied to fishery systems, or even marine coastal and watershed systems. Charles (2001) makes an effort towards systematic sustainability *assessment.* In his integrated approach, sustainability involves direct resource conservation, but also recognizes that, since fishery exploitation levels can vary over a wide range and still technically achieve 'conservation' (biologically sustainable yields), varying impacts on the broader ecosystem and the achievement of human goals must be taken into account in deciding upon the harvest strategy. Thus, a multifaceted view is required.

The discussions on sustainability are increasingly being linked with the critical concept of *resilience* (Charles 2001). The idea of resilience, a system's ability to absorb or bounce back from perturbations caused by natural or human actions (Holling 1973), was first formulated with ecosystems in mind. It is also relevant in other parts of the fishery system, including the human activities.

Charles (2001) suggests a sustainability assessment framework for evaluating both qualitatively and quantitatively the nature and extent of sustainability in a given resource system (present or proposed, see chapter 2). This includes a. evaluating a current situation (e.g. the sustainability of an existing fishery system, as a form of 'status report', for example, involving the assessment of both ecological and human carrying capacity) and b. predicting *a priori* the consequences of a proposed activity, such as a new coastal fishery or a proposed management approach, in terms of enhancing or reducing sustainability (in parallel with the Environmental Impact Assessment).

According to Charles, the sustainability assessment involves four steps (Charles 1997):

1. Deciding on a set of relevant sustainability components for the fishery system, which together reflect the overall idea of 'fishery sustainability'.
2. Developing a concrete set of criteria that must be evaluated in assessing each component of sustainability.
3. Determining a corresponding set of quantifiable sustainability indicators, reflecting the measurable status of each of the criteria, and allowing comparisons between criteria.
4. Formulating suitable means to aggregate the indicators into indices of sustainability, perhaps one for each component of sustainability (if the indicators within a given sustainability component are at least somewhat comparable), or to otherwise facilitate comparison across indicators, recognizing that comparisons of fundamentally non-

commensurable indicators (e.g. such as attitudes towards commercial fishing and increase of YPUE in IFD) should be left to policy-makers.

For the components of sustainability Charles (1994) suggests the following: ecological sustainability (avoiding foreclosure of future options), socio-economic sustainability (sustainable and equitable economic and social benefits), community sustainability (valuing community as more than a collection of individuals) and institutional sustainability (long-term capabilities/resource system manageability). According to Charles (1994), the components include following features:

Ecological sustainability consists of (a) long-standing concern for ensuring that harvests are sustainable, in the sense of avoiding depletion of the fish stocks, (b) the broader concern of maintaining the resource base and related species at levels that do not foreclose future options, and (c) the fundamental task of maintaining and or enhancing the resilience and overall health of the ecosystem.

Socio-economic sustainability focuses on the 'macro' level, i.e. maintaining or enhancing overall long term socio-economic welfare. This is based on a blend of relevant economic and social indicators, focusing essentially on the generation of sustainable net benefits (including resource rents), a reasonable distribution of those benefits amongst the fishery participants, and maintenance of the system's overall viability within local and global economies. Each indicator in this group is typically measured at the level of individuals, and aggregated across the given fishery system.

Community sustainability emphasizes the 'micro' level, i.e. focusing on the desirability of sustaining communities as valuable human systems in their own right, and more than a simple collection of individuals. Hence, the emphasis is on maintaining or enhancing the 'group' welfare of human communities in the fishery by maintaining or enhancing, in each community, its economic and socio-cultural well-being, its overall cohesiveness, and the long-term health of the relevant human systems.

Institutional sustainability involves maintaining suitable financial, administrative and organizational capability over the long term, as a prerequisite for these three components of sustainability. Institutional sustainability refers in particular to the sets of management rules by which the fishery is governed at fisher or community level, and whether formally (e.g. the legal system and the governmental agencies) or informally (e.g. fisher associations and non-governmental organizations). A key requirement in the pursuit of institutional sustainability is likely to be the manageability and enforceability of resource use regulations (Charles 2001).

These components of sustainability are applied in this study due to their extensiveness in terms of nature–society relation and relations within the society. This is required due to the extent of fishery-related interactions in the Finnish society (see chapter 3.4). In relation to the conceptions of sustainability (chapter 3.1), these components emphasize conceptions a. "critical natural capital", as ecological sustainability aims to a considerable extent at providing for human needs and b. "irreversible nature", with the third element of ecological sustainability.

Socio-economic, community and institutional sustainability by definition emphasize the anthropocentric conception a. However, the ability of legal and management institutions (i.e. institutional sustainability) is obviously required for fulfilling specific protection or conservation needs of species or areas according to conceptions b. and c. ("the value of nature").

It is important to notice that viewing less than four of the components of sustainability may lead to false conclusions, especially in the case of fishery system that has long historical roots and widespread importance in the society. Changes in the fishery system affect the elements of sustainability unevenly. According to Charles (2001) "*Overall sustainability of the fishery can be seen to require simultaneous achievement of all four components. Thus, a proposed fishing activity or fishery management measure will be unacceptable if it produces an overly negative impact on any one component. In other words, overall system sustainability would decline through a policy that increases one element at the expense of excessive reductions in any other*." However, theoretically it is possible that neutral or slightly negative effect on one element may still lead to positive overall sustainability. In some cases this could result from intended or unintended acceptance of anthropocentric instead of ecocentric sustainability (Arlinghaus et al. 2002).

The components of sustainability may be measured by quantitative means, as has been attempted in this thesis, in order to form indicators for measuring overall sustainability. The problem of this measurement lies in the choice of the indicators, for which there is no absolute criteria. For example with ecological sustainability, avoiding stock collapse is a clear criterion, but (in cases when this limit can be measured) setting that as a goal of fishery management immediately poses the question "how close to stock collapse limit can we go?", thus leaving the management with a number of options.

Another difficulty of measuring sustainability is determining the level of the non-biological components of sustainability, for which mainly qualitative approach has been applied (V). E.g. with socio-economic sustainability, what is an "adequate dispersion of economic benefits"? In this study the question touches the number of fishers that are offered an opportunity to utilize IFD, in terms of total number of fishers in the area and also sub-area specific limitation, as well as the owners receiving economic gains but potentially experiencing harms of increased economic utilization.

Another complication is the delay between measurement of state of resources and management measures. Establishing a novel management system will reveal its sustainability in the long run, when the actors involved have encountered various situations within the system and external effects. There can hardly be certainty if a management system can produce the "right" decision to any given situation at hand, but one can be more certain of the system's ability to address the situation in a manner that in the long run will promote sustainability.

3.3 Fisheries management – tools for sustainability

Fisheries management consists of the following elements (De la Mare 1998, Caddy 1999, Charles 2001): Assessment (i.e. determining stock sizes, efforts and catches, recognizing alternative management objectives), decision-making (i.e. choice of strategic objectives), selection of harvest strategies and tactics, implementation of chosen tactics and measures and controls over implementation. The Gordon–Schaefer-diagram (Gordon 1954, Anderson 1986) shows that with annual sustainable yield or revenue and operation costs in relation to annual fishing effort, given certain assumptions, any combination of effort and yield on the curve is sustainable biologically. This opens up a variety of harvesting options for the fishery management. The choice between them depends on the strategic goal set by the management. "*Indeed, strategic fishery goals are ultimately implemented in the fishery largely through the choice of a specific level of harvesting*" (Charles 2001).

The alternatives for the strategic goal, if it is determined by the management, are maximum biomass, maximum sustainable yield (MSY, see Graham 1935, Schaefer 1954 & 1957, Beverton & Holt 1957), maximum fishing employment (MFE), Maximum economic yield (MEY), Maximum social yield or optimum sustainable yield (OSY, Roedel 1975).

In OSY, an annual effort level maximizes a multi-objective blend of socio-economic values, including equity, employment and rents, with appropriate weighing of each goal. These objectives are determined by several actors in the fishery management systems, e.g. equity (in participation and access) initially by the legislation and in practice periodically by the local management. Thus, optimum yield is indeed an extremely flexible concept (Larkin 1977). None of these are explicitly set as a target of Finnish inland fisheries. The Fisheries Act (1982/286, 1§) aims to cover targets from conservation to commercial utilization. The target is greatly affected by the development of the management system, especially by the ownership structure. In practical fishery management this has resulted in policies that are in line with OSY as a strategic goal (Sipponen 1998).

The strategic goals mentioned above are essentially implemented by setting an annual effort level, determined according to best available information on the fish stocks. As there are considerable uncertainties concerning availability and accuracy of information (e.g. Hilden 1997, Charles 2001), in many cases resulting in drastic failures, fisheries management has been forced to look for more wide-ranging and far-sighted approaches, focusing beyond mere fish populations.

Risk management aims to find the best course of action for the management, in cases when risks concerning input or output have been identified, and quantified by risk assessment (Charles 2001). The process of dealing with risks includes two stages, risk assessment and risk management, in which the uncertainty is taken into account in the management. In many cases this takes place informally, with little or no documentation or link to assessment (Francis & Shotton 1997). The tools for dealing with these risks include precautionary approach and portfolio management (Sethi 2010).

Precautionary approach (Garcia 1994, Anon. 1995a, Charles 2001) involves the application of prudent foresight to avoid unacceptable or undesirable situations. At the core of precautionary approach is uncertainty concerning the state of fish stocks as well as concerning human activities (Charles 2001). Concerning applications of precautionary approach, according to Hilborn et al. (2001) "*Considerable progress has been made in the implementation of the precautionary approach to the protection of fish stocks, but applying precautionary approach to fishingcommunities lags considerably*".

Portfolio management aims at utilizing different fish stocks that are joined by ecology (e.g. predation) and unspecialized fishing technology and species in an ecologically unified area (Hanna 1998, Edwards et al. 2004). In adaptive management, management actions are implemented within a well-defined framework for setting goals, monitoring and evaluation of outcomes (Holling 1980, Walters 1986, Clark et al. 1995). There is a diversity of local or traditional practices for ecosystem management that have similarities to adaptive management (Berkes et al. 2000).

Fisheries management can and does take place also without externally imposed (e.g. state) management. Then the question is of *folk management*, which originates from fishers' need to manage their own activity in relation to natural resources. "*Formally defined it is any localized behavior originating outside state control that facilitates the sustainable utilization of renewable natural resources*" (Dyer & Goodwin 1994). Folk management can take similar forms with institutionalized management (e.g. controlling entry or enhancing productivity), and can develop credible commitments concerning the use of common pool resources, in many cases without relying on external authorities (Ostrom et al.1992).

Folk management has several synonyms, e.g. traditional management and localized management, self-management, indigenous management, community-based management and organic management (Dyer & Goodwin 1994). McCay (1981) described three basic strategies that are common in folk management:

1. The assertion of property rights over prime fishing spaces
2. The exclusion of outsiders from areas that fishing communities assert are their own
3. The manipulation of information such that localized fishers at least temporarily claim ownership to certain fish stocks

The concept of co-management was developed to describe management arrangements with joint responsibilities of government and local community (Pinkerton 1989, Berkes et al. 1991). Based on an extensive set of case-studies, Pinkerton formulated a set of general conditions associated with successful folk- and co-management regimes (see Pinkerton 1994a). In this context it is important to note that folk management exists alongside with externally imposed management regimes – partly influenced by them, partly in spite of them (Dyer & Goodwin 1994). That is to say when fishing and its regulation is conducted at least to some extent by local people with experience-based knowledge of the area and resource, no novel management arrangement can completely replace folk management.

Fishing grounds constitute one type of resource system, which is managed as common-pool resource. The term refers to a natural or man-made system large enough for producing benefits while still possible to exclude potential beneficiaries from its use (Ostrom 1990). Ostrom makes the distinction of resource system and resource unit, the latter referring to utility (appropriation or tangible use) of the system. Further, Ostrom (1990) refers to the resource as stock and harvest of use units as flow, linking this distinction with sustained use of renewable resources.

If the strategic level of resource exploitation has been determined, the fishery management needs to determine the measures (tactics) for achieving the goal. The focus can be on the harvesting sector, but integrated management takes into account the full fishery system, including processing, distribution, marketing and consumption (Charles 2001).

The choice between management measures (input and output controls, technical measures, ecologically based management and indirect economic instruments), depends on assessing the conservation, socio-economic and manageability implications of these categories. Eventually a set of management measures is chosen, based on an understanding of the extent to which each category (or measure) achieves the stated objectives, the extent to which each of these is compatible with the desired policies, and the extent to which each is feasible from a management perspective (Charles 2001).

The management cycle (Fig. 1) illustrates the phases of functioning management system where the participants affect the choices concerning the fishery and thereby its outcomes. Fisheries management as a system incorporates also physical world (De la Mare 1998), to which each management cycle needs to adapt.

Along with constantly occurring problems concerning the sustainable use of fish stocks there have been calls for more integrated solutions for developing fisheries management, such as “development of conceptual framework and an appropriate methodology for *interdisciplinary decision making* in fisheries management“(Stephenson & Lane 1995).

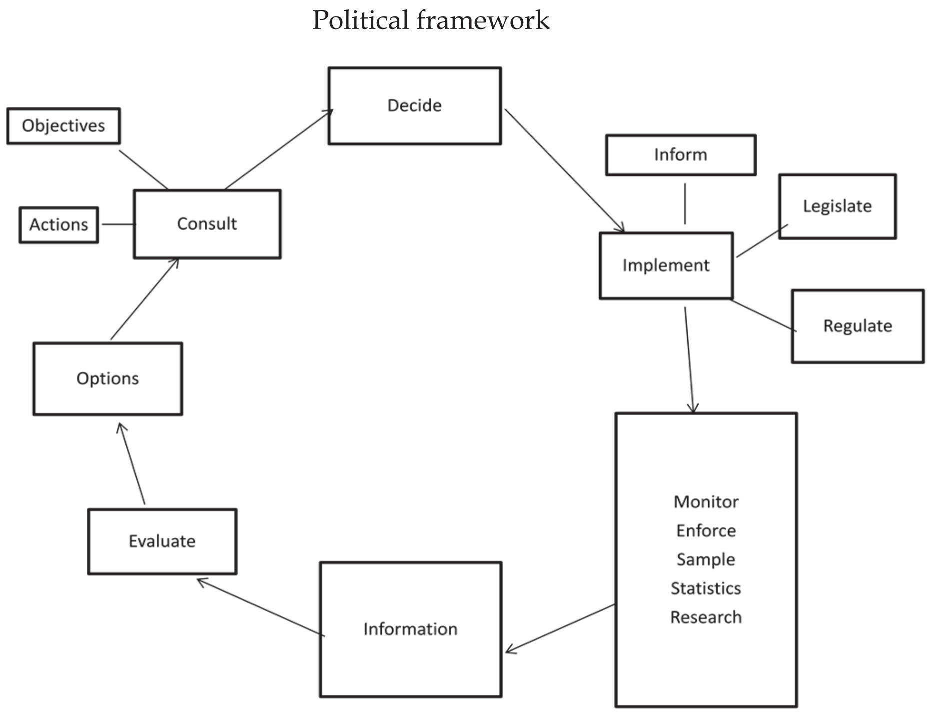

FIGURE 1 The idealized management cycle of fisheries systems (Anon 1995b).

The complexity of the fishery systems and the crises they face calls for holistic management approach in terms of ecosystem-based fishery management, precautionary approach and sharing management responsibilities between central and local management organizations (McClanahan & Castilla 2007). Sustainability is also considerably affected by the structure and historical development of the management system, which in the case of Finnish lake fisheries has over a period of 110 years and three major changes in legislation that have lead to the present institutional, social and geographical structure in the fisheries. The present renovation of the fisheries legislation may bring about considerable institutional and structural changes in the fisheries system (Anon 2012b).

3.4 Sustainability and property rights

Property rights are a fundamental factor in the use of natural resources. Most environmental problems can be seen as problems of incomplete, inconsistent or unenforced property rights regimes (Hanna et al. 1995). These regimes comprise property rights (entitlements regarding resource use) and property rules (with which these entitlements are exercised) (Hanna et al. 1995). “The tragedy of the commons" (Hardin 1968) clarified the outcome of inadequate specification of property rights to environmental services.

A fundamental link between natural resources and their use for human purposes is constructed through property rights. Property is linked with ownership of physical objects (e.g. land), but essentially property is a benefit stream that results from ownership. Thus, "*property is not an object but a social relation that defines the property holder with respect to something of value against all others*" (Bromley 1991). In essence property is a triadic social relation involving benefit streams, rights holders and duty bearers. In short, property includes a benefit stream for the property owner that is demarcated by rights (of the rights holders). Those not included in the rights holders are duty bearers, i.e. no matter what their relation to the property is, their duty is to respect the rights of the rights holders. Rights connected to natural resources can be divided to access and harvest rights, management rights and exclusion and alienation rights (Bromley 1991).

Excursion: Private ownership and fisheries management in Finland

In the case of lake fisheries in Finland (Sipponen 1999) the private property concerned is the fishing right. The social relation structured around private property forms a phenomenon that reaches deep and wide into the society. The connection of fishing rights to land ownership (Vihervuori 1988, Määttä 2002) initiated this development and the spreading ownership of rural land among urban population mainly through popularity of summer-cottages and urbanization of the society (Muje 1995a, Vilska 2006) secured its extensiveness.

The benefit stream vested in ownership of fishing rights in Finland includes:

i) fishing right of the shareholder in a shareholders' association (Fisheries Act 1982/286, 5§)
ii) right of participation in decision making (Act on jointly owned areas 2000/686, 8§)
iii) exclusion right (Fisheries Act 1982/286; 2, 61, 62§)
iv) alienation right (Fisheries Act 1982/286 [2000/687],18§)

Private ownership of fishing right is mainly structured through shareholders' associations especially on lakes (93 %), and partly by private individual or corporate ownership. In the statutory fisheries regions the majority of legal participants are representatives of shareholders' associations (Fisheries Act 1982/286, chapter 9). The right of participation in decision-making extends to fisheries region through representation of shareholders' association (Fisheries Act 1982/286, 73§). The size of a shareholder's share (usually land estate) defines the rights, according to Fisheries Act and by-laws of the shareholders' association. However, even the smallest estates do have all of these rights that in effect allow for recreational fishing (even with gill-nets), participation in decision-making (where in most cases one vote per man has been applied; Muje 1995a), thereby opening the possibility of exclusion of some other interest groups.

Finally, the alienation right may seem unimportant in the case of small estates, especially when licences are relatively inexpensive and other access rights are available. With larger estates this may grow in importance through connection to commercial fishing, but a change in the small (economic) importance of fragmented shares is only a matter of change in the market situation or in the interests concerning the regulation of use. In any case, these rights exist in the present legislation, forming a strong statutory connection between ownership and utilization of lake environment. Thereby the elements of sustainability are inherently connected to private ownership of fishing rights.

The benefits of ownership of fishing rights have been spread wide into the society with 1.35 million property units in shareholders' associations (Vilska 2006). In active shareholders' associations there were approximately 0.55 million shareholders in 1999 (Salmi et al. 2002). Personal access to fishing rights based on private ownership of more than doubles through family. The number of privately owned (by a sole owner) water areas was at the same time approximately 14400 (Salmi et al. 2002). The magnitude of private ownership of fishing rights in the Finnish society makes it socio-economically important factor that links rural and urban populations: Urbanization and fragmentation of rural land-ownership has led to a situation where the majority of shareholders both in terms of share and number are in fact non-local people (Muje et al. 2001).

The importance of this relation is emphasized by the popularity of subsistence and more recently recreational fishing: owner-shareholders are often active recreational fishers (Muje 1995b, Salmi et al. 2006), thus having knowledge both on local circumstances and the needs of other recreational fishers, of which there are 1.9 million (37 % of the population) (Anon. 2011c). Thereby also members of various interest groups participate in the local decision-making and obtain benefits from the ownership (Muje 1995a). The owners' views on the meanings of ownership are multifaceted (Tonder & Muje 2002) and strongly linked with the first three rights mentioned above.

Concerning the structure and potential development of fishery management, the common view of non-local shareholders of having ownership of a whole lake instead of only the shareholders' associations' designated area is noteworthy (Tonder & Muje 2002). This group of private owners seems to have a conception ownership that corresponds with resource- or ecosystem-based management.

3.5 Private ownership and rights of utilization

In Finnish lake fishery, angling and ice-fishing with rod do not require a permit at all, yet they are connected to ownership by a statutory compensation from the state to owners of fishing rights. Fishing with one lure can be done by a permit obtained from the state, as well as by local or regional licences.

As to harvest rights, private property is important. Fishing with efficient passive gear, like gill-nets and fyke-nets, and active gear like seines and trawls, require permit from the property owner. Seining in winter and trawling in summer are the most common gear used in commercial fishing. Trolling with more than one lure also need owner's permit. The most efficient (all commercial) gear are bound to private ownership, but as recreational fishing is extremely popular, a considerable part of harvesting is conducted outside ownership-based regulation.

Management rights are to a great extent bound to ownership through the owners' legal status as the main actor in care and maintenance of the fishery (Fisheries Act 1982/286, 2 §). Fisheries legislation includes exclusion rights concerning situations when the resource requires periodic or specific area for protection from use, but the law does not facilitate exclusion at will for the owners: The needs of commercial as well as recreational fishing should be met by the management (Fisheries Act 1982/286, 1§, 2§, 7§ [1996/1045 and 2000/687] & 11§ [2009/1462]). Alienation rights have developed recently allowing individual owners' fishing right to be subject of trade (Fisheries Act 1982, 18§ [2000/687]), which has opened some more opportunities for the commercial fishers.

The widespread private ownership, multiple recreational and commercial use of the lakes and the increased possibility of shareholders to utilize their property have emphasized ownership in relation to issues concerning sustainability. While economic development has been facilitated, the relations within and between interest groups may have become more complicated.

3.6 The management of Finnish lake fisheries

Resource management regimes are divided into four categories: State property regimes, private property regimes, common property regimes and non-property regimes (open access). The management of Finnish lakes is a combination of private property regime with state property regime reaching to the open water areas in nine major lakes. In the management procedures these are partly joined with the management of the private areas, as the local fisheries region is by law in charge of the management of state-owned public water areas (Fisheries Act 1982/286, 7§).

The structure of fisheries management is described at length in Sipponen (1999) and concisely in this thesis (III; access rights in chapter 3.5). Fishery association (since 2002 change of law (1989/758) shareholders' association of jointly possessed fishing water acts as fishery association in fishery-related matters) and its task in the management in private ownership of property may be misleading in two ways: Shareholders' association deals with fishery issues, but its historical base is in land ownership.

As water areas were the most typical type of area used for common purposes, fishery association were established in 1902 (Fisheries Act 1902) as a voluntary unit for managing jointly owned areas of adjacent land estates, and made compulsory in the 1951 Fisheries Act. This Act in effect marked the beginning of statutory ownership-based connection between fishery management and a wide range of social interests (see chapter 1.3.4). Based on the 1902 and 1951 Acts, the basic structure of local fishery management is bound to land-estates with no functional connection to water-areas, not to any unit of aquatic environment (Määttä 2002). Fishing on inland lakes has for the great majority of shareholders been a secondary source of livelihood (Lappalainen 1998).

Despite being the proprietor of fisheries association, i.e. a group of real-estate holders, the "*shareholder association is not a commercial unit, and earlier its activities have largely been based on self-management*" (Sipponen 1999). The main task of fisheries associations is to organize and manage fishing, the maintenance of the resource (Nordqvist 1903, Fisheries Act 1951/503, 53§ & 1982 /286, 2§) and practically all of fisheries associations' net income is used for this purpose (Salmi et al. 2002).

Fisheries regions were introduced to the management structure in the 1982 Fisheries Act (1982/286, 68§–85§), as a response to local fisheries associations' slow pace in forming larger management unit on ecologically determined areas on a voluntary basis (Sipponen 1999) and to overcome problems related to the small size of shareholder's associations (III).

At present fisheries regions have gained an established status as a regional/intermediate management unit, between provincial Fishery Districts (local fishery authority) and shareholders' associations. However, their legal status between private and public law is in some matters unclear or limited in terms of power in decision making. Geographically they cover in practice all inland waters, with the exception of state-owned public water on nine of the largest lakes (3 % of water area). Even this water area is under the control of fisheries region (Fisheries Act 1982/286, 7§).

3.7 Management structure, local policies and sustainability

In addition to the development of the management structure (see above), local rules play an important role in the decision-making of shareholders' associations (Sipponen 1999).

Presently the management system of commercial lake fisheries is a combination of folk management and at individual scale portfolio management (Sipponen et al. 2006), within ecologically in terms of aquatic environment arbitrary ownership structure (Muje & Tonder 2002, Määttä 2002). The allocation of fishing effort has been steered by fragmentation of management units and their policy of typically at maximum one commercial fisher per shareholders' association, and further the fishing effort has been self-regulated by commercial fishers during the license periods (Marjomäki 2003). Eventually the contents of the utilization policy in this context are a result of fragmented management structure, local licensing policy and self-regulation during license periods.

Finnish inland fisheries management applies a combination of input controls (number of gear-units), technical measures (mesh-sizes, gear-restrictions) and ecologically based management (closed seasons/periods, conservation areas, size-limits). These are applied primarily at the local level of management, in Fisheries Regions, consequently forming a lake or water-basin level measure.

At present, in Finnish lake fisheries, assessing the state of fish stocks within the local management for regulation of fishing is largely based on local experience based knowledge (Salmi et al. 2002, Tonder & Muje 2002). The gear unit system as a basis for regulation of fishing has no equivalence with the biological state of fish stocks, due to lack of accurate biological information and development of fishing techniques since the unit system was introduced in the 1950's (Marjomäki et al. 2006). Despite this, sustainability issues have obviously been in consideration in determining number of units needed for different types of gear in order to prevent excessive utilization. On the other hand, demand for local units has gradually over the past decades decreased, being about 47 % of the total units (Marjomäki et al. 2005). For commercial fishing, 19 % of the total units were reserved and 30 % of shareholders' associations on major lake areas received licence income from commercial fishing (Nykänen & Muje 2005).

Consequently, the fisheries system includes elements that both unintentionally and by specific management design or activity facilitate sustainability. The system also includes institutional elements that facilitate unsustainable practices (the gear unit system), in case applied to full capacity without well-based and up-to-date biological information.

3.8 Commercial lake fishing – current situation and need for development

Finnish commercial lake fishing operates on the same areas and biological resources with popular recreational fishing, and it is a multi-species fishery with trawl and winter-seine as the main techniques and vendace as the main target species (Anon. 2010).

Commercial lake fishing struggles with a number of challenges caused by competition from other sources of mainly imported fish products and difficulties with access to resources (Salmi & Salmi 1993, Jurvansuu 1997, Sipponen 1998). The number of fishers has steadily decreased over the past few decades, lately reaching 220 professionals with at least 30 % of income from fishing (Anon. 2010). The development is gradually approaching a situation where both production of vendace and an important part of domestic fish consumption may become compromised. The total catch has remained steady in the recent years and the stocks could sustain higher level of utilization (Anon. 2010).

Commercial fishers have in several studies pointed out the fragmented management structure and consequent difficulty to access resources as one of the main problems of the profession (e.g. Salmi & Auvinen 1997, Salmi 1997a, Nykänen & Muje 2005). In the context of decreasing number of commercial fishers on a relatively extensive resource base, a wider concept of resource seems appropriate for addressing both the needs of the commercial fishing and aims set in the Fisheries Act (1982, 1§). It is noteworthy that despite the fragmentation of ownership units also the owner/shareholders with a non-local and recreational-fishing oriented majority tend to view the resource at a level of a lake instead of their shareholders' associations' designated water area (Tonder & Muje 2002).

4 MATERIAL AND METHODS

4.1 Economic model and reconstruction of an IFD (I)

The economic model is based on game theory where as a consequence of competition, the number of fishers in a given area may change. The model studies the effect of fishing location choice on the biology and economics of lake fisheries.

In the model, the fishers allocate their fishing effort between two locations, being active only on one of them. The fishers compare the expected profits of the two available areas and choose the area that yields them better profit. Equilibrium in the fishing effort is found when no single fisher finds it profitable to switch to another lake.

The two lakes differ in their production potential and initial number of fishers. The lakes are assumed to be similar in size but the stock sizes may be different as a result of changing fishing effort. The fishers are also assumed to have perfect knowledge of the state of the stocks, therefore the factor determining the choice of area is the amount of competition. The model developed by e.g. Mesterton-Gibbons (1993) is followed, with different stock sizes for each lake, following the Gordon–Schaefer model.

In the reconstruction of IFD, yield per unit effort (YPUE, kg/haul) data from vendace seine fishing from a 21 year period of three lakes within 100 km distance in Kuusamo area in North-Eastern Finland was used. The modelling was conducted a) by comparing interlocked YPUE (i.e. YPUE of the whole IFD) to lake-specific YPUE and b) allocating the interlocked fishing effort each year to the two lakes with highest stock densities, thus forming an IFD-arrangement based on preserving the weakest stock. Based on the modellings, five stock-variation related situations that require attention in the management of an IFD were described.

4.2 Sustainability related concepts and practices, document analysis (II)

The concepts and practices applied in Finnish lake fisheries were studied using fishery-related studies and documents, including those that concern estimates on state of the resources and institutional arrangements in regulation of fishing, such as legislation. Also reports of fishing advisory offices of the Federation of Finnish fisheries associations were included in the analysis as well as commercial and recreational fishers' attitudes as expressed in surveys. The concepts and practices used in lake fisheries were then evaluated in relation to the four dimensions of sustainability (chapter 3.2, Charles 2001).

4.3 Interlocked use of inland fish resources: a new management strategy under private property rights (III)

The method used in III was a survey conducted by postal questionnaire. The sampling frame (n = 596) comprised of all known (by register of regional authority, members of local associations of commercial fishers and informants of Finnish Game and Fisheries Research Institute) full- and part-time commercial fishers on Finnish lakes. The final response rate was 49 % and the number of usable answers was 217. Fishers were grouped according to the most important gear type used between 1999 and 2003. Gear type and some other factors, potentially important in assessing the present type of fishing and effect of the IFD, were cross-tabulated.

Fishers' possibility to gain higher yield within the IFD and tendency to follow stock information in practice was assessed by stock indices from their main- and desired grounds. With this information the fishers' sensitivity to allocate their fishing effort according to the state of stocks in the present and the IFD situation were assessed.

4.4 Comparison of policies for spatial allocation of annual fishing effort (IV)

Three different vendace stocks were simulated with similar population parameters. The populations were modelled to produce either low or high and either independent or highly synchronous stochasticity in inter-annual recruitment variation. Four simple policies for spatial allocation of annual fishing effort between these stocks, (1) evenly allocated fishing effort, (2) fishers distributed evenly on two most abundant stocks, (3) all fishing effort concentrated only on the most abundant stock and (4) fishing effort distributed in proportion to stock abundances, were evaluated.

The fisher-specific effort was either constant or auto-regulated aiming at low variation in yield. The allocation policies were evaluated with respect to certain criteria implying ecological and economical sustainability of fisheries system, namely their ability to produce high average yield with low effort, low inter-annual variation in yield and low risk of stock collapse. The variation in both total and fisher specific yield was analyzed.

4.5 Sustainability of spatially wider fishery license arrangements on Finnish lakes (V)

Focus-group interviews were used to study the possibility of a wider license system for commercial fishing in two case study-areas (lakes Keitele and Orivesi). The method was applied to study socio-economic and institutional sustainability through following questions: a) does the fragmented ownership structure (shareholders' associations) form an obstacle for establishing an IFD, b) what kind of management arrangement within the present institutional structure would be realistic for an IFD, c) how commercial fishers would adapt to the IFD and d) how different types of information (local and scientific/expert knowledge) is used now and could be utilized in fisheries management of an IFD.

Focus-group interview data were analyzed in two ways. First, the factual information from the interview was analyzed, as if it was a result of structured interview (Sulkunen 1990). In this way, the results of the interviews and surveys could be compared as far as the same themes had been studied. The second level of analysis was a frame-analysis in which the subjects' relation to institutional and discursive practices was studied (see e.g. Nieminen 1994). Frames can determined as aggregates of the activities that support different realities (through which actors determine themselves and their social environment).

The purpose of frame analysis was to analyze the dynamics of two specific frames in relation to development of commercial fishery. Based on previous studies on the management system (Salmi & Salmi 1997, Muje et al. 2001, Salmi et al. 2002, Tonder & Muje 2002, Nykänen & Muje 2005) two frames were determined, according to which the relation to wider licence systems (i.e. development of economic utilization of lakes and fish stocks) in commercial fishing was interpreted:

1) Private ownership -frame. This frame is bound to the ownership of fishing rights and practices and values of owner groups. The value-basis is in peasant-type of ownership (*talonpoikainen maanomistus*) of land (Nieminen 1994), which means that it is value-rational to own land (i.e. fishing rights) and to utilize it. In this context the value-basis connected to lake-environment is multidimensional, including both non-economic and economic values.
2) Utilization-frame. This frame is closely connected to commercial fishing, private entrepreneurship and a view of lake environment (especially fish stocks) as a subject of economic utilization. The frame does not exclude non-economic values, but the question is about prioritization.

4.6 Economic feasibility and sustainability – case study (VI)

The data for this study were picked from the national survey described in chapter 4.3. All fishers active in Lake Keitele and its surrounding five lakes were included in the study. The economic situation of the individual fishers and its implications to state of the resource was assessed in two management applications, the present and the IFD application.

The fishers' needs, willingness and ability to increase their fishing effort were estimated according to the answers of the survey. The effect and costs of increased effort was analyzed up to the point where the increased mobility covers the costs of applying the IFD and opens the option of wider resource base. The effect of increased fishing effort to the state of the resource (fish stocks) in the IFD application was assumed to be linear. In addition, the IFD's effect on the economy of the management system was assessed by cost-benefit analysis, where the establishing costs were estimated and the increased incomes from the licences to the owners of fishing rights were known.

5 RESULTS AND DISCUSSION

5.1 Institutional sustainability

Institutional sustainability consists of the systems' financial, administrative and organizational capability to support the other three components of sustainability. For commercial vendace fishing the main condition to which the system needs to adapt is the high inter-annual fluctuation of the stocks.

In I, the prerequisites for IFD-arrangement in the present institutional structure of Finnish lake fisheries were studied by modelling the yields and profits of fishers from the actual YPUE data from commercial fishery of three lakes in Northern Finland and by a theoretical economic modelling.

Based on the model results, state of stocks in an IFD, five key questions and situations were formulated. The proper management rules should be found for these situations in order to fulfill the requirements of institutional sustainability (see chapter 3.2). These situations can be confronted both when establishing the arrangement and while IFD is already functioning:

a. depletion of resources, no good areas - How to cope with low stocks?
b. depletion of resources, few good areas - How high can the increased fishing effort be?
c. depletion of resources, several good areas - How to allocate the fishing effort spatially?
d. all stocks near long term average - No need for mobility?
e. no depletion of resources, one or more abundant stocks - How to share abundance?

At present, the management system and especially the fishers often face the problem of declining yield with limited chances to use the resource on the lisence area or to change target area (III).

Establishment of the IFD-arrangement can take place in any of the situations as long as the actors of management in each situation have enough information on the state of fish stocks. This is usually mainly experience based information which describes state of stocks roughly to the categories of low, mediocre or abundant stocks. A basic assumption was also that the present state is passing and there was going to be fluctuation within a certain period (I). A central question in the establishment of IFD is the geographical extent of the area: how many lakes and how many management units (shareholders' associations and fisheries regions; and from the fishers point of view sub-gronds) should be included (V)? The actors forming the arrangement need to consider this from the point of view of management institutions, interest groups and resource base when addressing the above questions.

Also the management units and commercial fishers in the surrounding areas will consider the geographical extent of the IFD, as they may wish to join or to keep out of the forming arrangement. The actors of the surrounding areas should be informed about planning of IFD, especially along the same watercourse, because it may affect resource management and fishers' possibility to use their present individual sub-grounds.

In the situation b., the main concern will be the maximum fishing effort in the IFD arrangement, in which a key element is the number of commercial fishers. The initial number of fishers is known by the management, and during the period of the establishment the number of fishers and the resulting fishing effort is considered in relation to the resource base, as well as the effects of periodical mobility of fishers. What kind of regulations are set for the number of fishers in the whole arrangement and its sub-areas? What methods of regulation are used for fishing (will there be e.g. periodical restrictions)? By answering these questions the actors at the same time consider the question of maximum fishing effort on each sub-area. This consideration is based on experience-based estimation on the sustainability of the fish stocks as well as coexistence of commercial fishing and other uses of the lake, i.e. social sustainability.

The IFD aims primarily at offering abundant fish stocks instead of low stocks. In a system with several separate stocks (in practice, several lakes), there may occur a situation where none of the stocks are low, but several are abundant (situation c.). Should the arrangement then open sub-grounds for fishers willing to increase their mobility? This question touches both the owners of fishing rights (supporting commercial fishery also when the stocks are high, by sharing abundance) and fishers within the arrangement (accepting competition within ones' "own" ground while the situation is at least good everywhere within IFD) (I).

Even as the IFD covers several separate lakes/stocks, a low-stock period may occur in all of them simultaneously (Marjomäki et al. 2004). Typically the fishers react to stock recession mainly by decreasing fishing effort (Salmi & Salmi 1993). In the absence of alternative fishing grounds or side-occupations individual fishers may need to increase fishing effort even when the yield does not cover the costs (Nykänen & Muje 2005).

In IFD arrangement, a limit reference point of YPUE can be determined, that could be used for sub-area specific fishing effort regulation. In the case that fishing needs to be ceased on a sub-area, also the means for monitoring the recovery of stocks should be decided. Mobility to a low-stock sub-area is unlikely in any case, so the monitoring (testing) could be done by local fisher. Another situation where mobility would not be needed is when all the sub-areas are near long-term average (situation d.). In this situation, the economic utility of increasing mobility would often be negative, and the fishers would mostly remain in their main-grounds, self-regulate their fishing and possibly shift to other target species. The management needs to consider if fishers should even in this situation be provided a possibility for mobility, e.g. if the licence period is longer than one season/year or if the information on stocks can be updated during the licence period.

In the establishment of IFD the actors would agree on:

a) geographical limits (of IFD and its sub-areas),
b) parties of the arrangement (legal contracts),
c) terms for entry (number of fishers, licensing),
d) information concerning the resource (what is used, what needs to be produced) and
e) annual/in-season regulation of fishing.

Making the contracts between the management institutions already will answer some questions concerning sustainability: geographical definition affects community, socio-economic and institutional sustainability. The parties of the contracts (legitimacy, acceptance by relevant actors) form the basis for socio-economic, community and institutional sustainability. The information on the resource used and produced for IFD affects community and institutional sustainability and eventually contract terms, licensing and regulation affect socio-economic and community sustainability. Through this process it should be emphasized that ecological sustainability is the key objective and basis for other aspects of sustainability.

According to the modelling the five situations (a.–e.) may change so that, once IFD is established and working, there would be need and possibility for mobility in approximately half of the seasons/years, usually in several years successively. As a consequence, IFD opens a wider portfolio of opportunities for the fishers in a long term and the possible negative effects (increased fishing effort, competition, and mobility on lakes) occur only periodically (I). Commercial fishing on Finnish lakes is at present not regulated during the fishing season (due to trust between the shareholders' associations and the fishers and lack of yield-monitoring). Thereby the in-season regulation takes place by fishers' self-regulation, where the key factor is profitability in relation to costs of fishing and market situation (Marjomäki 2003, Nykänen & Muje 2005). In some cases this conduct has caused doubts among other users of the resource and even conflicts between the user groups (Salmi 1997b), whilst the shareholders' associations in general tend to rely on fisher's self-regulation (Muje 2010).

The key concept of Finnish fisheries management, the gear unit system, is problematic from the institutional sustainability point of view (II). This would be even more challenging if the IFD approach will be applied. It relates the number of gear units to the water area of each management unit (fisheries association) usually 1 – 2, on average 1.5 units per hectare (Marjomäki et al. 2005). The efficiency of many fishing techniques has increased considerably due to development in materials (e.g. nylon nets) and technology (motorized commercial and recreational fishing) (Lappalainen 1998). At the same time environmental changes have caused threats to fish stocks (pollution, dams, water-level regulation etc.). As a consequence many predator species are facing recruitment overfishing, which has become a threat to natural reproduction (e.g. Koivurinta 1994, Syrjänen 2010).

At present, the gear unit system includes considerable potential for unsustainable fishing (II). In practice this mismatch of total gear units, as applied by shareholders' associations, and ecological sustainability has lead to a situation where merely 47 % of the total units are being obtained and used by fishers (Nykänen & Muje 2005). Some shareholders' associations (19 %) are aware that taking all of the total gear units to use would not be possible due to the quality of present modern fishing gear and shareholders local knowledge on the resource (Nykänen & Muje 2005). Thus, the limit for gear units in IFD-arrangement, maximum number of gears, could be regulated within the present gear-unit system (combined with recreational and subsistence fishing), but it cannot be applied up to the total gear units, since that is not defined according to the biological production of the resource (fish stocks) (II).

Another problem in the total gear unit system is that it only regulates fishing licenced by the shareholders' associations, thus leaving fishing based on public fishing rights (right to engage in angling, ice fishing and lure fishing with one rod (Fisheries Act 1996/1045, 8§) out. In any water area, both the total gear units and ecological carrying capacity can be exceeded despite the owners' effort to regulate fishing sustainably. The legislation includes means for regulating fishing by the authorities if excessive fishing effort appears (Fisheries Act 2003/154, 11§), but this may take place only after observed, possibly ecologically unsustainable fishing has taken place (II).

In practice this leads to a question if the present level of utilization (use of gear units) is a consequence of the management structure, where utilization is limited by its fragmentation, rather than active regulation by the management. In other words, the present management structure may direct the fishery disproportionally in relation to active regulation of the management institutions.

In the present fishing regulation where questions of protecting species and habitats, rational and maximum use of fish stocks are interpreted by the shareholders' associations, the regulation in effect explicitly depends on the local experience-based knowledge (V). As there is no continuous and regionally extensive supply of scientific or other expert knowledge over most fish stocks and species, expert knowledge has been ranked at place 6. in significance of the information sources for the shareholders' associations (Nykänen & Muje 2005). The connections of local decision makers to fisheries research were scarce (Salmi et al. 2002). In several cases, the fisheries regulation issues have been taken to the court of law, and the expert statement on the state of stocks and fishing effort from scientific researchers is used.

Thereby in the owner-based management, the statutory local level of institutional management structure, mainly local knowledge-based conception on the ecological and social sustainability is applied. This is supported by the Fisheries Act (1982/286, 1§), as there is no demand on acquiring scientific or expert knowledge, even if it were available. The regulation of fishing is conducted within the legislation, but it is noteworthy that actual definitions concerning the sustainability are specific to each management unit (shareholders' association). A typical example of this is licensing one trawl per shareholders' association (if its area is seen suitable for the purpose), usually independent of the decision of other associations on the lake or the total situation on the lake. Eventually ecological sustainability depends heavily on the self-regulation of commercial fishers.

The law gives the local management tools for sustainability but fragmented management is a continuous problem for institutional, social and ecological sustainability. Commercial fishers' access to resources is limited (III), fishing effort (licences) is seldom allocated evenly on a single body of water (area of biological production suitable for commercial fishing) and self-regulation is within this limitation thereby inefficient. The practical solution to the problem of fragmented management has been one commercial fisher per shareholders' association, and this applied within a single lake has formed a somewhat constant number of fishers (which from the management point of view may have limited conflict situations, and from fishers' point of view conveniently limited competition on their "home fishing ground", as a simple way to accommodate the relatively small number of commercial lake fishers).

The Fisheries Act includes several stipulations that relate to sustainability, forming a basis on which local management units and fishers have had an opportunity to build sustainable resource utilization (II). As an institutional basis of fisheries management it devolves considerable tasks of combining its wide-ranging goals to the shareholders' associations and fisheries regions. The local bodies' capability to fulfill this task is hindered by fragmented management structure and, in terms of biological resource, inaccurate conceptual basis and to some extent, lack of participation. In the present management structure, fisheries regions are the only considerable organization to build IFD on (V). Fisheries regions have many and lack only few qualities typical for a successful co-management institution (Pinkerton 1994b, Sipponen 1999, Tonder & Muje 2002, Salonen 2005).

However, the successful application of IFD is dependent on local (regional) circumstances, and in some cases the present situation may prove more beneficial for the socio-economic system. IFD–type of management could be theoretically enforced also through legislation, in which case the challenge is the organisation and motivation of local actors. As illustrated in a context of vendace fishery, a top-down regulation causes inflexibility that may result in failure in coping with changing ecological conditions (Rova & Carlsson 2001).

5.2 Ecological sustainability

A lake is an appropriate unit for describing the resource base of commercial inland fisheries, because yield is an outcome of biological production in the whole lake, and with migratory species even wider area, not only of accessible areas. Commercial inland fisheries concentrated in 67 single lakes which fishers regarded as their main grounds, covering 14 633 km² (44 % of inland waters in Finland). There are no reserve lakes, and the actual licence area was 26 % of inland waters (III).

Situations where the utilization of vendace and other main species for commercial fishing has been clearly over the limit of ecological sustainability of the resource are scarce. Reported overfishing has occurred on Lake Päijänne (increased trawling affecting the whitefish; Sipponen & Valkeajärvi 2002) and on Lake SW Pyhäjärvi (Sarvala 2008). The regulation has taken place mainly by fishers' self-regulation during the season, and when necessary fishers have looked for side-grounds elsewhere, with varying success. This way shareholder's association -based system has rarely been in a situation where the number of commercial fishers has required regulation. In practice this mode of combined number of fishers (per management unit) and in-season self-regulation has proved acceptable for the management and thereby it has generally been able to maintain ecological sustainability. The market situation has obviously been in a central role in fishers' self-regulation.

In most cases, ecologically sustainable utilization of vendace stocks has been reached by these somewhat inaccurate regulation and information methods. This can been seen as a joint result of fragmented management structure, its constraining effect on demand of licences, decrease in gill-net fishing and commercial fishers' self-regulation, that jointly have led to moderate use of fish stocks. Most other valuable species, such as brown trout (*Salmo trutta* L.), salmon (*Salmo salar* L.) and pikeperch (*Sander lucioperca* (L.)), are still sub-optimally utilized because of growth overfishing, i.e. the fish are caught at a relatively small size and a considerable part of the growing potential is thereby wasted (Salo 1988, Koivurinta 1994, Syrjänen 2010). In the case of brown trout and salmon also recruitment overfishing takes place (Syrjänen 2010), mainly caused by recreational fishing. Explicit concepts and local information have not been utilized systematically concerning the whole of the resource (II). For this purpose IFD offers tools that enable aiming at ecological sustainability concerning the whole multi-species fishery.

The fishers' observed tendency to aim for areas with abundant stocks supports ecological sustainability. The comparison of the state of main- and subground fish stocks (III) showed that local fishers' opinion on the status of vendace stocks had an effect on the choice of subgrounds. During periods of low stocks, fishers looked for better fishing grounds. Fishers harvesting main grounds with weak stocks had more subgrounds and desired fishing grounds than those fishers who harvested main grounds with strong stocks. However, there was no considerable difference in the proportion of catch caught from the main ground between high and low stock periods, which shows how tight bond fishers have to their main ground.

On the basis of stock abundance index, benefit from mobility was obvious particularly during low stocks. On the other hand fishers with "good" main grounds often had one or two subgrounds at use, and in many cases these areas had lower stock abundance index than the main grounds. This indicates that also other factors (access, distance) than stock abundance influence on the selection of fishing grounds (III). In any case IFD would enable more 'state of stocks' – oriented regulation and self-regulation in commercial fishing, compatible with the definition of ecological sustainability.

The present system fails to take advantage of a basic feature of vendace stocks, high stochastic variability in the number of recruits. The higher it is the more advantage there is for allocating fishing to the most abundant/dense stocks, when there are several options available (for regulation by management and for fishers' self-regulation). Concerning ecological sustainability a probable result would be decreased risk of stock collapse (IV). Mere re-allocation of present fishing effort would produce slight (8 %) increase in annual YPUE (I), and VI showed the low threshold in terms of fishing mortality in a new fishing-ground for reaching the situation where the fisher has an additional ground in his portfolio of resources for in-season self-regulation. The advantage of higher stochastic variability can only be observed by an extensive data on catch and fishing effort. In some areas this can produce more utility from the application of IFD.

5.3 Socio-economic sustainability

The commercial fishers (44 % of them) have obtained licences to one or more side-grounds (III). Thereby the fishers have in practice applied IFD-type of solution in their own activity, having on average 1.7 grounds in use. Nearly 23 % of fishers employed two grounds, i.e. one sub-ground in addition to main ground, and minority of fishers (20 %) harvested three or more grounds. The fishing effort takes place mainly on the main ground due to practical and economic (cost of licences and mobility) reasons, where on average 87 % of the catch is taken.

Approximately half (48 %) of commercial fishers were personally interested in fishing on wider resource base than at present. This was typically motivated by increasing professionalism (Nykänen & Muje 2005), which enables competition with other domestic and imported fish products. Concerning the competition just 5 % of fishers thought that the number of fishers should be decreased and 2.5 % mentioned that regional limitations should be applied (Nykänen & Muje 2005).

Concerning the social circumstance of commercial fishing, the main factor is the private ownership -based management, through which many of the other fishery-related interests are mediated. The owners of the fishing rights (shareholders' associations) had a positive opinion on the commercial fishing and its development in the Finnish lake district (Salmi et al. 2002). In 1999, a survey showed that 81 % of the chairmen of shareholders' associations were of the opinion that commercial fishing did not harm recreational fishing, and just 8 % had the opposite stand. Further, 63 % of chairmen thought that the increase of commercial fishing could be done without risk to fish stocks, and 27 % of them thought there would be a risk (Salmi et al. 2002). Obviously risks and conflicts were local and could be dealt by local management (in the present arrangement or within an IFD). A survey concerning shareholders' associations view on a concrete IFD-type of development in their own area revealed the owners' acceptance at general level (Nykänen & Muje 2005) and V documented this more elaborately.

The lakes with commercial fishers' main- and side-grounds included nearly all grounds which fishers wished to get access to (III). Thus, there were no reserve lakes for commercial fishing. The coexistence of commercial and other forms of fishing did not seem to be a major problem, although the most active members of shareholders' associations also were fishing the same target species as the commercial fishers (40 %) (Nykänen & Muje 2005). The problems caused by the use of same areas and same resources were local and thereby possible to be solved locally, given the appropriate institutional tools. The use of the same resource base and shareholders' associations positive views on commercial fishing indicate a capacity for more reasonable distribution of the benefits vested in the private ownership.

Majority of fishers (62 %) harvested mainly privately (shareholders' associations) owned fishing grounds, 30 % mainly public (fisheries regions) and 8 % corporations' (enterprises, congregations) grounds. Contribution of state-owned public waters to the outcome of inland fisheries was considerable, in particular when their small proportion (3 %) of the surface area of inland waters is taken into account. Total yield per fisher from public waters in 1999-2003 was 37 % higher than from private ones, and average daily yield per fisher 36 % higher, respectively. Public ownership provided fishers access to nearer stocks than other ownership types (Figure 4 in III).

Small-scale mobility was a dominant feature of inland fisheries and fishing took place nearer than 100 km from fisher's residence. Main grounds were quite near to fishers' permanent residence, but sub-grounds much further away (Figures 1 and 3 in III). Only five enterprises had employed large-scale mobility (distances up to 540 km) coinciding with asynchrony of vendace stock fluctuation (III). The concentration and lack of reserve grounds in commercial fishing suggest that IFD -approach is a possible way to more efficient use of the fish stocks especially in the case of vendace than the present system. Time frame of utilizing an abundant year-class of recruits in a given area in vendace fisheries is just 1-3 years (Marjomäki 2003).

When IFD-arrangement is established, the socio-economic advantages depend greatly on the actual area-specific regulation of fishing. All types of uneven allocation tested in the model (IV) would help the fishers to reach the improvements they expect to the present situation: catch security would increase, activity could be turned into more professional, by providing equal or higher maximum average annual yield with comparable or lower average annual fishing effort and much lower inter-annual variation of yield of individual fisher. Thus, the arrangement can enhance socio-economic sustainability. Being able to use the resource more according to the state of stocks was also one of the expressed goals of the fishers, i.e. the sustainable generation of resource rent was their explicit goal.

The choice of type of regulation between the uneven allocation alternatives can be based on the question "how intensive can the fishing be during high stock periods within one sub-area?" To this question the regulation alternatives 2 – 4 (IV) give somewhat different answers. In the build-up of the system (e.g. total and sub-area specific maximum number of fishers) community and social sustainability issues can be taken into account. The probable outcome concerning ecological sustainability, decreased risk of stock collapse, supports socio-economic sustainability by decreasing the risk to availability of a key resource.

Concerning socio-economic, community and institutional sustainability all of the uneven-allocation alternatives (2 – 4, IV) are somewhat different. Their application also poses different demands on the information required. The alternative 4, where fishing is allocated on all sub-areas according to the state of stocks would require most accurate information but if this is available it would also produce least mobility and pressure on social sustainability. Alternative 2 would work with less accurate information (need to identify only the weakest stock/sub-area), and it would produce some more mobility, but also decrease all possible negative effects of commercial fishing in one sub-area. Alternative 3 requires yet more accurate information (showing the strongest stock/sub-area) and it would shift all fishing effort there. This would most likely exceed social sustainability in any region of present lake fisheries. In options 2 and 3 the fishing can be regulated according to experience-based information, whereas the stock-density -based regulation would require up-to-date catch and fishing effort -information analysis. This could well be facilitated by license-terms even within the present legislation.

All types of uneven allocation tested in the model (IV) would help the fishers to reach the improvements they expect in the present situation (Nykänen & Muje 2005): catch security would increase, activity could be turned into more professional by providing equal or higher maximum average annual yield with comparable or lower average annual fishing effort and much lower inter-annual variation of yield of individual fisher. Thus, the arrangement can enhance socio-economic sustainability. Being able to use the resource more according to the state of stocks was also one of the expressed goals of the fishers (Nykänen & Muje 2005).

In the focus groups (V), the participants considered the establishment and working of an IFD-arrangement in a situation which equates real decision making in a fisheries region. Thereby they had to relate their own and their reference groups' interest to those of other participants in a situation where they were directly subjected to the criticism of the other parties. The actual decision making on the IFD takes place in the meetings of shareholders associations, where the participants are mainly owners but in some cases also commercial fishers.

Motivation for establishing an IFD-arrangement could be found despite the in-built obstacles related to the fragmented management structure. The owners' group emphasized some features of the arrangement that would be beneficial for them. These were (a possibility for) more accurate information on the fish stocks, regulation of fishing according to state of stocks, more even allocation of fishing effort and better utilization of human resources in the local management. These factors would improve the shareholders' associations activity in their central field of action (Fisheries Act 1982/286, 1§), as the production of the resource could be utilized more efficiently during medium and low stocks. IFD would offer concrete improvements to shareholders' associations in terms of information, human resources and meeting the main goal of their activity (V). These factors were not measured in economic terms, yet also these may bring economic benefits. Small economic benefit could be drawn from increased income from licenses to commercial fishing (IV).

An arrangement between shareholders associations and fisheries regions was seen in both key interest groups as a reasonable target, as fisheries regions as an established regional actor is in terms of participation and regional extent a suitable actor. An arrangement between shareholders' associations was not considered possible even by their own representatives, which illustrates the difficulty of development based solely on them. The regional extent would seem to fit most readily within 1 or 2 fisheries regions and its expansion to other nearby region was considered possible, after its functionality had been tested in practice (V).

From the owners' point of view this kind of geographical limitation means that in practice only local fishers would change fishing grounds from time to time. The challenge to social sustainability would be small, when the number of fishers is limited to the present number. This may even be crucial concerning the initial adaptation to the arrangement (V).

For the fishers a defining limit of a functional IFD is day-trip from home. The geographical dimension set by the views of the owners and fishers is somewhat coherent, and in the areas of the focus-group study possible to combine. This consensus of local scale, based on the actors' own points of view forms a solid background for establishing an IFD arrangement (V). In addition to being an ecologically coherent unit, IFD must be coherent and practical also for the management and the fishers. This does not rule out the possibility for occasional mobility between IFD areas (remote mobility), which needs to be taken into account in the conditions of the agreements (i.e. consider the facilitation of remote mobility in case of high stocks and limited main-ground fishing effort).

The shareholders' associations are interested in IFD arrangement both for selfish reasons and reasons beneficial to commercial fishers (V). The arrangement could allocate the present fishing effort more evenly to the waters of shareholders associations. The flipside of this is the possibility for occasionally higher fishing effort on any sub-area (I). On the other hand this would at the same time decrease fishing effort on other sub-areas, resulting in less competition on catch between commercial and recreational fishing and restoration of declined stocks.

Thereby the consideration brought up more clearly than before the temporal dimension of the decisions; i.e. decision made now would affect commercial fishing, and fishing in general, in the long term more broadly than the present arrangement. Thus, the participants had to consider the different management situations (see chapter 3.1) where present type of allocation would be most common, but higher and lower fishing effort periods occurred. This was obviously a difficult task for the shareholders. The view was mainly positive, but within the interest group the opposite stand may turn out strong in the actual decision making (V).

According to the modelling (I) the five situations may change so that there would be need and possibility for mobility in approximately half of the seasons/years, usually in several years successively. As a consequence, IFD opens wider portfolio of opportunities for the fishers in a long term and the possible negative effects occur only periodically.

Two other factors in the shareholders' views suggested increase of socio-economic sustainability in IFD-arrangement. Aging and decreasing number of the active members is a problem the shareholders associations face continuously, even though the member-base is very extensive. All associations do not have the human resources (information, experience, dedication) for promoting their own interests in fishery matters (V). IFD would form a wide and somewhat complex system, which requires perspective and good local knowledge. In these matters the associations can in most cases resort to each other, i.e. their own reference group, from which representatives with these qualities can easily be found at wider regional scale.

Developing the information system is another factor that motivates the shareholders to IFD (V). In the present system, the relationship between the owners (shareholders' association) and the commercial fishers is typically long-lasting and partly based on trust at individual level. The number of commercial fishers per lake-basin has been limited to few constant licence-holders, whose activity the local owners know over a long period of time. The owners also understand the limitations of the fishers' activity, e.g. self-regulation during low stocks and when the demand is low. These factors have decreased the owners' need for creating a continuous monitoring system on the local or regional level of management. The fishers have valued this line of action because of the risk of more accurate catch or fishing effort data of individual fishers made public.

In a wider and more open arrangement of licences, the owners consider more accurate information on the fishery important in order to get a solid information-basis for regulation. For the fishers producing information for the purpose of the management in IFD is acceptable, if the data is processed so that it provides index-level information per sub-area (V). IFD may produce information on fish stocks that, being more up-to-date and accurate than before, could prove the total or sub-area specific maximum number of fishers too low for efficient utilization of the fish stocks. Thus, the option of allowing remote utilization should be considered in the arrangement.

Commercial fishers also get information from their colleagues (V, Nykänen & Muje 2005). At present the shareholders' association -based allocation of fishing, small number fishers moving beyond day-trip and great majority of catch being caught from the main ground has kept the competition between commercial fishers relatively low. Thereby, mobile fishers often have cooperation with local fishers on remote grounds, and information on the state of stocks is by rule not a factor of competition. Periodically increased utilization of same stocks within IFD may further emphasize the information-flow within the profession, but as indicated in I, even in lack of co-operation the economic outcome is positive.

Information on the level of utilization of the resource has a major role in the coexistence of local actors, between the shareholders' associations and between them and the commercial fishers. For the shareholders' associations the management unit-specific limitation in number of fishers and fishers' self-regulation have provided sufficient information, and for the fishers, in addition to these, information provided by other fishers (within the main or side-ground) (Nykänen & Muje 2005).

Within this mode the shareholders associations have built trust with the local commercial fisher concerning the state of stocks and level of utilization. By rule, any accurate information on the fishing effort or catch has not been required from the fishers. Thereby the shareholders' associations have had no need nor the information for developing more accurate monitoring of the fish stocks, and e.g. defining "safety limits" for number of fishers or fishing effort per area. In IFD-arrangement, where a defined number of fishers would be allowed to use an interlocked stock and its sub-areas more freely, this type of definition would be practically possible and also required: a total and sub-area -specific maximum fishing effort is a fundamental factor considering all sides of sustainability. This seems to be relatively unproblematic for the commercial fishers. Muje (2010) observed that the commercial fishers accepted the demand of more accurate information inquires as one of the most important terms for constructing an IFD, as long as individual catch-information would not be made public, and the reference points would be based on the abundance of stocks.

5.4 Economic sustainability

The results of the economic model (I) show that IFD, in particular by encouraging mobility of fishermen, can obtain higher sustainable economic benefits from the fishery. The yield data analysis shows that an interlocked resource may considerably decrease fluctuations of yield in professional vendace fishing. This implies that the interlocked approach would increase the cost-effectiveness and decrease the inter-annual variability in income of the fishermen, thus promoting sustainability in the commercial fishing and making it potentially a more viable livelihood.

Within the present management arrangement, the number of sub-grounds accounted for higher yields except for the first sub-ground (III). By harvesting three or four lakes - which formed an interlocked stock – fishers could improve their fishing outcome compared to those sticking only to main ground and one stock. In particular the fourth stock contributed remarkably to success e.g. in terms of daily catch. Also the performance of interlocked stocks exceeded that of the main ground only, except in regards the mean of daily catch. Annual net income was calculated as the difference of the value of the catch in producer prices (1.7 € kg^{-1}) and fishing costs (running costs, wages and capital costs). Combination of two grounds was the most disadvantageous; probably the requirements of mobility were worst internalized among fishers that had chosen this strategy.

Due to entry limitations and harvesting restrictions trawl- and winter seine-fishers were compelled to fish further away than they wished, as their desired grounds were located nearer than their present sub-grounds. Locality featured in particular open-water seine and vendace gill net fishing which were associated with part-time fishing and smaller income expectations than trawling and winter seining. Thus, there was an extra cost for fishers using the most efficient types of gear. Fishers pursuing desired grounds had higher objectives both for maximum and acceptable minimum fisheries income than those who were satisfied with their present opportunities (III).

In accordance with the basic idea of interlocked stock (I), fishers harvesting in particular four stocks managed to ensure themselves a more constant resource in terms of range of the stock index. This partly explains the observation that the more fishing grounds fishers had at their disposal, the larger was the number of fishers sharing perceived need for excess grounds (III).

Prices of fishing licences were rather low as compared to fishing income and accounted only a fraction of fishers' annual running costs (III). Pricing diverged more in terms of individual gears than of ownership regime. Highest prices were charged in public grounds from trawl- and seine-fishers, as there was a tendency among private local owners to charge themselves lower fees than from non-local "outsiders". However, such factors as water ownership or licence fees did not explain significantly fisher's choice of fishing grounds. Only every fourth fisher expressed willingness to pay on an average 25 % higher licence fees than presently even if that would enable access to desired fishing grounds – an indication of poorly functioning market for commercial licences.

The simulation of fishing effort allocation (IV) showed that all fishing arrangements with uneven fishing effort proved more productive than even allocation of fishing effort. The present management system does not produce even fishing effort within the resource area, but with individual fishers' fishing typically centered to the area of one lake (87 % of the catch from main ground; III), the present allocation is overwhelmingly more even than in any IFD-type of allocation (IV).

In addition to the commercial fishers' interest in IFD, the other key interest groups' view on IFD-type of development in their own waters (V) showed that the fragmentation of ownership units and limited economic importance of the resource to the shareholders did not form an unsurmountable obstacle for the arrangement. All interest groups presented views consistent with utilization-frame. Thus, fish stocks and lake environment can be thought as a subject of economic utilization, which is necessary for development of economic sustainability. This finding is consistent with view of finding, understanding and managing "people conflicts" as the primary need in fisheries governance aiming at sustainability (Arlinghaus 2005).

Unification of the management arrangements of commercial fishing brings obvious advantages also for the shareholders. Among them economic importance was mainly seen as a possibility to keep up the maintenance of fish stocks and to some extent as a possibility to improve the commercial fishers conditions.

The economic case-study (VI) showed that IFD arrangement offers to fishers and fisheries managers a tool for enhancing economic sustainability. First, it opens the option for planning the commercial activity over a wider resource base, *interlocked stock.* With moderate cost for the management system and with no cost for individual fisher, this provides the fishers with more economic security than the present situation by extending the portfolio of fishing grounds (and possibly of species) that the fisher can utilize.

The case study does not clarify the economic potential of IFD as this is in each season largely dependent on decisions of the fishers when they have a) obtained the licences, b) gained first-hand information on the available stocks and c) decided on target area(s) according to this information, given the external economic factors (demand, price). If the commercial fishing under these conditions follows stock abundance, IFD could improve the economic performance of the fishery as a whole in the area, as YPUE in the long term increases the fishers' income per fishing effort would rise. Over a longer period the economic potential of the system is also affected by the changes in fishing effort between the sub-areas and its consequences to the biological resource.

With moderate cost for the management system and with no cost for individual fisher this provides the fishers with more economic security than the present situation by extending the portfolio of fishing grounds (and possibly of species) that the fisher can utilize (VI). Given the assumption of linear growth of catch as fishing effort increases, a few percent increase in the fishing effort could cover the additional costs of mobility. The fishers would have an opportunity to utilize the best resource out of a portfolio that consists of one or two more fishing-grounds than at present.

In a geographical scale preferred by the fishers (III), their most important goals for developing the fishery can be achieved: inter-annual change in catch decreases, catch-security improves, activity can be tuned to more professional and the fish stocks can be utilized more accurately according to the state of fish stocks (Nykänen & Muje 2005).

Given the assumption of linear growth of catch as fishing effort increases, already a few percent increase in the fishing effort would cover the additional costs of mobility and the fishers would have an opportunity to utilize the best resource out of a portfolio that consists of one or two more fishing grounds than at present. In other words, the cost at the point of 'breaking even' as fishers look for the most economical way of and ground for fishing each year, both in terms of income for the fisher and fishing mortality for the fish stocks, is remarkably low. Fishing activity beyond this point is most likely to be (self-) directed to the most abundant stock(s) in the fishers portfolio (as indicated in III), which is one of the primary goals of the IFD. Access to more abundant stocks can actually lower the total fishing effort by producing higher YPUE.

The system does not necessarily induce additional costs for the management. Information costs will increase the systems' costs, in case the data on YPUE fishers already at present produce is used systematically. The level of additional information costs will depend on the extent and accuracy required. There is likely to be increased pressure for developing the stock information-system, especially concerning areas of intensive commercial fishing, as practically all of them are simultaneously used for recreational fishing and other socially widespread purposes.

5.5 Community sustainability

The difference between shareholders association -based system and an IFD in terms of community sustainability is not self-evident. It depends on the need for developing the economic utilization, i.e. how well the present arrangement fulfills the needs of commercial fishing. If the fishers express the need for development, follows the question how this can be done? The present obstacles caused by the fragmented management structure could be removed by arranging more mobility over the limits of management units to a wider resource-base. On areas where there is relatively few commercial fishers on wide resource base (as on parts of Lake Saimaa or Northern Central Finland), even the fishers may prefer the present system. In these situations fishers' self-regulation and trust between the actors in the regulation has usually been sufficient to support community sustainability.

Once the need for the development of commercial activity is observed (III), the development needs to get acceptance among the key interest groups and actors. In this case the ownership-based local management and widespread recreational use are linked to commercial use at many levels. The focus-group study (V) showed that this acceptance can be gained within shareholders associations, in which many of the several overlapping interest are represented. At a national scale this support for locally well grounded commercial development within the shareholders' associations was observed in a survey, where 52 % of their chairmen regarded IFD-type of development possible in their own waters (Nykänen & Muje 2005). This relatively widespread acceptance may be partly based on relatively small and decreasing number of commercial fishers, but also on few experienced problems related to commercial lake fishing (Salmi et al. 2002).

As the IFD-type of commercial development can be established within the present institutional arrangement (management bodies, legislation) (III), the key interest groups' interest in the system can also be explained by harnessing the management institutions (shareholders associations, fisheries regions) by legal mutual contracts into the system (V). This enforces the role of the traditional land-ownership based -management thus building on the past, socially deep-rooted development of community sustainability.

The question concerning the further development of community sustainability is will the wider interlocked resource base also help the land owner community-based management to ecologically defined structures? In fact, the spatial synchrony in the inter-annual population variation of vendace, typically 100 – 300 km (Marjomäki et al. 2004), supports wider arrangements for commercial fishing than suggested by most fishers and local management. In order to optimize the benefit of spatial asynchrony of fish stocks, the system may need to allow occasional access to an IFD for fishers from other areas for years/seasons of high stocks, in case the "regular" fishing capacity is not adequate. Including a regulatory procedure for these situations in each IFD would actually enable solving this problem.

5.6 Overall sustainability

In situations where the utilization of fish stocks is to be made more efficient by increasing professionalism, number of fishers or improving state of stocks, IFD-arrangement is able to produce socio-economic and institutional sustainability by improving the fishers' economic possibilities and by producing more accurate information, and thereby tools and human resources for the resource management.

Once the need for increasing the mobility of commercial fishers has been identified and decision on establishing an IFD has been made, the private ownership based management is capable of addressing the questions presented in chapter 5.1, based on the dynamics of the vendace stocks. The most challenging questions are the first 3 (a.–c.), concerning total or partial low-stock situations within the region. The shareholders positive attitudes to the development in general and concrete, locally based ideas on its practical application (V) indicate that resource-based regulation over long time-span is a realistic alternative. Initially the maximum fishing effort within an IFD could be based on the present number of fishers, and in each arrangement the sub-area –specific limitations could be based on this. It is noteworthy that both the geographical dimension and type of dynamic allocation of commercial fishing need to be based on local, case-specific consideration.

As the accuracy of both experience-based and scientific information can be improved along with fishers' increased mobility, there is potential for more accurate regulation (including self-regulation) and adjusting the limitations. The two last questions (d., e.) relating to at least moderate stocks, would most likely result in "status quo" -type of regulation, with no increased mobility and its effects. Furthermore, the arrangement could also provide a tool for dealing with low harvest rate in high stock periods.

The economic case study (VI), based on empirical data on the desired size of the area, number of fishers and the economics of their activity, gives objective proof to the results of the survey (III) and modelling of IFD-system (I, IV). The IFD-type of development offers a number of other benefits, including indirect economic benefits, for the owners: diminishing human resources in the local management could be used more efficiently, including securing own interest groups representation on resource-based wider scale, and possibility to obtain more accurate information on the state of stocks, both of which may facilitate economic gain through increased resource rent and decreased maintenance costs.

IFD aims at improving commercial fishers' access to resources and thereby the economic efficiency of the fisheries. A recent study on the effect of property right regime to the catch and employment in commercial inland fishing in Europe shows the higher efficiency of public ownership (Sipponen et al. 2010).

The study on IFD reflects the situation within the present (dominant) property right regime, yet public ownership on 10 major lakes has clearly channeled part of the pressure for easier commercial access. While IFD has potential for improving the economic efficiency of the fishery system within private property right regime, it needs to be noted that the regime in question has developed over a long historical process, it is not an outcome of a sudden decision on privatization. During this process the joint ownership of shareholders in fisheries associations became established and widespread first since the 1950's (Muje 1995a, Määttä 2002) and since 1970's the increase of commercial lake fishing. IFD could naturally be applied in the context of public property regime, yet it would pose other questions concerning sustainability.

IFD clearly has potential to enhance overall sustainability. Eventually overall sustainability depends on the success of each application in responding to the needs of local fishers, in forming the regulation for the fishing and how sensitive the regulation of commercial fishery is to the variation in social carrying capacity in each area, as well as to the 'secondary' target species of commercial fishing (whitefish, pikeperch, brown trout, salmon) that are important for other user groups.

6 CONCLUSIONS

The results suggest considerable benefits of IFD compared to the present arrangement of commercial lake fishery. It would facilitate institutional development where systematic ecology-based application of present structurally restricted practices would benefit from the past development of the management system and tie it more coherently to the conceptual basis of sustainability.

The acceptance of fisheries region as the body for the establishment of IFDs shows that the fisheries regions are a considerable institutional step towards sustainability and co-management even with its shortcomings e.g. in limited participation. Presently it uses the advantages of self-management with considerable potential of expert knowledge to be available in the decision-making process. IFD-type dynamic spatial allocation of fishing effort could supply the fishery management system with qualities that facilitate the use of more sophisticated management targets and approaches, e.g. precautionary approach.

IFD facilitates pulse harvest -type of fishing effort that includes a conservation benefit: after intensive harvest periods, rotational closure of sub-areas gives vendace populations sufficient recovery time. The key factor for ecological sustainability of the system is what harvest options fishers utilise once the access to several grounds has been opened. For further study, the main ecological question is how IFD will in practice affect the abundance, quality and dynamics of fish stocks in various area-specific applications when fishers' choice of available sub-areas under the influence of external economic factors has taken effect.

Concerning socio-economic sustainability, the fishers' attitude towards periodic competition in use of the resources remains an open question. In order to gain new grounds within an IFD fishers who in some cases have owner-based right to the area in question need to allow their present main grounds to be open for increased fishing effort according to sub-area specific regulation. This would call for tolerance of colleagues, as the economic model shows that even with no cooperation of fishers interlocked utilization may be economically beneficial.

Socio-economically, a question for further study is: will the IFD or any other application with wider resource base result in generally accepted distribution of environmental goods (fish, i.e. resource rent)? The IFD also has potential to upgrade management of commercial fishing to the level which has been applied to many forms of recreational fishing in fisheries region –scale of licensing. As many of the issues concerning recreational and commercial fisheries are remarkably similar (Cooke & Cowx 2006), there are grounds for considering these under a joint IFD-type of management.

The key interest groups' resemblance in terms of considering fish stocks as resource for economic utilization provides an important base for developing commercial lake fishery. This requires inclusion of shareholders in the planning process. An important question concerning the long-term economic effect of IFD is will it, by offering more target areas and target species, decrease commercial fishers' dependence on other occupations? As many fishers wish to retain the portfolio of side-occupations (Salmi 2005), how rural pluriactivity could be integrated with IFD?

Concerning the owners, the non-economic benefits of the IFD (more efficient management, improved information on the resource) may be sufficient incentives for the development once the initial threshold of limited motivation in changing status quo has been crossed. There seems to be potential in the present system to combine and develop some of the advantages of private ownership and co-management.

The IFD could essentially enhance community sustainability by resource-based regulation to bring issues concerning the state of stocks and their commercial utilization to a level where they can be addressed with the best available information on fishing effort and state of stocks. In an IFD-type of system, one of the important questions concerning community sustainability would be how to integrate the occasional mobility to remote grounds to the distinctively local scale of IFD preferred by the main interest groups.

The IFD has considerable potential to enhance overall sustainability of the fishery system. It would provide a resource-based approach to the management of fish resources and lake environment at a socio-economically acceptable scale. IFD bears considerable potential for supporting socio-ecological practices aiming at resilience and sustainability (Folke et al. 1998), based on the long historical development of the management institutions. Based on fisheries regions, the scale of IFD would still be relatively small, bearing potential for combining objectives of commercial and recreational fisheries (Cowx & Van Anrooy 2010). The institutional base in the development is in key role. In the case of fisheries regions there is potential for combining the ownership-based interests with co-management in a way that builds their adaptive capacity and collective rationality (Rova 2006).

The development of the arrangement in all aspects of sustainability requires use of the more accurate information potentially provided by the system, which would enable more efficient use of both local and scientific knowledge (Mackinson & Nøttestad 1998). Application of this information through a learning process over a long period of time would in effect be a step towards adaptive management (Walters 1986) as the prime management strategy in commercial lake fishery. This becomes more important when fishing effort is increased through number of fishers and increased demand of lake fish. More intensive commercial use of fish stocks can be sustainable only if based on dynamic spatial allocation and up-to-date information on the state of stocks.

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Nearly twenty years ago I joined a research project on the subject of fisheries in the changing society as a trainee. The project took place in Rural Research Centre of the University of Helsinki, located in Mikkeli. My task was to collect data and documents. The main body of this data consisted of the minutes of fisheries associations' annual meetings over a period of 30 years. It soon became clear, as one of my colleagues put it, that "you could make a dissertation out of these". But first, there was the Master's thesis to be done. That I did in the same project, entering the world of fisheries research as a human geographer in the University of Joensuu.

The following step took me to get an insight of questions of ownership of land, and water areas, or more precisely, fishing rights, in a Finnish game and Fisheries Research Institute's project. The project "Water owners' profile" was the first major effort to open up the connection of private ownership, local and regional management and the multiple uses and meanings of aquatic environments at a national scale.

Right after that, I joined the team of fisheries research here at the University of Jyväskylä, in the project SUNARE of the Academy of Finland. Our sub-project, Interlocked sustainable use of fish resources (INSURE) focused on the sustainability of commercial lake fishery. This was the actual start of this work. I changed fish biology and fisheries as my main subject in the PhD studies and I felt like I was taking the third major step in understanding Finnish fisheries.

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YHTEENVETO (RÉSUMÉ IN FINNISH)

Yhtenäisresurssin hyödyntämiseen perustuvan alueellisen kalatalousjärjestelmän kestävyys sisävesiammattikalastuksessa

Tämän tutkimuksen tarkoituksena oli tutkia Suomen sisävesien ammattikalastusjärjestelmän kestävyyttä. Tutkimuksessa tarkasteltiin useiden erillisten kalakantojen muodostaman yhtenäisresurssin (IFD, interlocked fishing district) soveltuvuutta Suomen sisävesien kalatalousjärjestelmään. Tutkimuksen lähtökohtana olivat muikun keskeisyys ammattikalastuksen saalislajina, muikkukantojen vuosien välisen vaihtelun aiheuttamat ongelmat ammattikalastukselle sekä vesialueiden (kalastusoikeuden) yksityisomistuksen ja vapaa-ajankalastuksen laajuus yhteiskunnassa. Näistä lähtökohdista ammattikalastuksen kestävyyden tutkiminen edellytti kestävyys-käsitteen laajaa määrittelyä. Tutkimuksessa sovellettiin Charlesin (2001) jaottelua neljään kestävyyden osa-alueeseen: ekologinen, sosio-ekonominen, yhteisöllinen ja institutionaalinen kestävyys ja näistä muodostuva kokonaiskestävyys.

Tutkimuksen ensimmäisessä osajulkaisussa tarkasteltiin ammattikalastuksen tarpeisiin kehitettyä yhtenäisresurssia, joka sisältää useita erillisiä kalakantoja, ratkaisuna kalakannan vaihtelusta johtuviin ammattikalastuksen ongelmiin ja resurssien kestävän käytön kehittämiseen. Todelliseen saalis- ja pyyntiponnistustietoon perustuvalla 21-vuotisella aikasarjalla kolmelta erilliseltä saman alueen järveltä mallinnettiin yhtenäisresurssin potentiaalisia hyötyjä ja vaatimuksia ohjausjärjestelmälle. Mallinnusten mukaan jo toteutuneen pyyntiponnistuksen tasaisempi jakautuminen kalastajien kesken tukisi sosioekonomista kestävyyttä. Jos kalastusta lisäksi säädeltäisiin siten, että pyyntiponnistus kohdistuu kahteen runsaimpaan kantaan kolmannen, heikoimman kannan jäädessä vuosittain hyödyntämättä, pitkän aikavälin keskimääräinen saalis nousisi noin 8 % (ajoittain lisääntyvän pyyntiponnistuksen ja yhden osakannan vuosittaisen hyödyntämättömyyden vaikutuksia kalakantojen runsauteen ei huomioitu). Lisäksi havaittiin, että kolmen osakannan järjestelmässä pitkällä aikavälillä noin puolet vuosista oli sellaisia, että yhtenäisresurssin sisällä olisi hyödyllistä tai tarpeen lisätä kalastajien liikkuvuutta. Osatutkimuksen taloudellinen mallinnus tehtiin teoreettisesti kahden osaresurssin järjestelmässä. Mallinnus osoitti, että kalastajien lisääntyvä liikkuvuus IFD-järjestelmässä voi tukea kalastuksen taloudellista kestävyyttä.

Artikkelissa II tarkasteltiin kalatalousjärjestelmän keskeisiä kestävyyteen liittyviä käsitteitä ja käytäntöjä. Kalastuskunnissa 1900-luvun alkupuolelta saakka sovellettu pinta-alaan perustuva pyydysyksikkömäärä on näistä tärkeimpiä. Pyyntitekniikoiden kehittyminen ja ympäristömuutokset ovat johtaneet tilanteeseen, jossa yksikköjärjestelmä mahdollistaa ekologisesti kestämättömän kalastuksen. Sovellettuna IFD-tyyppiseen kalastusjärjestelyyn yksikköjärjestelmää voidaan käyttää vain kalastusoikeuden jakoon, mutta sitä ei voida käyttää maksimipyyntiponnituksen määrittelyyn, koska sitä ei ole määritelty

kalaresurssien ekologisen kestävyyden perusteella. Yksikköjärjestelmä ei myöskään huomioi yleiskalastusoikeuksin tapahtuvaa kalastusta, joten riippumatta paikallisesta kalastuksen ohjailusta ekologinen kestävyys voi tietyissä tilanteissa vaarantua. Kokonaisyksikkömäärästä on Suomen sisävesissä keskimäärin kuitenkin käytössä vain noin puolet, mikä voi johtua osittain hallintojärjestelmän rikkonaisuudesta. Näin ollen järjestelmän pirstaloituminen olisi rajoittanut kalastusta kalastuksen aktiivisen säätelyn ohella. Kalastuslaki on muodostanut perustan, jonka avulla paikalliset hallintoyksiköt ovat voineet rakentaa kestävää resurssin hyödyntämistä. Tämä tehtävä on laissa määrätty niille. Paikallishallinnon fragmentoituminen, epätarkka käsitteellinen perusta ja jossain määrin osallistumisen puute rajoittavat osakaskuntien mahdollisuuksia hoitaa tätä tehtävää kestävästi.

Artikkelissa III tarkasteltiin ammattikalastajien nykyistä liikkuvuutta ja kalaresurssien hyödyntämistä sekä sen kehittämistarvetta sisävesillä. Kalastajien pääsy kalastuskohteisiin on rajoitettu ja pyyntiponnistus yksittäisten järvienkin sisällä jakautuu epätasaisesti heikentäen ammattikalastuksen itsesäätelyn tehoa. Ammattikalastus keskittyy 67 järvelle, jotka kattavat 44 % sisävesien pinta-alasta. Reservijärviä ei ole ja ammattikalastuksen lupa-alueet kattoivat 26 % sisävesien pinta-alasta. Lähes puolet ammattikalastajista oli hyötynyt sivukohteista. Kalastuskohteita oli keskimäärin 1,7. Pääkohteesta saatiin kuitenkin 87 % kokonaissaaliista. Pääsy kolmeen tai neljään kalastuskohteeseen lisäsi saatua kokonaissaalista. Liikkuvuus perustui osaksi kalakantojen tilaan: sivukohteiden muikkukannat olivat paremmassa tilassa (runsaampia) kuin pääkohteiden. Kalastajista 48 % toivoi nykyistä laajempia alueita käyttöönsä, mutta pääsääntöisesti päivämatkan sisällä. Lisäalueita haluavilla kalastajilla oli muita korkeampi tavoitetaso sekä minimi- että tavoitekalastustulon suhteen.

Artikkelissa IV tutkittiin muikkukantojen erilaisten hyödyntämisstrategioiden vaikutusta kalataloudelliseen kestävyyteen. Nykyinen ammattikalastuksen ohjausjärjestelmä ei kykene hyödyntämään muikkukantojen perusominaisuutta, vuosiluokan runsauden suurta satunnaisvaihtelua. Mallinnuksen mukaan kaikki pyyntiponnistuksen epätasaisen kohdentamisen mallit tukisivat kalastuksen kestävyyttä. Tämä tapahtuisi käytännössä samalla tai suuremmalla vuotuisella keskisaaliilla ja nykyisellä tai pienemmällä pyyntiponnistuksella sekä kalastajakohtaisesti huomattavasti pienemmällä vuosisaaliin vaihtelulla. Nykyinen järjestelmä ei muodosta alueellisesti tasaista pyyntiponnistusta, mutta koska valtaosa saaliista tulee pääkohteista, kalastajien laajempi liikkumismahdollisuus tukisi muikkukantojen luonnollisen vaihtelun mukaista hyödyntämistä.

Artikkelissa V tutkittiin fokusryhmämenetelmällä keskeisten intressiryhmien suhtautumista ammattikalastukseen ja sen ohjailun kehittämiseen IFD:n mukaiseksi. Nykyisellään kalastuksen säätely sekä lajien ja järviympäristön suojelu tapahtuu huomattavassa määrin paikallistasolla paikallisen tiedon ja kokemuksen varassa. Nykyisessä hallintorakenteessa kalastusalueet ovat ainoa hyväksyttävä toimija IFD:n perustaksi. Sen rooli osakaskuntien yhteistyön ja resurssien hallinto- ja hoitokäytäntöjen yhtenäistämisessä on muodostunut merkittäväksi. Vesialueiden omistajakunnassa motivaatiota IFD:n muodostamiseen on olemassa huolimatta rikkonaisesta omistus- ja hallintorakenteesta ja suoran taloudellisen hyödyn puutteesta. Mahdollinen tarkempi tieto resurssin tilasta, pyyntiponnistuksen tasaisempi jakautuminen ja osakaskunnan resurssien tehokkaampi hyödyntäminen olisivat IFD:n tuottamia hyötyjä omistajille. IFD:n mittakaava muodostuu kalastajien (päivämatka kotoa) ja omistajien (kalastusalueen puitteissa tutut osakaskunnat) kannalta luontevasti 1–2 kalastusalueen kokoon. Tässä mittakaavassa voidaan ottaa huomioon myös resurssien tehokkaan hyödyntämisen ja tätä laajempaa liikkuvuutta toivovien (harvojen) ammattikalastajien tarpeet. Ammattikalastajien ilmaiseman laajemman aluetarpeen lisäksi muiden intressiryhmien näkemykset osoittivat, että hallintojärjestelmän pirstaloituminen ja suoran taloudellisen hyödyn puute eivät ole ylikäymätön este sisävesiammattikalastuksen kehittämisessä.

Artikkelin VI tapaustutkimuksessa hyödynnettiin kyselyntutkimuksen (III) aineistoa kalastajien toiminnasta neljän vuoden jaksolla potentiaalisella yhteisresurssialueella. Tutkimuksessa osoitettiin, että IFD tarjoaa sekä hallinnolle että ammattikalastajille välineitä taloudellisen kestävyyden parantamiseen. Pienellä hallinto- ja kalastajakohtaisilla kuluilla järjestelmä laajentaa kalastajien toiminta-aluetta siten, että toiminnan taloudellista optimointia kalastajien itsesäätelyn puitteissa resurssien tila huomioon voidaan edistää. Tapaustutkimus vahvistaa mallinnusten (I ja IV) sekä kyselytutkimuksen (III) tuloksia koskien IFD-alueen toiminnallista mittakaavaa ja sen mahdollisia taloudellisia hyötyjä.

Kestävyyden eri osa-alueiden tarkastelun perusteella yhtenäisresurssilla on mahdollista lisätä sisävesien ammattikalastuksen kokonaiskestävyyttä yksityisomistukseen perustuvassa hallintojärjestelmässä. Ammattikalastuksen saalisvarmuus paranisi ja toimintaa voitaisiin kehittää ammattimaisemmaksi.

Kokonaiskestävyyden parantaminen edellyttää järjestelyn suunnittelussa aluekohtaista ammattikalastajien tarpeiden tuntemusta sekä muiden intressiryhmien huomioimista koskien myös vapaa-ajankalastuksessa merkittävien lajien (siika, kuha, taimen, järvilohi) kalastuksen säätelyä.

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