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Capital and environmental valuation in the Finnish fisheries – technical aspects and policy implications

Doctoral Dissertation

Heidi Pokki

Luke

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Academic dissertation

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Summary

Heidi Pokki, Natural Resources Institute Finland

Fish stocks in the Baltic Sea are an important natural resource for Finland; targeted by both commercial and recreational fishermen. Fisheries managers require data on the economic value of commercial and recreational fisheries for decision making and to assess the economic sustainability of fisheries. The volume of recreational catch of salmon in Finland is greater than the volume of commercial catch. However, there is marginally information available on the recreational value of salmon angling. These data deficiencies hinder the possibility of fishery managers to make optimal regulatory decisions concerning fish stocks.

Additionally, the angler preferences and related angler profiles should be considered in the decision making process as the reaction to different management measures can vary considerably depending on the angler type. This thesis contributes to the alleviation of the existing data deficiencies by contributing knowledge on the economic state of marine commercial fisheries and on the economic value of salmon angling.

Defining an economic value is often ambiguous as the valuation methods involve inaccuracies which affect the reliability of the estimates. Therefore, it would be beneficial for the data end users to understand the consequences of the choices made in the estimation process in order to interpret the results correctly for decision making.

In this thesis, the application of two different valuation methods: the perpetual inventory method and the travel cost method is described for defining the value of capital and recreational fishing in Finland. The perpetual inventory method is applied for estimating the capital value of the marine commercial fishing fleet of Finland. The thesis describes the justification for the choices made in the estimation process and how these choices affect the results. In addition, the differences between economic and financial analysis are discussed.

Moreover, the thesis describes the value estimation of salmon angling in the River Teno and the River Tornionjoki employing the travel cost method. The studies use a two-step estimation procedure, which considers the potential endogeneity of on-site time per fishing trip. The case study of salmon angling in the River Tornionjoki explores the influence of angler profiles on the fishing behavior; the length of a fishing trip and the number of trips taken. The results show that the importance of increasing catch rate for the recreational benefit obtained by the angler is smaller than expected and the importance of salmon catch differs between the Teno and Tornionjoki rivers. In the River Teno, the experience of catching salmon in the previous season increased, on average, the number of fishing trips during the following season. In the River Tornionjoki the higher catch rate reduced the average number of fishing trips and the length of a trip during the season.

The results presented in this thesis can be utilized for e.g. bio-economic modeling, assessing the sustainability of commercial fisheries of Finland, evaluating the implementation of EU common fisheries policy, and defining river specific fishing regulations.

Keywords: capital valuation, economic analysis, environmental valuation, financial analysis, fisheries, perpetual inventory method, recreational fisheries, salmon, travel cost method

Tiivistelmä

Itämeren kalakannat ovat Suomelle tärkeä luonnonresurssi, jota hyödyntävät niin kaupalliset kalastajat kuin virkistyskalastajatkin. Kalataloushallinto tarvitsee päätöksenteon tueksi tietoa sekä kaupallisen kalastuksen että virkistyskalastuksen taloudellisesta arvosta kalastuksen taloudellisen kestävyyden arvioimiseksi. Lohen virkistyskalastuksen saalis Suomessa on kaupallisen kalastuksen saaliista suurempi, mutta tietoa lohen kalastuksen virkistysarvosta on ollut niukasti saatavilla. Tiedon puutteet heikentävät kalataloushallinnon mahdollisuuksia tehdä optimaalisia säätelypäätöksiä.

Lisäksi päätöksenteossa tulisi huomioida kalastajien preferenssit ja niihin liittyvät kalastajaprofiilit, sillä erityyppiset kalastajat voivat reagoida hyvinkin eri tavoin tarjolla oleviin säätelytoimenpiteisiin. Tämä väitöskirja vastaa osaltaan edellä esitettyihin tiedonpuutteisiin tuottamalla tietoa merialueen kaupallisen kalastuksen taloudellisesta tilasta sekä lohen virkistyskalastuksen taloudellisesta arvosta.

Taloudellisen arvon määrittäminen ei ole usein yksiselitteistä, sillä arvottamismenetelmiin liittyvät epätarkkuudet vaikuttavat tulosten luotettavuuteen. Tiedon loppukäyttäjien olisikin hyvä ymmärtää estimoinneissa tehtyjen valintojen seuraukset, jotta tuloksia osataan tulkita oikein päätöksenteossa.

Tässä väitöskirjassa kuvataan kuinka kahta erilaista arvottamismenetelmää, investointikertymämenetelmää ja matkakustannusmenetelmää, sovelletaan Suomessa pääoma-arvon määrittämiseen sekä virkistyskalastuksen arvottamiseen. Investointikertymämenetelmää sovelletaan Suomessa merialueen kaupallisen kalastuksen laivaston pääoma-arvon laskentaan. Väitöskirjassa perustellaan estimointiprosessissa tehdyt valinnat, kuvataan kuinka nämä valinnat vaikuttavat tuloksiin, sekä keskustellaan taloudellisen ja kirjanpitoanalyysin eroista.

Lisäksi väitöskirjassa kuvataan kuinka Tenon ja Tornionjoen lohen virkistyskalastuksen taloudellinen arvo estimoidaan matkakustannusmenetelmää käyttäen. Tutkimuksissa käytetään kaksivaiheista estimointia, joka huomioi kalastusmatkan keston mahdollisen endogeenisyyden. Tornionjoen virkistyskalastusta koskevassa tutkimuksessa tarkastellaan kalastajaprofiilien vaikutuksia kalastuskäyttäytymiseen, eli kalastusmatkan kestoon ja käyntikertoihin. Tulokset näyttävät, että saalisvarmuuden lisäämisen merkitys kalastajan kokemaan virkistyshyötyyn on oletettua pienempi ja lohisaaliin merkitys eroaa Tenojoen ja Tornionjoen välillä. Tenojoella edellisen kalastuskauden saaliskokemus lisäsi seuraavan kauden keskimääräistä kalastuskäyntien määrää. Tornionjoella puolestaan korkeampi saalistaso vähensi keskimääräistä käyntikertojen määrää ja kalastusmatkan kestoa kuluvan kauden aikana.

Tässä väitöskirjassa esitettyjä tuloksia voidaan hyödyntää mm. bioekonomisessa mallinnuksessa, Suomen kaupallisen kalastuksen kestävyyden arvioinnissa, Euroopan yhteisen kalastuspolitiikan täytäntöönpanon arvioinnissa sekä jokikohtaisten kalastussääntöjen määrittelemisessä.

Asiasanat: pääoma-arvon määritys, taloudellinen analyysi, ympäristön arvottaminen, kirjanpitoanalyysi, kalatalous, investointikertymämenetelmä, virkistyskalastus, lohi, matkakustannusmenetelmä

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Life brings you to unexpected places. I would have never imagined working in fisheries economics or statistics, but sometimes you need to build upon your weaknesses and choose the less obvious path. Environmental economics is fascinating because at this moment in time, the world has, perhaps, more focus on the sustainable use of natural resources than ever. Now natural resources are seen not only as a resource to be exploited, but also as a source of wellbeing; bringing peace of mind, health benefits and cultural heritage. The recreational use of natural resources has so much potential in Finland, and therefore more research is strongly needed.

Many times I have been questioning the whole process of postgraduate studies. Why do I want to go through all this? I have been lucky enough to have sufficient workload and interesting working opportunities in Luke without professional need to dig deeper in the academic world. Now looking back at all the struggles and periods of unproductive breaks over the past eight years, I can see that the journey was long and bumpy but was nevertheless rewarding. It was mostly stumbling in the dark, questioning own capabilities while also experiencing some small, shortly-lived victories. Ultimately, the journey has been worthwhile. I believe in personal development and you grow the most when facing difficulties, exposing yourself to new learnings.

In this journey I am most grateful for all the amazing people I have worked with, and had the privilege to learn from. I would like to thank my supervisors Marko Lindroos (University of Helsinki) and Eija Pouta (Luke) for their wise advice and patient guidance over the years. For teaching me most about writing papers and valuation research I would like to thank Janne Artell (Luke), Ville Ovaskainen (Luke), Jette Jacobsen (University of Copenhagen) and Søren Olsen (University of Copenhagen). I am so grateful for all the time and effort you have devoted for this project. I would also like to thank Jarno Virtanen (Luke), Atso Romakkaniemi (Luke), Päivi Eskelinen (Luke) and Anssi Ahvonen (Luke) for sharing their knowledge on fisheries in Finland and for believing in me. Many thanks to all my co-writers and co-workers from Luke. Special thanks to Panu Orell, Jorma Kuusela and Ville Vähä for their local expertise and data collection in the field. And finally I would like to express my deepest gratitude to my husband Janne for being onboard in all the adventures in life we have embraced.

Let our natural resources flourish so that we can enjoy them.

List of original articles

This thesis is based on the original articles listed below, which are referred to in the text by their Roman numerals. Articles are reprinted with the kind permission of the publishers.

I. Pokki, H., Virtanen, J. & Karvinen, S. 2018. Comparison of economic analysis with financial analysis of fisheries: Application of the perpetual inventory method to the Finnish fishing fleet. Marine Policy 95: 239-247. https://doi.org/10.1016/j.marpol.2018.05.022

II. Pokki, H., Artell, J., Mikkola, J., Orell, P. & Ovaskainen, V. 2018. Valuing recreational salmon fishing at a remote site in Finland: A travel cost analysis. Fisheries Research 208: 145-156. https://doi.org/10.1016/j.fishres.2018.07.013

III. Pokki, H., Jacobsen, J. B., Olsen, S. B. & Romakkaniemi, A. 2020. Understanding angler profiles in cases of heterogeneous count data – a travel cost model. Fisheries Research 221, 105377. https://doi.org/10.1016/j.fishres.2019.105377

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1. Introduction

Fish stocks are an important natural resource for Finland and a topic of controversy. Atlantic salmon is one of the main target species of the Finnish commercial fisheries, and catching salmon is highly valued by both commercial and recreational fishermen. Wild salmon is also important source of income for locals engaged in fishing tourism related businesses. However, different stakeholders have strongly differing opinions on how the salmon stocks should be managed and exploited. Stock conservation interests vary among different stakeholders and the fishing opportunities of commercial and recreational fishers are interconnected. While Finnish commercial fishermen target the salmon populations in the Baltic Sea, the recreational anglers of northern Finland can target several salmon populations from Baltic Sea and Barents Sea, some more abundant than the others (ICES 2017).

River Teno and River Tornionjoki are the two most important freely flowing salmon rivers in Finland. The River Teno has the largest wild Atlantic salmon stock complex in the world, supporting several abundant Atlantic salmon populations of Barents Sea (Vähä et al. 2007; Anon. 2012). Teno river is an attractive fishing destination for the recreational anglers thanks to a good reputation, relatively high catch rates of wild salmon and the possibility to catch very large fish (Anon. 2015). The River Tornionjoki is one of the largest spawning rivers of Atlantic salmon in the world, currently accounting for more than one third of all salmon in the Batic Sea region (ICES 2017). For the last two decades, the Tornionjoki salmon stock has been recovering from the past overfishing in the Baltic Sea and the salmon spawning runs into the river have increased (Romakkaniemi et al. 2003; ICES 2017). These two rivers annually attract around 18,000 recreational fishermen from Finland alone (Erkinaro et al., 2017; Romakkaniemi et al. 2010). Fishing tourism is major source of income and employment for the local communities and entrepreneurs.

The Finnish fisheries are dominated in number by small coastal fishing vessels. According to the Finnish fleet register, there were approximately 1,800 active vessels under 12 meters using passive gears in 2017. The majority of the coastal fishermen only work seasonally and many of them have additional sources of income such as fishing tourism. Coastal fisheries are very concentrated with only ~300 vessels accounting for 80% of the total value of the catch (OSF 2018a). There were 114 coastal commercial fishermen making a salmon catch worth of over 1,000 euros in 2017 (OSF 2018a). Statistics show that the commercial catch of salmon has been decreasing since the peak in 1990 while the share of recreational catch of the total catch has become more important (OSF 2018a, 2018b). Over 50% of the salmon catch in the Baltic Sea and in the River Tornionjoki was made by recreational fishermen in 2016. In many other countries as well, the importance of recreational fisheries as a source of fishing mortality is increasing (Arlinghaus et al. 2016). Meanwhile there is a growing competition of access to fish stocks between commercial and recreational fishermen (Edwards 1990). This competition has led fisheries managers to show interest in the economic implications of fishery allocations between commercial and recreational fishermen (Edwards 1990).

Fish stocks are a common property by nature. The famous 'Tragedy of Commons' introduced by Hardin (1968) occurs with open access leading to overexploitation of common resources (Goodstein 2008). Overfishing and excess capitalization are therefore relevant issues connected to the common property nature of fisheries (Gordon 1954). In open access situation, fishermen do not pay any entry fee for the utilization of a common fish resource, fishing is not restricted and new vessels enter fisheries until zero net revenues are gained. This is not economically optimal. When natural resources are exploited efficiently, the access is restricted and the long-run profits or resource rents are earned by those retaining access to the resource (Goodstein 2008). Overfishing has also been an issue in Finland as the wild salmon stocks in the Gulf of Bothnia have been overfished in the past, and more strict fishing restrictions have been introduced to help the stocks to recover (Romakkaniemi et al. 2003).

The EU common fisheries policy (CFP) aims to promote sustainable fisheries and contains a particular objective of adjusting the fishing capacity to be in balance with the levels of fishing opportunities (European Commission 2013, 2014; STECF, 2016). Sustainability of fisheries is evaluated by the Scientific Technical and Economic Committee for Fisheries (STECF), which assess if the country-level fishing capacity is in balance with the level of fishing opportunities (European Commission 2014; STECF 2016). In this evaluation process, the fishing capacity (i.e. the capital invested in commercial fishing) plays a key role and so data on the value of capital, investments and capital costs are needed. The fisheries economists have been trying to solve the issues of overcapitalization and overflow of investments while the level of capitalization is often poorly documented (Kirkley and Squires 1998). The capital stock has often been considered in terms of number of vessels (Kirkley and Squires 1998), which is not an adequate measure, especially in the case of heterogeneous fleet. Therefore more sophisticated methods for valuing capital stock in fisheries, such as the perpetual inventory method, have been developed (Grafton et al. 2006). Accurate valuation of capital, investments and capital costs is fundamental for reliable analysis of the economic performance and evaluating the sustainability of EU fisheries (STECF 2016).

Fisheries regulations are put in place to preserve fish stocks, to correct the economic inefficiency related to free entry and the losses of economic rent of fisheries (Scott 1979). Fisheries economists have called for more conservative investments in fisheries sector through fisheries management to prevent the overexploitation of fish stocks (Clark 1973; Clark et al. 1979; Charles 1983). Economists recommend fisheries management to introduce individual transferable quota (ITQ) systems, where a fisheries board sets a total allowable catch (TAC), and each fisher obtains a fishing permit allowing for certain percentage of the TAC (Goodstein 2008). ITQ systems for salmon fishing have been implemented in Finnish marine commercial fisheries since 2017.

Recreational fishing in the northern salmon rivers of Finland is managed through a fishing permit system and river-specific fishing regulations in order to avoid overfishing by recreational anglers. However, angling in River Teno or River Tornionjoki has not been restricted by TAC. No limit has been set for the total number of fishing permits sold either, until new restrictions in River Teno in 2018. A new fishing agreement between Norway and Finland along with a new fishing regulation for River Teno were introduced in May 2017 (Anon. 2017). Consequently, fishing in the Finnish side of River Teno became more restricted for fishing tourists and the number of fishing permits per angler per season was restricted. The locals and the Utsjoki municipality were also affected as both are highly dependent on the income that fishing tourism brings to the area.

Recreational angling is known to create substantial socio-economic benefits (Parkkila et al. 2010). However, data deficiencies hinder the decision making process to determine an optimal management strategy (Cooke et al. 2016). Finnish fisheries management is calling for more data on the socio-economic aspects of recreational fisheries, while coastal commercial fishers are struggling with making their fisheries business sufficiently profitable. Optimal fisheries regulations can not be decided without knowledge on the sustainability of commercial fisheries and balance between fishing capacity and fishing opportunities. It is equally important to understand the impact of recreational fisheries on the fish stocks, the society level welfare gained by the recreational salmon anglers and the regional economic impact of fishing tourism. Moreover, knowledge on the angler preferences and motivation affecting fishing behavior is needed for evaluating appropriate fisheries management. The angler’s response to certain policy changes might vary depending on the angler’s preferences for fishing site and related behavioral patterns.

Defining economic value can sometimes be challenging. Generally the marginal value of a private good is derived from market prices. However, market price data can be limited in cases where the good is rarely traded on the market (e.g. fishing trawlers in Finland). In addition, some goods lack clear ownership, and thus have no markets or market price (e.g. salmon angling). Non-market valuation techniques have been developed to establish an economic value for a good without markets. Defining an economic value requires selecting a suitable valuation method and making several assumptions and simplifications while applying the method to gain an unbiased estimate. While no valuation method is perfect, the assumptions and modifications made in the model can have substantial effect on the value derived. From a fisheries management point of view, it is therefore crucial not only to acquire data on the economic value of fisheries, but also to understand how the underlying simplification and assumptions affect the estimation process to correctly interpret the results when making policy decisions.

This thesis gives insight on the economic sustainability of coastal small-scale fisheries (including salmon fishing), while increasing awareness of the recreational value of salmon angling. The aim of this thesis is to increase knowledge on the economic benefits of commercial and recreational fishing in Finland and to discuss technical aspects of two valuation techniques applied: the perpetual inventory method and the travel cost method. Valuation of two very different cases is considered: private goods in the form of capital (fishing fleet) and public goods in the form of environmental amenity (salmon angling). The concept of resource rent (producer surplus) in the commercial fisheries context is discussed through comparison of economic and financial analyses. The concept of consumer surplus in the context of salmon angling is presented through two valuation studies on recreational salmon angling. Research presented in this thesis does not itself allow for advising on optimal allocation and exploitation of fish resources. However, the knowledge gained can be used as a reference in bio-economic modeling (such as Oinonen et al. 2016), and by fisheries managers when assessing the economic viability of Finnish coastal fisheries and when setting regulations for recreational fishing in the salmon rivers.

The thesis seeks to answer the following research questions:

- What is the difference between economic and financial analyses in terms of the profitability (economic benefit) of the Finnish commercial fleet?
- Which factors are indicators of angling behavior (i.e., the time spent on site per trip and the number of trips taken per season) in River Teno and in River Tornionjoki?
- What is the consumer surplus (economic benefit) of a fishing trip in euros in the River Teno and the River Tornionjoki?
- How does catch affect fishing behavior of anglers?

These research questions are addressed in the following studies:

Study I illustrates the difference between economic analysis and financial analysis and discusses the implications of different analysis approaches to the profitability and balance indicators evaluated at an EU level. In the economic analysis, application of the perpetual inventory method (PIM) in the Finnish marine commercial fishing fleet is demonstrated and the challenges of the method are discussed. The applicapility of the perpetual inventory method is questioned in the case of low-activity small scale fishing operating with old vessels. This study is the first to evaluate the applicability of the perpetual inventory method in the case of a heterogenous fishing fleet while showing the implications of capital estimation to the economic and balance indicators.

Study II estimates the use value of salmon angling in the River Teno in Finland employing a single-site travel cost model. The role of on-site time in welfare estimation is discussed and the treatment of endogenous on-site time in the trip demand model is presented. The study adds to the sparse literature on the treatment of on-site time in a trip demand model in the case of a remote fishing destination. The study explores how the experience of catching salmon in one fishing season affects the likelihood of returning the following season.

Study III shows how motivation for angling affects the fishing behavior in the River Tornionjoki in Finland. Employing an explorative factor analysis the study explores, whether distinct types of anglers can be identified from their preferences for fishing site attributes which affect angling trip patterns. Potential endogeneity of on-site time in the trip demand model is explored. Two separate trip demand models are estimated using travel cost method considering the length of a fishing trip and angler profiles discovered. The novelty of this study is simultaneously taking into account the heterogeneity of angler preferences for site attributes and on-site time while estimating the recreational use value of salmon angling.

2. Methods

This section presents the methodology used in Article I for valuing the Finnish commercial fishing fleet and in Articles II and III for valuing salmon angling. Before looking at the valuation methods, it is reasonable to start with identifying the differences between economic analysis and financial analysis in the context of commercial fisheries. When the sustainability and viability of commercial fisheries is assessed from the economic point of view, it is a matter of long-term time horizon (Schuhbauer and Sumaila 2016; Tisdell 1996). In economic analysis, the costs are based on the opportunity costs of production factors (Atkinson et al. 2012; Grafton et al. 2006; Mankiw and Taylor 2006) and the resource rent (Anon. 2005) 'is the sustained return society obtains from owning a stock' (Nielsen et al. 2012) in the long term. Financial analysis in turn examines the actual profitability based on the explicit costs paid by the enterprises and describes the financial position of the segment at the current time. Capital invested in fishing capacity is a major production factor. The capital costs are defined differently in financial and economic analysis. Whereas capital costs in financial statements relate to accounting rules and the financial position of enterprises, in economic analysis, capital costs relate to the capital employed in fisheries. The PIM is applied in Article I for valuing capital of commercial fisheries in economic analysis and the concept of PIM is presented more fully in the section 2.1.

In monetary terms, the measure of benefit for an individual consuming an environmental good, such as salmon angling is "willingness to pay (WTP) to secure that benefit or willingness to forgo the same" (Bateman et al. 2002). Consumer surplus is a welfare measure which describes the net change in welfare for the consumption of an environmental good (Bateman et al. 2002). Basically consumer surplus is the difference between the price paid by the recreationist and the price that they are willing to pay for the environmental amenity. Consumer surplus per angling trip is estimated in Articles II and III applying travel cost method, which describes the net change in angler welfare generated by an average angling trip.

Total economic value is a useful tool for evaluating the social welfare impact of different policy options in the case of environmental amenities such as recreational fishing. The total economic value consists of use and non-use values. Use values relate to the actual and planned use of the natural resource. Non-use values can be measured with the willingness to pay to maintain a natural resource existing without any intention to use it (Bateman et al. 2002). Further, a use value is comprised of three components: direct use value, indirect use value and option value (Bateman et al. 2002; Garrod and Willis 1999). Direct use value is the value individuals give for using a resource such as fish stock. The resource can be used for either commercial purposes or for recreation. Indirect use value exists when individuals benefit from ecosystem functions supported by a resource rather than actually using it (for example - carbon sequestration by forests). Option value represents the value people give for having the option to use a resource in the future even if they are not currently using the resource. The concept of the travel cost method (TCM) applied for estimating the direct use value of salmon angling in Articles II and III is introduced later in section 2.2.

Non-use values include altruistic values, existence values and bequest values (Bateman et al. 2002). Altruistic economic value expresses the willingness to pay of an individual to ensure that another individual secures some gain in wellbeing. Existence value is the value given on a natural resource, even when people do not have an intention to ever use the resource. Bequest values show the willingness to pay to ensure the ability of future generations to use the resource (Bateman et al. 2002, Garrod and Willis 1999).

2.1. Measuring the value of capital in fisheries: perpetual inventory method

To determine the resource rent in economic analysis, the capital value or capital stock of the fleet needs first to be measured (Anon. 2005). The capital stock can be valued in several practical ways: 1) finding a direct estimate of the capital stock, 2) using book values from accounting and adjusting them for inflation, mergers and accounting procedures or 3) using the PIM (Hulten 1990). Market data do not sufficiently take into account the value of capital services in the case where some of the capital has been rented. Hence, some indirect methods for measuring the capital have been developed, such as perpetual inventory method (Hulten 1990). Book values might be easily acquired, but they do not necessarily reflect the market prices very well if the fleet is comprised of older vessels. Hedonic models are also applied in the fisheries literature for capital valuation. Hedonic modelling is based on the assumption that the hedonic price of a commodity can be measured as a function of its attributes, and economic agents value these attributes (Hulten 1990). Empirical applications of hedonic models in commercial fisheries have been introduced by e.g. Guyader et al. (2003) and Kirkley and Squires (1998).

In a Data Collection Framework context (European Commission 2010) the PIM developed by the OECD (OECD 2001) is the preferred method for estimating the capital value of commercial fishing fleet. When measuring capital stock of the fleet employing PIM, vessel attributes such as length, gross or net tonnage and carrying capacity can be used as proxy variables affecting the capital value of a vessel (Grafton et al. 2006). The PIM estimates the aggregate capital stock of a certain year by accumulating the past purchase of assets (investments) over their estimated service lives; i. e. by aggregating of the value of all vintages of vessels. The value of a vessel is assumed to comprise of four components or assets: hull, engine, electronics and other equipment, and the value of each asset can be calculated (see Eq. 2 and 3). Historical prices reflecting the original acquisition price, current prices or constant prices can be employed when estimating the value of aggregate capital stock. A depreciation function is applied to calculate the consumption of fixed capital (depreciation). The net capital stock is obtained by subtracting the accumulated capital consumption from the gross capital stock. The capital costs, including depreciation and interest, can be calculated using a given depreciation schedule and interest rate respectively. (OECD 2009)

In the Data Collection Framework (European Commission 2010) for European Union fisheries, the definitions of capital stock by OECD (2009) are followed when perpetual inventory method is applied. Gross capital stock (GCS) is the stock of assets surviving from past investment and re-valued at the purchase prices of new capital goods for a reference period. The gross capital stock at year t can be calculated with the following equation:

$$K_t^G = \Omega_0 I_t + \Omega_1 I_{t-1} + \ldots + \Omega_T I_{t-T}, \quad (1)$$

where retirements are distributed over time and Ω_t is the proportion of assets surviving to time t (Hulten, 1990).

Net capital stock (NCS) is the difference between the gross capital stock and the consumption of fixed capital. The net capital stock of the year t can be derived using the following formula:

$$NCS_t = GCS_{t-1} + I_t - R_t - D_t, \quad (2)$$

Where GCS_{t-1} is the initial gross capital stock at the beginning of the year t, I_t denotes the investments made during the year t, R_t are the retirements made during the year t and D_t is the depreciation of the year t. (Gambino et al. 2007)

Based on the EU legislation (European Commission 2010), Member states are obliged to report the capital value of the fleet based on either its replacement value or its historical value. The replacement value gives the value of an asset at current prices on the basis of what it would cost to replace it if it was acquired today (Gambino et al. 2007). The gross replacement value (GRV) reflects the value of an asset as if it was acquired today as new and no depreciations had yet been made. The gross replacement value of an asset i at time t can be written as:

$$GRV_{it} = RPCU_t \times CU_t \times Share_i, \quad (3)$$

where $RPCU_t$ is the replacement price per capacity unit in a given year t, CU_t is the selected capacity unit in a given year t and $Share_i$ is the share of the value of the asset i in the total value of the vessel. (Gambino et al. 2007)

The gross historical value of an asset (GHVA) gives the value of an asset at the historical prices at a specific time point defined as:

$$GHVA_{it} = HPCU_t \times CU_t \times Share_i \times PI_{it}, \quad (4)$$

where $HPCU_t$ is the historical price per capacity unit at time t and PI_{it} is the price index of an asset i at time t. (Gambino et al. 2007)

The perpetual inventory method requires many assumptions while EU Member States can decide on the default values without well-defined EU-level guidelines. Careful determination of the default values is nonetheless critical as a small change can have a major influence on the capital value estimates. Moreover, selecting a particular price determinant for the vessels (such as book value) in a price per capacity unit calculation greatly affects the replacement value estimated and thus has an additional impact on economic profitability assessment.

2.2. Economic valuation of recreational fishing: travel cost method

Recreational fishing is an environmental amenity, which has no observable market price. Generally non-market goods have public good properties of some degree while pure public good is non-rival and non-excludable (Bateman et al. 2002; Goodstein 2008). Wild salmon as a natural resourse is a common good by nature. Common goods are rivalrous and non-excludable. Consumption of a good is rivalrous when a person's consumption of that good reduces the amount available to others – i.e. the same fish can only be caught once. Non-excludable means it is not possible to supply the good only to some people and exclude others from using it (Bateman et al. 2002). Due to high transaction costs and free riding, the free market is not able to provide enough environmental amenities (Goodstein 2008).

Several valuation techniques have been developed to place an economic value on an environmental amenity without any markets. These valuation techniques can be divided into three main approaches: stated preference methods (SP), revealed preference methods (RP) and benefit transfer (Bateman et al. 2002). Stated preference techniques are questionnaire-based techniques which are used to study preferences of individuals by asking them questions on how much they are willing to pay (or to accept) for a certain set of alternatives. Stated preference methods include contingent valuation and choice experiment methods. Revealed preference (RP) techniques employ market information associated to the good or service in question to place a value. As the actual decisions by individuals are reliable indicators of preferences, the revealed preference techniques are preferable methods in cases where sufficient data are available. Revealed preference methods include random utility/discrete choice models, actual market data, hedonic pricing, travel cost method and avertive behavior (Bateman et al. 2002; Garrod and Willis 1999). In benefit transfer an original valuation study already conducted at one site is adapted to a new policy application at the same site or to a different site, and this is often done for cost-efficiency (Bateman et al. 2002).

The travel cost method was selected for the analysis in the two valuation studies presented in this thesis for two reasons: data on travel expenses, and on-site expenses were easily collectable together with annual catch statistics data and TCM is a fairly straightforward method to use. TCM has also been widely used in the recreational fisheries valuation literature (e.g. Agnello and Han 1993; Curtis 2002; Ezzy et al. 2012; Fleming and Cook 2008; Morey et al. 1991; Morey and Waldman 1998; Shrestha et al. 2002). TCM is applicable for valuing direct and indirect use, but it is not applicable to non-users. Thus TCM does not allow for calculating the total economic value of the environmental amenity. The method is based on actual, observed behavior and thus the data are assumed to reflect the real consumer preferences well. Collecting the data for TCM is often not as resource intensive as in some other valuation techniques.

TCM was first introduced by Hotelling (1949). The TCM concept was that a demand curve for visits to a recreational site can be constructed from visitor data using the costs associated with reaching the site. The consumer surplus of a recreational trip can then be calculated making use of demand curve parameter estimates. In practice, TCM studies have demonstrated that an increase in the price of access to the recreation site or to the cost of travel decreases the visitation rate (Garrod and Willis 1999). TCM is useful for valuing both single and multiple sites.

The single-site travel cost model estimated in Articles II and III of this thesis is a demand model for recreational trips such as fishing trips to a recreation site by an individual over a fishing season (Parsons 2003). The demand is the number of fishing trips to the site over a season. In addition to travel costs, the demand for recreation trips is assumed to be explained by e.g. travel cost to substitute site, and sociodemografic factors such as income and age. The demand fuction for recreational fishing trips using a single-site model can thus be written as (Parsons 2003):

$$r = f(tc_r, tc_s, y, z), \qquad (5)$$

where r is the number of trips per season, tc_r is the recreation trip cost, tc_s is a vector of trip costs to substitute recreation sites, y is income and z is a vector of demographic variables affecting the number of trips taken. The basic assumption in TCM is that higher travel costs result in fewer recreational trips per season and thus a negative coefficient of recreation trip cost tc_r is expected. The income effect is accounted for by the y's, i.e. a positive coefficient of y means that higher income level implies more frequent trips per season. The substitution effect is accounted for by the tc_s's which are the prices of trips to substitute sites. People living close to a substitute site are expected to have lower number of trips to the site of interest as they substitute trips to the other recreation site. This substitution effect is manifested by the positive coefficient of tc_s.

Unfortunately, there is no general agreement on how substitute sites should be treated in the travel cost model (Garrod and Willis 1999). Defining substitute sites can be troublesome especially in Nordic open access conditions as well as finding a suitable estimate for the substitute trip prices. When single-site travel cost models are estimated in practice, the substitute sites are often ignored, and thus the consumer surplus and the recreational use value of the site are overestimated.

Once the demand function for fishing trips has been estimated, the average consumer surplus can be calculated. The consumer surplus is the grey area under the estimated demand curve ($f(tc_r, tc_s, y, z)$) and above the average travel cost to the site p_0 (Figure 1).

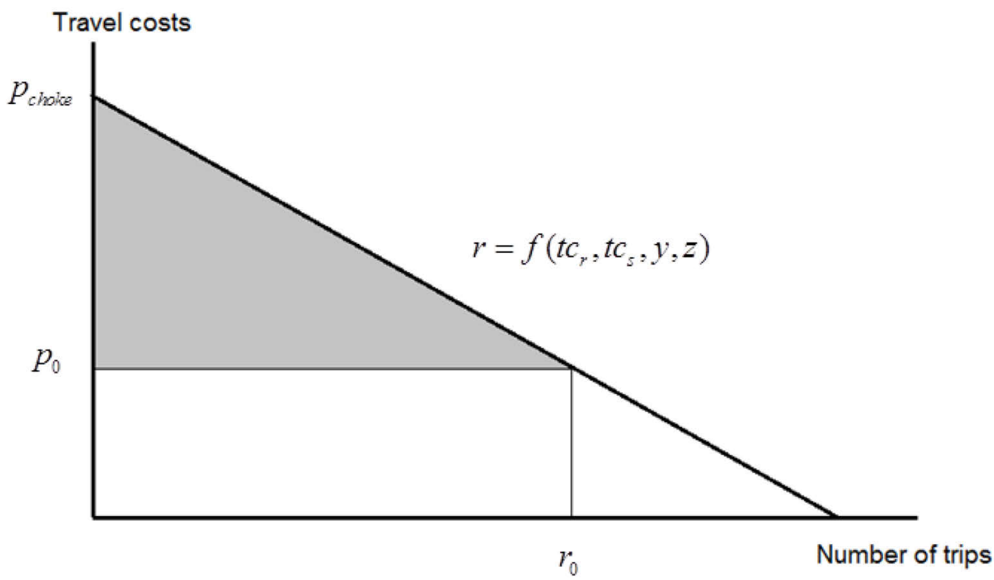

Figure 1. Demand for fishing trips and consumer surplus.

The choke price p_{choke} is the trip price where the demand of trips r falls to zero. Mathematically consumer surplus is:

$$\Delta w = \int_{p_0}^{p_{choke}} f(tc_r, tc_s, y, z)dtc_r \ . \qquad (6)$$

A problem of multipurpose trips arises when a trip to a recreation site includes other benefit-generating activities than the recreation activity of interest, in our case salmon angling. These multi-purpose trips might pose a misspecification problem if only the total trip price including all the recreation activities is observed and no separate price data are available for the salmon angling. Inclusion of other activities in the trip price affects the consumer surplus estimate and the estimate of the travel cost coefficient is likely biased (Loomis et al. 2000). To correct this, Smith and Kopp (1980) have suggested identifying those visitors undertaking multi-purpose trips and omitting them from the sample. In the valuation studies presented in this thesis, there was no question included in the questionnaire identifying anglers on multi-purpose trips. At least the Teno river area is a very remote fishing destination, and joint recreation options during the fishing season are very limited. Another issue is multidestination trips, where a recreational trip to a particular site is not separable from trips to other sites, and thus trip costs are not separable either. Estimating a single-site model in multidestination case results to biased estimates (Garrod and Willis 1999).

When analysis on the effect of quality changes in the fishing site is needed, instead of a single-site model, multiple-site models might be more suitable. Multiple-site models can consider multiple substitute sites and use variation between sites to estimate the welfare effect of quality change in one site (Parkkila et al. 2010). Random utility maximisation (RUM) and hedonic travel cost modeling are examples of multiple-site models (Pendleton and Mendelsohn 2000). Employing a RUM model, it is possible to estimate the preferences for different types of recreation or multiple recreation sites considered by the consumer (Garrod and Willis 1999). The hedonic travel cost method is applied for revealing how much users are willing to pay for the individual characteristics of outdoor recreation sites (Pendleton and Mendelsohn 2000).

2.3. Time in travel cost models

The value of time is one more heavily debated topics in the recreational valuation literature considering applications of travel cost method (e.g. Bockstael et al. 1987; McKean et al. 2003, Ovaskainen et al. 2012). In order to obtain unbiased estimates, it is crucial to incorporate the cost of travel time in the travel cost variable (Cesario and Knetsch 1970). The value placed on the time travelled or time spent on a recreation site can affect greatly the estimated value of a recreational activity. The value of time varies across individuals, and can vary depending on the occupation, employment situation and purpose of the journey (Garrod and Willis 1999). Following the fraction of wage rate approach introduced by Cesario (1976), one commonly used practice is to use some proportion of the wage rate as the opportunity cost of time. The most commonly utilized convention is to take one third of the wage rate as the opportunity cost of time (Hellerstein and Mendehlsohn 1993; Englin and Cameron 1996). This approach is also taken in Articles II and III when defining the cost of travel time and on-site time. If individuals have fixed working hours and they are not able to freely choose between work and leisure time, the validity of using a fraction of the wage rate approach can be questioned (Bockstael et al. 1987; McKean et al. 2003). Statistical techniques have also been employed for determining the choice of time costs (e.g. Bateman et al. 1996; McConnell and Strand 1981). Discussion of the value of time continues while this was not the main focus of the current thesis.

A fundamental assumption of travel cost method is that travel costs are mainly defining the demand for recreational trips and for unbiased welfare estimates the recreational trips are assumed to be homogenous in regard the length of a trip (Garrod and Willis 1999; McConnell 1992). Smith and Kopp (1980) presented the statement that recreational trips may not be homogenous and this has important implications to the consumer surplus estimates when the travel cost method is used. Non-homogenous trip data denotes that visitors travelling long distances to the recreation site might spend more time on-site per trip than those travelling shorter distances (Smith and Kopp 1980). There exists empirical evidence supporting the statement of non-homogenous trips (Bell and Leeworthy 1990) and the consumer surplus estimates could be biased if the heterogeneity of data was not appropriately considered in the estimation. Reducing the heterogeneity in estimation can be accomplished by dividing the data into more homogenous groups and estimating a separate travel cost model for each group (Acharya et al. 2003; Bell and Leeworthy 1990). This approach was taken in Article III of this thesis, where separate trip demand models were estimated for short and long visits.

Modeling recreational demand with travel cost analysis can be further improved by carefully modeling the on-site time, especially in the case of endogenous on-site time (Berman and Kim 1999). For unbiased consumer surplus estimates, the explanatory variables in the travel cost model need to be exogenous and uncorrelated with the error term of the model. On-site time can be regarded as an exogenous variable in the trip demand model, if the length of stay varies little among visitors and the on-site time is a predetermined variable in the model. In case an explanatory variable is correlated with the error term and explained by the other variables of the model, the variable is considered endogenous. On-site time can be regarded as an endogenous variable when varying the on-site time affects the price of a trip. If an endogenous variable, the on-site time is considered as a decision variable that is dependent on different cost- and site-specific factors and the length of stay varies considerably among visitors.

Endogeneity of on-site time in recreational demand models can be addressed in several ways (Berman and Kim 1999; Landry and McConnell 2007; Larson 1993; McConnell 1992). In the articles II and III of this thesis, the stepwise estimation procedure outlined by McConnell (1992) is applied, whereby an auxiliary regression is first used to determine whether on-site time is endogenous or exogenous, and the specification of the main trip demand model depends on the outcome of the first step. The null hypothesis tested is that the parameters of demand function for on-site time are not jointly significantly different from zero. If the on-site time per trip is significantly explained by travel costs per trip and the per-hour cost of on-site time, on-site time can be considered endogenous. In this case, the on-site time per trip is excluded from the trip demand model and the opportunity cost of on-site time (per-hour cost of time spent on site) is included in the model as a separate explanatory variable.

However, if the on-site time is considered exogenous, the per-trip cost of time spent on site is directly incorporated with other travel costs into a composite full-cost variable. Furthermore, the on-site time per trip is included as explanatory variable in the trip generating function (McConnell 1992).

3. Survey data and estimation procedures

3.1. Application of the perpetual inventory method to the Finnish commercial fishing fleet

In article I, the perpetual inventory method is applied to the Finnish commercial fisheries to estimate the capital value and capital costs for each vessel segment. In addition, the effect of different modes of analyses to the profitability and balance indicators are discussed. The data for the study was collected by Natural Resources Institute Finland (Luke) and related to annual economic data collection of fisheries (European Commission 2010). Data sources were the Finnish fleet register, financial statements data from Statistics Finland and an account survey to small scale fishermen and trawlers conducted by Luke. In addition, the 2013 insurance values for trawlers were collected from two Finnish fishing insurance associations.

Based on the Finnish fleet register, the active marine commercial fishing fleet of Finland was composed of 1,849 vessels in 2013. Although most of the income of the commercial fisheries comes from trawling, the Finnish fisheries are dominated in number by small coastal fishing vessels which made up 97 % of the active fishing vessels in 2013. Majority of coastal fishermen only work seasonally and small scale fisheries is a highly concentrated business.

Article I describes that five steps were taken to estimate the price per capacity unit for capital value estimation following guidance documents in Data Collection Framework (IREPA 2006; STECF 2011). First, the historical values of vessels expressed by insurance and book values were collected and validated. While both book values and insurance values were obtained for small vessels using passive gears, only insurance values were available for trawlers. Second, the cumulated depreciation costs were estimated. Third, the gross replacement or historical value according to the fleet segment was calculated. Fourth, the vessel replacement values at 2013 prices were calculated by applying price indexes. And finally, the price per capacity unit (PCU) for each fleet segment was calculated based on gross replacement value and gross tonnage (Table 1).

When applying the PIM, the value of the vessel is assumed to compose of four components: the hull, engine, electronics and other equipment (including gear and deck and storage equipment). For these four components, a separate economic value (or capital value) and depreciation was calculated. The total capital value of a vessel is obtained by adding up the values of these four components. (IREPA 2006)

Table 1. Price per gross tonnage by fleet segments in 2013 (€).

Fleet segment	PCU from insurance values (€)	PCU from book values (€)
Vessels using passive gears, 0–12 metres	28,477	21,957
Pelagic trawlers, 12–24 metres	14,161	
Pelagic trawlers, over 24 metres	10,592	

Several assumptions need to be made when estimating the capital value or capital stock of the fleet according to the PIM. In order to attain accurate estimates of the capital value, each member state needs to carefully determine the national shares of the capital components in the total value, the component depreciation rates and the service lives of the components (STECF 2011). Article I describes in detail how the default values used in the capital value estimation of the Finnish fleet were determined. A degressive depreciation scheme was applied to calculate the net capital value of the vessels.

Article I discusses briefly the valuation of fishing rights in relation to capital valuation in fisheries. In an ideal situation, the intangible assets should be valued separately from tangibles when calculating the resource rent in economic analysis or accounting profit in financial analysis. However, no commonly agreed method under the Data Collection Framework for estimating the value of intangibles exists. If intangible assets such as fishing rights are freely tradable, they should be valued at the market price assuming infinite lifetime for the asset (Gambino et al. 2007). When fishing rights are not tradable their value is attached to the vessel and a separate value for fishing rights cannot be observed on the market. In this case, hedonic modelling could be used for estimating the value of fishing rights (Gambino et al. 2007). In cases where the fishing rights are not tradable, such as in Finland in 2013, only the value of tangible assets of fisheries should be reported (Gambino et al. 2007) until further guidance is available. Thus, the value of intangibles was not considered when comparing the economic and financial analysis of the Finnish fishing fleet.

In article I the profitability and balance indicators from economic analysis using the PIM are compared with the results from financial analysis, where the capital value refers to the fixed tangible assets in the balance sheet. Moreover, the capital costs in the PIM refer to the estimated depreciation and the opportunity cost of the capital invested in the fleet. Whereas, the depreciation in the financial analysis originates from the depreciation schedule following the national accounting rules, and the financial costs are real net interest costs recorded in the accounts.

3.2. Valuing demand for angling in the River Teno

Article II of this thesis utilises fishing trip data collected by the Finnish Game and Fisheries Research Institute (FGFRI) from recreational anglers visiting the River Teno after the 2011 fishing season. A sample of 700 Finnish anglers living outside Utsjoki municipality was selected for the study. These anglers received a mail questionnaire inquiring *inter alia* how much money was spent on travel, on accommodation and other services on-site during the fishing trips made in 2011 fishing season to the River Teno (Figure 2).

Often, the recreational trip data are collected from on-site visitors excluding the non-users and all visitors in the sample have taken at least one trip to the site. The number of trips taken to a recreation site over a season can thus take only non-negative integer values. Moreover, most recreationists take only a few trips during a season, while only few more active recreationists take more frequent trips. Hence, the distribution of number of trips is in many cases skewed, with a long right hand tail. Using ordinary least squares estimator would lead to biased estimates (Cameron and Trivedi 1998). Truncation and non-negative integer values are typically handled in the valuation literature by using a regression model with a truncated Poisson, or negative binomial probability distribution (Cameron and Trivedi 1986, 1998; Creel and Loomis 1990; Grogger and Carson 1991; Hellerstein 1991; Hellerstein and Mendelsohn 1993; Shaw 1988). All respondents in the study presented in article II had visited the River Teno at least once during the season. Consequently, the distribution of the sample can be considered truncated at zero visits.

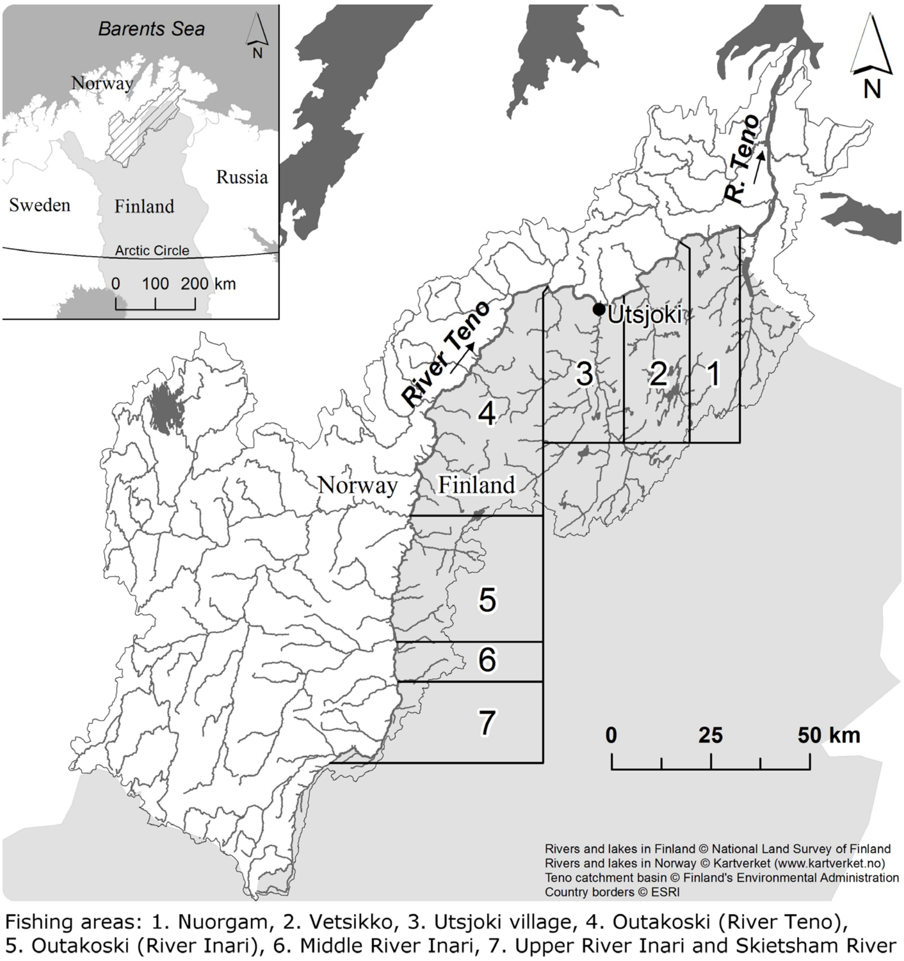

Figure 2. The Teno fishing permit area covering the Teno-Inarijoki river system.

The fishing trip data employed in Article II were not typical for travel cost models as only few trips during the fishing season was taken, but an average length of a fishing trip was approximately 7 days. Thus, the on-site costs were proportionally high compared to travel costs. In cases when only few, but long lasting trips are taken to a fishing site, the travel costs might not take up most of the costs, but other costs could be more importand for determining the demand for angling trips. Moreover, the on-site time can be seen as a source of utility and a cost (McConnell 1992).

In Article II, a two-step estimation procedure outlined by McConnell (1992) was followed. In the first step, the potential endogeneity of on-site time was examined by estimating the demand for on-site time per fishing trip. To show the effect of salmon catch for the demand of on-site time per fishing trip, two separate on-site time demand models were estimated. Ordinary least squares was used in the estimation instead of count data models because the on-site time dependant variable did not take integer values. Both of the models used proved that on-site time can be regarded as endogenous in the demand models for fishing trips. In the second step, the trip demand model was accordingly specified and estimated by using truncated count data estimators. As the on-site time was considered endogenous in both models, the on-site time cost and on-site expenditures were included in the trip demand models as separate cost variables.

The distribution of the number of trips taken is often modeled by using a Poisson distribution. Employing a Poisson distribution and attaining unbiased estimates requires that the mean and variance are equal in the trip frequency distribution (Cameron and Trivedi 1986). If the variance is larger than the mean, overdispersion might be present, and conversely, trip data could be underdispersed. In case of overdispersion, the truncated negative binomial model allowing the sample variance to exceed the sample mean could be used instead of basic Poisson model (Cameron and Trivedi 1986; Grogger and Carson 1991). In Article II two truncated negative binomial models were estimated to investigate the potential overdispersion of the trip data. No overdispersion was detected, but trip data might rather be undersdispersed and thus truncated Poisson model was chosen for the analysis.

After estimating the demand functions for angling trips in Article II, the average recreational value per angling trip indicated by consumer surplus was calculated using the parameter estimates for the travel cost variable. Finally, the total recreational use value of salmon angling in the River Teno was calculated based on the total number of fishing permits bought, the average number of trips per angler (per season) and the consumer surplus per visit estimated.

3.3. Angler profiles and demand for angling in the River Tornionjoki

Article III utilises angling trip data collected from recreational anglers of River Tornionjoki by Natural Resources Institute Finland (Luke) following the 2016 fishing season. The mail survey targeted a sample of 1,500 anglers comprising both local and visiting recreational anglers. Besides questions on fishing effort and catch, the survey questionnaire contained questions on travel expenses and costs accumulated on site. Using a predesigned set-up of different site attribute statements, anglers were also asked to rate their motivation for choosing the River Tornionjoki (Figure 3) as their fishing destination. The data on preferences for site attributes was employed in the explanatory factor analysis for identifying angler profiles. Over 99% of the respondents had been angling at least once in the River Tornionjoki during the 2016 fishing season. Number of fishing trips taken was reported by 772 anglers. Approximately half of the respondents visited the River Tornionjoki only once in 2016 and the average length of a fishing trip was 4 days.

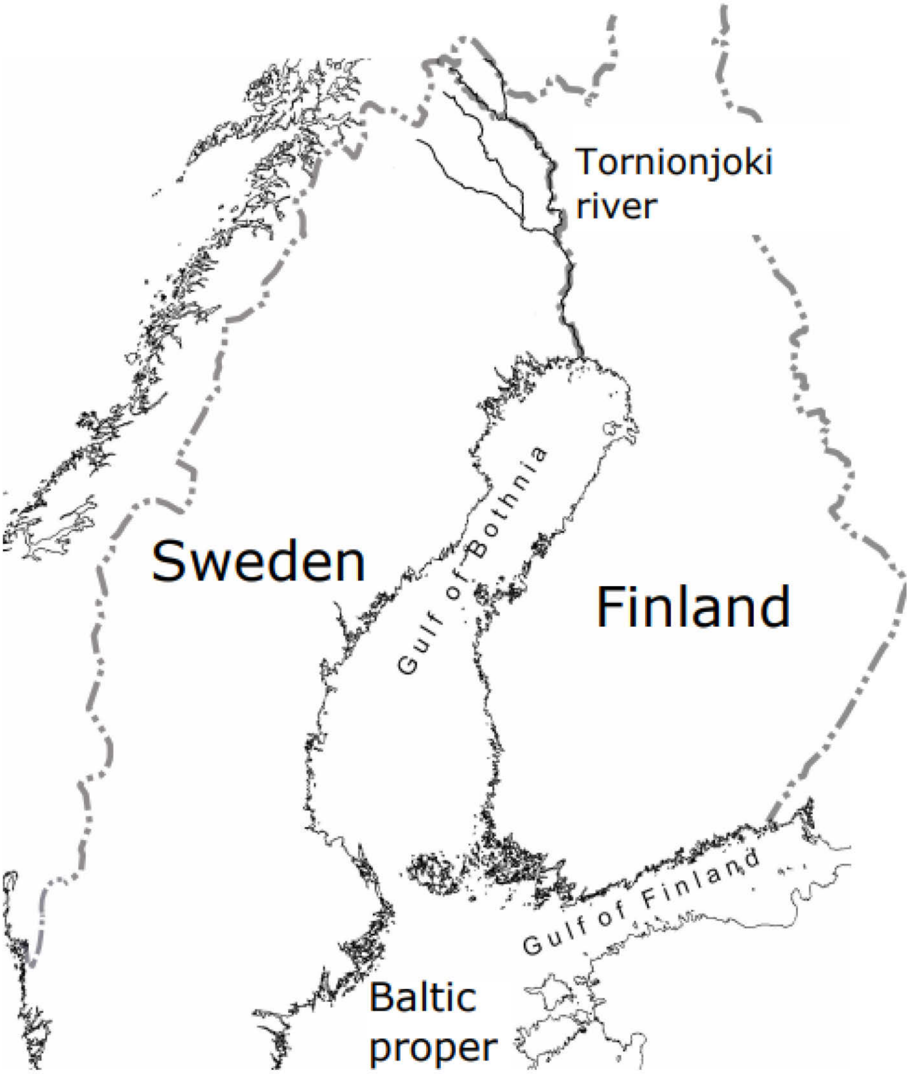

Figure 3. The River Tornionjoki is situated on the border between northern Finland and Sweden.

In Article III, a stepwise estimation procedure was followed in the travel cost model estimation. First, an explanatory factory analysis was performed employing the data on appreciation of site attributes in order to find latent attitudinal variables, referred to as angler profiles, affecting the length of stay or number of trips taken to the River Tornionjoki. Article III presents that three common factors or angler profiles could be identified. These angler profiles were named as ‘nature lover’ factor, ‘easy fishing’ factor and ‘selective angler’ factor. Once these angler profiles were identified, the factor scores for each angler were included as explanatory variables in the travel cost model estimation. Before estimating demand for fishing days and fishing trips, the heterogeneity of the trip data was accounted for by dividing the data into two separate sub-samples: short and long visits.

Next, the potential endogeneity of on-site time in trip demand model was tested by estimating a separate model for the demand of on-site time for each sub-sample and testing the null hypothesis that the parameters of the models are not jointly significantly different from zero. The parameters of the model were found to be jointly statistically significant indicating that the parameters as a group explain to some extent the on-site time of a fishing trip. Hence, the on-site time was determined to be an endogenously determined variable in both of the trip demand models estimated.

As a final step, a separate angling trip demand model for each sub-sample was estimated using truncated count data estimators. The potential overdispersion of trip data was reviewed by estimating a truncated negative binomial model for the demand of angling trips and testing the significance of the overdispersion parameter (Cameron and Trivedi 1998). In the case of short visits, overdispersion in the angling trip data was detected, while the data for long visits were not overdispersed. Accordingly, a truncated negative binomial model was used to estimate the demand for angling trips of short visits and a truncated Poisson model was used for estimating the demand for angling trips of long visits. Finally, the average recreational value per angling trip indicated by consumer surplus was calculated for short and long visits using the parameter estimates of the travel cost variable.

4. Summaries of articles

4.1. Article I. Comparison of economic analysis with financial analysis of fisheries: Application of the perpetual inventory method to the Finnish fishing fleet

The study presents how the perpetual inventory method is applied in Finland to measure the capital value of the marine commercial fishing fleet. The results from economic analysis using the PIM are compared with those from financial analysis to show the implications of different modes of analysis to the profitability and the balance indicators. The study demonstates that sometimes the different analysis approaches, focusing on short-term or long-term perspective, present a different picture of the profitability and the balance between fishing opportunities and the fishing capacity. Based on the financial statements data, the net profits of all vessel segments were positive indicating a profitable business in the short term. When looking at the long term profitability, the PIM was applied to calculate the opportunity cost of capital, and the net profit of the whole fleet was negative. Moreover, the net profit of small-scale fleet was substantially lower when the insurance values were used for calculating the price per capacity unit (€/GT) compared to when the book values were used.

When the analysis was carried out concentrating on the more active part of the small-scale vessels, those generating annual turnover of more than 8,500 euros, the results from economic and financial analysis were more compatible. The active part of the small-scale fleet was found to create significant resource rent, while the small-scale segment as a whole was considered imbalanced. Therefore, one of the main conclusions of the study was that results from economic analysis and financial analysis in terms of profitability can be contradictary. A fleet segment with many old, low-activity vessels could show a positive profit in the financial statements and be profitable in short term while economic analysis could indicate losses. In the long-term perspective it is not profitable to invest renewing the old vessels with the current fleet structure, and the fleet segment could have declining number of active vessels.

The study also discusses the notable uncertainties that are linked to the perpetual inventory method and the sensitivity of the method; a small modification in one of the assumptions used in the valuation model (such as price per capacity unit, service lives, composition of the vessel, depreciation scheme, etc.) can change the results drastically. Nevertheless, setting up the default values for these assumptions that match the conditions of the member state in question require careful consideration, and gathering reliable data can be challenging. To guarantee comparable results of the economic analysis of commercial fleet at the EU level, setting up clear guidelines for the common approach to applying the perpetual inventory method would be very valuable and this would allow more thorough understanding of the economic performance of the EU fishing fleet.

4.2. Article II. Valuing recreational salmon fishing at a remote site in Finland: A travel cost analysis

In this study, the economic value of recreational salmon fishing in the River Teno was estimated using a single-site travel cost model while considering the role of on-site time in the welfare measurement. Following McConnell (1992) approach, also applied by Acharya et al. (2003), a two-step estimation procedure was applied, whereby the potential endogeneity of on-site time was first investigated with an auxiliary on-site time regression. In the second step, the main trip demand model was specified and estimated according to the outcome of the first step.

To show the effect of time cost of the travel in this study, two travel cost variables were constructed and employed in the travel cost model estimation: driving costs only and combined travel costs. Estimating the demand for on-site time proved that on-site time should be treated as an endogenous variable in both trip demand models. Thus, the trip demand models were specified accordingly including the on-site time cost per hour as a separate explanatory cost variable.

The main finding of the study was that previous experience of making a catch in the River Teno increased the likelihood to visit the river the following fishing season. Hence, sustainable management of salmon stocks is important not only from the ecological point of view, but also generating increased recreational value to the anglers and income to the locals related to fishing tourism. Moreover, the study found that a higher income level of the respondent indicates more frequent, but shorter visits.

The consumer surplus per average angling trip to the River Teno was estimated to range from 235 to 338 euros, depending on the function specification estimated, while the corresponding total recreational use value was estimated to range from 2.6 to 3.7 million euros. There results clearly indicate that recreational angling in the River Teno has substantial welfare effect for the anglers. Moreover, fisheries managers can contribute to the value attained by anglers through sustainable management actions supporting abundant salmon stocks in the River Teno.

4.3. Article III. Understanding angler profiles in cases of heterogeneous count data – a travel cost model

The study investigated how angler's preferences for fishing site attributes affects the length of a fishing trip, the number of trips taken and the welfare measures of angling in the River Tornionjoki in Finland. A stepwise estimation procedure was introduced, whereby angler profiles were first identified by explanatory factor analysis and these profiles were incorporated in the fishing trip demand estimation. Based on the explanatory factor analysis, three angler profiles were identified named as 'nature lovers', 'easy fishing' and 'selective anglers'. The factor scores of angler profile attained for each angler were included in the on-site time demand and trip demand functions as explanatory variables.

The conventional travel cost model has been criticized for not accounting for spatial limitations properly as visitor traveling long distances are likely to stay longer on a fishing trip and thus trips are not homogenous (Smith and Kopp 1980). To reduce heterogeneity in the data, separate on-site time and trip demand models were estimated for short and long visits. The estimate of consumer surplus per angling trip for short visits was 121 euros and for long visits 159 euros.

The study indicates that anglers with a stronger selective angler profile had a tendency to take more frequent short visits to the River Tornionjoki than other anglers. Further, anglers with a stronger nature lover profile made more frequent long visits than other anglers. Often in case of remote fishing destination characterized by a long average on-site time per fishing trip, the on-site costs can be important for defining the demand for fishing trips. The results showed that in the case of the River Tornionjoki, on-site costs are not significant either for short or long visits. This could be an indication of inelasticity of angling trip demand in relation to changes in price of a fishing day.

Another major finding of the study was that higher number of salmon caught per fishing day decreases the length of a fishing trip and the number of trips taken within fishing season. Locals appear to adjust their on-site time depending on the catch outcome to a greater extent than the fishing tourists. The results showed that anglers return home once a certain desired amount of catch is reached. Fisheries managers can make use of these findings when identifying suitable fisheries policies and fishing regulations for the River Tornionjoki.

5. Conclusions and discussion

Fish stocks are an important natural resource for Finland and they are targeted by both commercial fishermen and recreational anglers. Fisheries managers need to make well-justified decisions on the allocation of the fish resource between commercial and recreational fishermen to maintain sustainable and abundant fish stocks. Meanwhile fisheries managers would ideally try to secure the highest possible benefits to society. However, this requires wide knowledge on sustainability of fishing and the economic impact of commercial and recreational fisheries. In addition to estimates of economic value of fisheries, it is equally important that fisheries managers understand the reliability of these estimates and what uncertainties underlie in the representativeness of the data, valuation methods and the analysis used. This thesis transparently describes the estimation process of capital value in commercial fisheries of Finland applying the PIM and the value of salmon angling in two Finnish salmon rivers employing the TCM.

In article I economic and financial analysis of the Finnish marine commercial fleet is compared and the implication of these two approaches to the profitability and balance indicators are discussed. The difference of these modes of analysis comes from the treatment of capital and capital costs. Capital value in the economic analysis using the PIM refers to capital invested in the sector, while in financial analysis capital value refers to the fixed tangible assets in the balance sheet. Moreover, capital costs from the PIM refer to the estimated consumption of fixed capital and the opportunity cost of capital invested in the fleet. In financial analysis, the national accounting rules set the depreciation schedule and the financial costs are the real net interest costs recorded in the accounts.

Economic analysis is a well-justified method, when one is interested in the long-term sustainability of fisheries. In the short term, a fleet segment with old vessels may seem profitable, but economic analysis can indicate losses. In this case, investments for renewing the old vessels would not be profitable with the current fleet structure, and the fleet is not balanced in the long term. The number of Finnish fishing vessels in operation has been declining over the past two decades. The declining trend is likely continuing in the small-scale coastal fishing where the actual accounting profits are not high enough to cover the investments required in new vessels.

The capital value estimation with the PIM involves notable inaccuracies as small change is one of the default values used can have conciderable effect on the estimated value of capital. The strength of the PIM is that it is straightforward to apply once all the assumptions on service lives, depreciation schemes etc. are decided on. However, gathering reliable data on vessel prices, asset service lives and retirements can be challenging. In addition different vintages of vessels probably have different levels of technology, which is not considered by the PIM. Further studies could include examining the utility of hedonic modeling when assessing the capital value of the fleet. Hedonic models could be valuable especially in cases, where the fishing rights are tied to the vessels and they form substantial part of the vessel value. Furthermore, the valuation techniques for valuing intangible assets in fisheries should be explored, and guidelines for reporting the intangibles should be given in the EU data collection framework of fisheries.

Articles II and III employ travel cost method (TCM) for valuing salmon angling trips to the River Teno and the River Tornionjoki in Finland. TCM is a well-suited method for valuing recreational trips as the method is based on observed behavior and the data are assumed to reflect real consumer preferences well. The data are often easily collectable with fairly limited resources and the method is in principle straightforward to apply. However, TCM is not applicable to non-users and only recreational value can be calculated. Several issues regarding the specification and estimation of the model can arise, which can complicate the estimation. Endogeneity of on-site time, issue of multipurpose trips, potential overdispersion (or underdispersion) of trip data are some examples of specification issues discussed in this thesis.

Articles II and III show that the estimated consumer surplus per angling trip is notably smaller in the River Tornionjoki than in the River Teno. Evidently, some of the difference in the estimates is explained by the location of the rivers and the smaller travel expenses to the River Tornionjoki from southern Finland. In the case of the River Tornionjoki, the on-site costs did not explain the number of trips per season, which could be an indication of inelastic demand in relation to changes in price of a fishing day. The River Tornionjoki is more accessible for anglers from Southern Finland causing substitution between the River Tornionjoki and the River Teno to be low. If this assumption of inelastic demand and few substitutions holds, an increase in on-site service price would not markedly affect the average amount of fishing trips per angler to the River Tornionjoki.

A somewhat surprising result found in Article II was that on-site time cost had a positive coefficient in the trip demand model; higher income seems to imply more frequent, but shorter visits to the River Teno per season. Thus, anglers do not consider the cost of time spent on-site as a cost, and anglers with high income are more frequent visitors in the River Teno than others, but tend to stay for shorter durations per fishing trip. The consumer surplus estimates derived in the article II could be used to obtain estimates of the benefits from restoration of migratory fish stocks in other salmon rivers in Finland. However, benefit transfer from the freely flowing River Teno to a modified river requires careful evaluation.

Generally fisheries managers seem to think high catch rates are indicating higher participation rates, and indeed catch is often an important element for satisfactory angling experience (Arlinghaus 2006; Arlinghaus et al. 2008). The valuation studies on salmon angling presented in this thesis demonstrate how the role of catch explaining fishing behaviour can vary depending on the fishing destination. In the River Teno, the past experience of catching salmon was found to increase the likelihood of visiting the river the following season. Sustainable management of salmon stocks in the River Teno is relevant for increasing the recreational benefits of visitors and for bringing more income for the local fishing tourism businesses. Article III in turn shows that the role of catch in the angling experience is not so straightforward and the importance of catch varies among angler profiles. Higher catch rate was an indication of less time spent on-site per angling trip in the case of the River Tornionjoki. Moreover, higher salmon catch reduced the frequency of angling trips withing the season. In article III anglers seemed to follow a strategy of ending the trip once sufficient catch was obtained. This kind of behavior has been seen in the previous research on angler satisfaction from catch where the marginal return of angler utility decreases as catch rate increases (Arlinghaus et al. 2014).

When fish stocks are abundant, as in Tornionjoki, increasing catch rates through stocking or fishing restrictions might not be optimal. Instead, fisheries managers might want to concentrate on maintaining trophy fish when they want to maximize the utility gained by the anglers (Arlinghaus et al. 2014). Moreover, certain angler groups such as nature lovers might be indifferent in regard to catch opportunities. However, if fishery managers want to reduce the effects of the catch-related behaviour among anglers, regulations setting limits on the catches and/or effort would be required. Likely the highest overall benefit to the society would be reached by setting limit to the individual angler's fishing instead of setting total seasonal allowable catch.

Future research on the salmon angling in the northern rivers of Finland could include consideration of substitution effect between the salmon rivers and other substitutes for fishing. For example new surveys could be carried out to study the joint experience of wild salmon angling in the Arctic environment compared to wild salmon angling in more temperate southern environment. More research is also needed on the individual interaction of on-site time and planning of recreational trips. This could be studied by a survey examining the nested decision-making process before fishing season and on site during the season. Finally, updated bio-economic model comparable to the model used by Oinonen et al. (2016) could eludicate the optimal fisheries policy regarding Atlantic salmon of the Baltic Sea simultaneously considering commercial and recreational salmon fishing and different behavioural patterns of different angler types.

This thesis gives an insight on the economic sustainability of the coastal small-scale fisheries including salmon fishing, while increasing awareness on the recreational value of salmon angling in the northern rivers of Finland. This thesis does not take a stand or advice on the optimal exploitation of fish resources. However, it gives valuable reference for future research and fisheries management on the state of the Finnish coastal small-scale fisheries and on the value recreational anglers place on wild salmon angling in Finland. The trend is clear. Commercial fishing of salmon has been declining since the 1990s and the long term profitability of small-scale fisheries as a whole is low resulting to declining number of operational small-scale vessels. Meanwhile the importance of recreational catch and fishing tourism in general in Finland is increasing. Freely flowing river with well-managed wild salmon stock attracks fishing tourists and bring more income for the locals. With abundant salmon stocks comes the potential to boost the salmon angling tourism in Finland. However, catch alone does not define the value of fishing experience for the anglers as individuals differ in their preferences and motivation for fishing. Thus is it crucial to understand the preferences underlying in the decision making of going fishing and why preferences differ between anglers and what makes a fishing site attractive for aglers.

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