Economic Valuation of Sport-Fishing in Sweden:

Empirical Findings and Methodological Developments

Anton Paulrud
Department of Forest Economics
Umeå

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To my mother and farther

Abstract

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Little is currently known about the net benefits and, therefore, the importance of recreational fishing in Sweden from an economic point of view. This thesis is an attempt to fill this gap by providing a number of empirical valuation studies on recreational fishing in Sweden. Furthermore, the thesis also proposes a number of methodological improvements of the currently available methods for measuring environmental benefits. The empirical results suggest that the economic value of sport-fishing in Sweden is higher than previously thought. In studies carried out at the Byske river, the Kaitum river and in the Bohus region (which includes river, lake and sea fishing), I find that the net value per day is roughly about SEK 100 (with variations depending on quality characteristics, travel costs and so on). In contrast, earlier studies find values that are much lower. Furthermore, I also find that the marginal value (per kg or number) varies significantly according to the type of fishing (ordinary, put and take, coastal, guide-boat, river), ranging from a few SEK (coastal fishing in Bohus region) to several hundred SEK for obtaining a "trophy fish" in the Kaitum river.

A simple way of obtaining the marginal value of catch for each respondent within a contingent valuation experiment is proposed. Secondly, a multi-attribute extension of the contingent valuation method is devised, allowing a straightforward way to estimate the value of changing site characteristics. Thirdly, a new approach to designing a choice experiment is introduced, showing how a theoretically consistent design procedure by approximation can be implemented in a simple manner. Fourthly, a re-interpretation of a model often used in valuing environmental goods (the Random Utility Maximizing (RUM) model) is offered.

While we are able to estimate the value of fish management in several dimensions (catch and release, bag limit and so on), the next step is to fully integrate this effort with available insights from ecological modelling of fish resources.

Keywords: travel cost, contingent valuation, choice experiment, policy, management, bio-economic, sport-fishing, recreation, angling, marginal values, spike model, random utility.

Author's address: Anton Paulrud. Department of Forest Economics. SLU.
S-901 83 Umeå, Sweden. E-mail: *Anton.Paulrud@sekon.slu.se*

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Introduction

Of the about 6.3 million people aged between 16 to 74 who currently live in Sweden, 1.7 million claim to have engaged in sport-fishing at least once a year in recent years (Finfo, 2000). This and other statistics suggest that sport-fishing[1] (angling) is a very important recreational activity for Swedes (SOU, 2001:2). However, there are many other important and competing uses of the underlying water resource (Finn, 1997; Finn and Snellman, 1997; SOU, 2001:2). For example, hydropower remains critically important for Sweden's electricity supply and has a significant influence on fish stocks and water areas. Commercial fishing provides employment in certain areas of Sweden, but naturally adds to the pressure on the fish stock. Continued growth in the popularity of angling is also adding to an increased demand on the resource of fish.

Competing uses of the resource mean that we have to make choices. This dissertation is part of resource economists' continued efforts to shed light on the benefits and costs of the use of our natural resources and environments, focussing on recreational fishing. Indeed, specific knowledge of the economic value of angling is useful to government officials so that they can make informed decisions about the proper allocation of water resources.

Fisheries management has traditionally focused on the commercial side, with less attention being directed to the recreational aspect. Less is known about the values associated with angling. The reason is clear; unlike commercial fishing, there is no market for establishing all the values involved. Indeed, market mechanisms do not always work, and often do not even exist, for recreational resources. While we have some market information on items such as the expenses anglers incur, the social value of the resource may actually be far above such costs; angling is normally available to users at a nominal charge or is free. Therefore, we need specialized methods to disentangle the relevant social benefits.

From a societal point of view, we might make better decisions when we know more about the "true" value of fishing recreation. In addition, managers who understand the preferences of potential anglers will be better positioned to make informed planning decisions (Bennett and Blamey, 2001). This is, in any event, a starting point for the analysis presented in this thesis.

The thesis consists of two parts: an introduction to the theory of environmental valuation and five scientific papers. Papers I through V are presented in the second and last part. The first paper presents results from a study of different types of sport-fishing in Western Sweden. The second paper shows how to estimate the

[1] The Swedish law defines recreational fishing to include both subsistence use and sport-fishing. In this thesis, following the legal definition, sport-fishing is fishing with rod, hook, and line for the purpose of recreation, and the catch are for use in the own household. Compared to sport-fishing, subsistence use is normally carried out with multi-catch equipment (for example, a net), but the catch is also only consumed by the household.

marginal value of the catch for each angler and is a simple extension of current methodology. The third paper presents a novel way of using contingent valuation with simultaneous valuation of multiple attributes. The fourth paper identifies and places value on the attributes associated with sport-fishing in the Kaitum River and examines the trade-offs between these attributes. Embedded in the choice experiment is a trip frequency model, such that we can predict the changes in trip frequency from improved fish management. The last paper discusses and presents a theoretically more satisfying model for the dichotomous choice contingent valuation method.

Objectives

The thesis aims to do the following:

* To further develop and refine a number of non-market valuation methods as applied to recreational fishing.

* To identify and quantify social-economic values connected to sport-fishing in Sweden and to analyze how these values are affected by quality factors relating to the sport-fishing site.

Theory – what is it that we want to measure in valuation studies?

Economic values are based on subjective individual preferences and are closely connected to individual choice. In the perfect market economy, the individual picks the basket of goods that maximizes subjective utility subject to a budget constraint. Each good is considered to contribute positively to utility and the individual simply chooses the configuration of goods that allows maximum utility given the budget. One implication of this is that market price and marginal utilities are closely connected; price is in fact proportional to the marginal utility obtained. Consequently, a change in a market price is related to an underlying welfare - or utility - change. A higher price usually translates into less consumption, which in itself is a welfare loss to the individual. Conversely, a lowered price usually translates into higher consumption and a welfare increase.

The measurement of such welfare changes lies at the heart of welfare economics and is a natural starting point for the work in this thesis. Here, however, we are interested in welfare changes when there are no markets available for the goods under consideration. In short, what we want to measure is welfare (utility) change, converted into a convenient unit, which is usually money.

We are primarily interested in a certain class of goods that contributes to utility, yet for institutional or other reasons finds no way into the market. Examples of such goods are particularly abundant when we are studying the environment and our natural resources; many of us place a value on the preservation of pristine natural environments, yet will "be appalled by the thought of ever visiting them", to paraphrase Krutilla's (1967) influential piece on economists' thinking about value. There are also many of us who enjoy a day of fishing and are particularly pleased to find that we, at least in Sweden, can often enjoy this recreational activity for free. Many things have a value, but not a price.

It is useful to distinguish between the marginal value of a good and its total value, drinking water being a very good illustration. At our current consumption level, the marginal value of an extra litre of water is insignificant (in Sweden), yet the total value of water consumption is probably very high, possibly infinite. Consider also the recreational angler who has had a successful fishing trip and is displaying his trophy-salmon to friends and anyone else interested in hearing all the exaggerations about the catch. What is the value to him of catching another trophy-fish? This is the maximum amount of money that he would abstain from in order to secure the next salmon, without being worse off from such an exchange. Suppose instead that we encounter the very same person, assuming now that he has been struggling unsuccessfully for days to bag that trophy-salmon. When asking him how much he would pay for bagging a trophy-salmon, the marginal value will almost certainly be higher, compared to the value of catching the second salmon. Thus, at the margin, values can be different, whether or not we are considering market priced goods or goods that are not priced in a market.

The total value of a natural resource is, in a certain specific sense, the sum of all the marginal values. Thus, we can ask the angler how much he would maximally be willing to pay for two trophy-salmon, rather than the value of one additional salmon, given one already caught, or one salmon given that no salmon has been caught. The conceptual difference between total and marginal values is very important, not the least because this thesis provides estimates of both these quantities.

How can we then turn these theoretical ideas into something empirically useful? The literature contains many different concepts. Here we shall limit ourselves to the most frequently used monetary measures of welfare change; compensating variation (CV), equivalent variation (EV) and consumer surplus (CS).

To calculate the CV, one fixes the level of utility ex ante (the level before). One can obtain the CV for a particular environmental change by simply asking about the amount of money that will make the subjective utility equal to the ex ante utility level. For example, consider an improvement of a fishing site. We can obtain the CV by asking the individual the maximum amount of money he would be willing to maximally abstain from in order to secure the improvement. Alternatively, by fixing the utility to the ex post situation, we can extract the amount of money that the individual considers to be the minimum compensation for not having access to the improved site. This is the EV measure.

We can employ a similar idea for a market good and a price decrease. The Marshallian Consumer Surplus (CS) measure is calculated by using a demand curve, which describes the relation between the price and the quantity demanded. The CS equals the area bounded by this curve from the initial to the final price. Thus, for each given quantity of the good, there is a difference between the market price and the maximum amount of money the individual is willing to pay for it. Summing this surplus for all quantities up to the equilibrium consumption level, we obtain the CS.

In general, there are differences between the CV, EV and CS and there is no reason to expect that they will be the same in any given application. Consider the difference between the willingness-to-pay (WTP) and the willingness-to-accept compensation (WTA), which translates to the CV or the EV depending on the project. WTP is bounded by our income, but there is no such limit on WTA. Therefore, the difference can be arbitrarily large. There is a considerable literature that explores the reasons for the difference between WTP and WTA (see Johansson (1987) and Shogren et al. (1994) for a good exposition). Let us now turn to the question of how to measure the CV, EV and CS in practice. In particular, we will focus on the measurement of these quantities for non-market goods.

Empirical Methods – How can we measure welfare change?

Several techniques have been developed for valuing environmental goods or non-market goods in general (Garrod and Willis, 1999; Ward and Beal, 2000; Bennet and Blamey, 2001; Bateman et al., 2002; Carson et al., 1996). The techniques can roughly be divided into two groups, indirect and direct. The first group of methods, the indirect, is also called Revealed Preference (RP). The second group of methods, the direct, is also called Stated Preference (SP). A direct method is based on direct questions about the individual's CV or EV. In this thesis, we will use several variants of both RP and SP-methods, and suggest how they can be extended in various ways. In the next section, we shall look at some of the advantages and disadvantages of these methods in more detail.

Revealed Preference methods

The first group of non-market valuation methods involves, as noted, the indirect valuation of people's preferences as revealed through their actions in markets (Ward and Beal, 2000; Herriges and Kling, 1999; Smith and Desvouges, 1986). This connection to actual behaviour is also the main advantage; we actually know that certain amounts of money have been spent, as revealed by market choices. The main drawback of the indirect methods for valuing environmental goods is that we cannot estimate values that leave no trace in a market, existence values (also known as passive use values) being a prime example.

There are two dominant RP methods; hedonic pricing and travel cost. Perhaps the most intuitive is the hedonic pricing method (HPM). The technique was first developed by Griliches (1971) and Rosen (1974). The method consists of estimating the implicit prices of characteristics that differentiate closely related products (Perman et al., 1996). The resource might be defined in terms of a service it yields or a characteristic it embodies; the value of this service or characteristic is thought to be embodied in marketed goods. For example, if the only difference between two houses is the view of a nearby park, the price difference is interpreted as the value of the view to the house owner. The analysis can simply be done by, in a first step, regressing price against characteristics of the good (and other variables) as independent variables.

This method has pros and cons. For example, it needs consumers who are fully informed about the quality characteristics of the product. There are a number of other technical problems, see e.g. Mäler (1974). It also has a number of advantages, because it may be quite inexpensive to carry out and can provide useful information about the link between the price of a good and its characteristics.

There are other ways to use existing relations between environmental goods and market-priced goods. One way is the Travel Cost Method[2] (TCM), introduced in a famous letter by Hotelling (1947). The TCM is probably the most used valuation method for the valuation of recreation in general and water recreation in particular (Ward and Beal, 2000; Bockstael et al., 1987). It is built on the assumption that an individual will visit a site if the benefit from the visit is at least as large as the costs (travel costs and opportunity cost of travel time). The method assumes that individuals alter their visitation rates according to changes in cost. For example, changes in entrance fees will have the same effect as changes in travel costs. The method uses information about people's actual travel cost to determine the WTP through the construction of a demand curve. The demand depends on the quality

[2] The Travel Cost Method (TCM) was developed by Harold Hotelling (1947), a respected economist/statistician in the USA, to evaluate the value of recreation in America's national parks. In his letter, he described a method based on travel costs and visitation frequency. He used this data to derive the demand curve from which the willingness to pay and the consumer surplus could be calculated. The TCM was further developed during the 1960s (Clawson, 1959; Knetsch, 1963; Clawson and Knetsch, 1963).

of the site, which gives an opportunity to also derive the WTP for a change in the attributes.

The TCM has been used to estimate total values and/or to estimate values per day. The literature describes four areas of application: total valuation of a new or existing site; prediction of trip frequency; valuation of a site quality change; and policy changes in both trip frequency and in monetary terms. The TCM can be based on individual data (ITCM) or zonal averages (ZTCM). For the ZTCM, the average travel cost of zones and the average participation rate of zones is used. The ITCM and the ZTCM are well established methods for the valuation of recreational activities such as angling (Ward and Beal, 2000).

The classical Hotelling (1947) approach is based on the following steps (Ward and Beal, 2000). The first step includes collection of data from visitors, essentially including information on costs, frequency, and place of residence. The next step is to define concentric travel zones (regional zones with similar travel costs) and calculate the mean cost per visit and trip frequency per capita from each zone. The third step involves the choice of model for the relationship between the trip frequency per capita and the travel cost. The fourth step requires the collection of socio-economic data from each zone (e.g., age, sex, and income), data that is used in the model as additional explanatory variables[3]. The estimated model[4] can then be used to obtain a demand curve, illustrating how price affects visitation[5]. The consumer surplus can be calculated by estimating the area under the function.

A problem is the limited range of recreational activities and characteristics that can be valued. An advantage is the modest data requirements. Other issues include the difficulties of valuing individual characteristics and the opportunity costs of travel time. Yet, the statistically more complex travel cost models do not always perform better than the simpler ZTCM (Hellerstein, 1995). In the last decade, however, the popularity of ZTCM has decreased.

There are a number of practical problems, such as accounting for substitutes (Caulkins et al., 1985; Freeman III, 1993), dealing with multiple sites (Fletcher et

[3] The selection of regressors must be consistent with economic theory. Standard neoclassical demand theory requires that demand equations express the quantity of a good as a function of the price of the good, price of related goods, household income, and other variables (which are related to systematic changes in preferences (Ziemer et al., 1980).

[4] Linear, quadratic, and semilog functional forms have been used widely in empirical applications of this model (Ziemer et al., 1980). Linear and semilog functions have often been employed due to computational or analytical advantages. Other functional forms have also been used often on the basis of statistical significance and consistency of the estimated coefficients with theoretical expectations. As the results of Ziemer et al. (1980) show, the choice of functional form can have a significant effect on the consumer surplus values derived from the model. The last decade has seen an increase in the use of the Poisson Model.

[5] The ZTCM is based on various assumptions, e.g. that the travel is based on a single visit to the actual site and that the travel in itself gives no utility or disutility (Brännlund and Kriström, 1998).

al., 1990; Milon, 1991; O'Neil and Davis, 1991; Loomis, 1989; Sorg and Loomis, 1986); handling multiple-purpose and multiple-destination trips; incorporating quality attributes (Kealy and Bishop, 1986; Whitehead, 1993; Loomis, 1989; Sorg and Loomis, 1986), and capturing the impact of time spent on site (McConnell, 1992; Wilman, 1980). Other technical problems include the selection of the functional form (Smith, 1989) and how to value the opportunity cost of time (Fletcher et al., 1990; Smith, 1989; McConnell, 1985).

During the last several years, research on ITCM has concentrated on refining the method statistically. Recently, count data models, such as Poisson models, have been proposed (Creel and Loomis, 1992; Lin et al., 1996; Feather, 1995). The need to handle quality attributes (such as catch from fishing) and participation decisions have resulted in refined techniques that use jointly estimated models and double hurdle models (Englin et al., 1998; Shonkwiler and Shaw, 1996; Haab and McConnel, 1996).

The travel cost approach can also be based on the Random Utility Maximisation (RUM, McFadden, 1973, 1974, 1978) hypothesis (Smith, 1989; Herriges and Kling, 1999). A RUM based TCM model (RUMTCM) describes an individual's decision process by focusing on the different attributes that affect the individual's choice at different steps in decision process. Unlike the ITCM, the RUMTCM models the probability of visiting a site. The RUMTCM are used to describe an individual's choice of recreation site from a finite set of sites.

Data from both the actual trip and previous trips are collected. In contrast to the ITCM model, RUMTCM models may include a large number of substitute sites. The quality attributes for and the distances to the site and the substitutes have to be identified. Therefore, the data collection for the RUMTCM is more demanding.

During the last decade, RUMTCM has dominated the literature. A significant part of the literature on RUMTCM has focused on nested-models, where the individual's choice is made sequentially[6] (Freeman III, 1993). In the first nest, the individual chooses between fishing and other recreational activities. At the next level, he/she chooses a fishing site. The empirical results may be sensitive to the choice of nesting structure (Feather, 1994; Hauber and Parsons, 1996). Tests of nesting structures are developed in Hausmann and McFadden (1984). Other issues, connected to TCM, include on-site sampling (Laitila, 1999; Shaw, 1988).

Durden and Shogren (1988), Fletcher et al. (1990), Smith (1989), Herriges and Kling (1999), Smith and Desvouges (1986), and Ward and Beal (2000) review the methodological issues relating to TCM. Table 1 presents a small sample of TCM studies on angling.

[6] An advantage is that this avoids the problem that probabilities for a choice between two alternatives are affected by a third irrelevant alternative (Independence of Irrelevant Alternatives, IIA).

Table 1. A small sample of empirical RP surveys on angling.

Author and Year	Title of study	Type, approach and source of data	Principal finding
Berman et al. (1997)	Estimating Net Benefits of Re-allocation: Discrete Choice Models of Sport and Com-mercial Fishing.	RUMTCM. Mail and telephone surveys. Discrete choice (DC) models based on RUM for both angling and commercial fishing.	Results for a midrange scenario (10 scenarios are presented) for run size and prize suggests that the commercial losses roughly offset sport-fishing gains.
Freeman III (1995)	The benefits of water quality improvements for marine recreation: a review of the empirical evidence.	TCM, CVM and HPM. A empirical bibliography of marine recreation including fishing, boating and beach visits etc.	There is substantial variation in the estimated values. The link between policy (management) and the attributes of the activity that people value (for example catch rate) have not been established.
Greene et al. (1997)	Demand for Recreational Fishing in Tampa Bay, Florida: A Random Utility Approach.	RUMTCM. Telephone survey. A nested RUMTCM is used to estimate access values.	Results suggest that average annual values for the bay alone are USD 18 and USD 0.05 for participants and non-participants, respectively. The values suggest some recreational fishing value even for non-participants (perhaps option value).
Hausman et al. (1995)	A Utility-consistent, Combined Discrete Choice and Count Data Model – Assessing Recre-ational Use Losses Due to Natural Resource Damage.	CM (RP) combined with TCM. Mail survey. .A DC RUM based site choice model combined with a trip-model.	A two-stage budgeting approach is used. Measures site substitution correctly and derives welfare estimates in a utility consistent way.
Leuschner et al. (1987)	A Comparative Analysis for Wilderness User Fee Policy.	ZTCM. Mail survey.	User characteristics, trip characteristics, and the TCM all indicated that reasonable fees did not cause a difference between populations or trip behaviour.
Lin et al. (1996)	Welfare Effects of Fishery Policies: Native American Treaty Rights and Recreational Salmon Fishing.	CM (RP) combined with TCM. Mail survey. A DC RUM based site choice model combined with a trip-model.	Management options have dramatically different welfare effects.
O'Neill and Davis (1991)	Alternative Definitions of Demand for Recre-ational Angling in	ZTCM, ITCM. Mail survey. The effect of three alternative definitions of demand on	The approach using individual visits was found to be more satisfactory in statistical terms and in relation to estimates of

	Northern Ireland.	estimated parameters are explored.	user benefits.
Provencher and Bishop (1997)	An Estimable Dynamic Model of Recreation Behaviour with an Application to Great Lakes Angling.	Dynamic RUMTCM. Methodological with empirical example. Mail and telephone survey.	An estimable model of recreation behaviour in which the recreation decision is cast as a dynamic programming problem. The contribution is both empirical and methodological.
Samples and Bishop (1985)	Estimating the Value of Variation in Anglers' Success Rates: An Application of the Multiple-Site Travel Cost Method.	ZTCM. Mail survey. An estimation model is presented to measure anglers' valuations of changes in catch rates.	Presents net values of the angling sites and marginal values of the catch. The procedure entails first estimating values in a multiple site approach and secondly regressing the results with the different rates of angling success.
Schuhmann (1998)	Deriving Species-Specific Benefits Measures for Expected Catch Improvements in a Random Utility Framework.	RUMTCM. On-site interviews. A random utility model with site choice is combined with a model for catch rate (poison model).	Mean WTP per trip are measured for two different types of improvement scenarios. Differences in the WTP of an improvement in the catch of different species and for different types of angling.
Schuhmann and Schwabe, (2003)	An Analysis of Congestion Measures and Heterogeneous Angler Preferences in a Random Utility Model of Recreational Fishing.	RUMTCM. On-site interviews. Illustrates how well alternative measures of expected congestion succeed in helping to explain site choice. Investigates if different user groups are affected differently by expected congestion.	Reviews literature on congestion. Congestion is important for site choice. The manner in which congestion is represented can lead to substantial differences in the potential welfare gains from changes in site quality. Recreational users may have heterogeneous preferences for different quality characteristics.
Sorg and Loomis (1986)	Economic Value of Idaho Sport Fisheries with an Update on Valuation Techniques.	ZTCM with multi-site specification. CVM asking for WTP above actual costs. Mail and telephone surveys.	Mean CS and WTP values per day and per trip. The CVM gave WTP values on double catch and double size of fish.
Whitehead, (1993)	Benefits of Quality Changes in Recreational Fishing: A Single Site Travel Cost Approach.	ITCM with a single site specification. On-site interviews. Measures of exogenous recreation quality are used from a regression model.	Variation in expected recreation quality is found from prediction of a catch rate regression model. The number of trips increases with increases in recreation quality. Changes of CS from quality changes are estimated using individual variation in quality and estimates of recreation benefits.

Stated Preference Methods

During the last few decades, the use of SP for valuation has increased (Carson et al., 1996; Louviere et al. 2000; Bateman et al. 2002; Carson, 2004). The most commonly used direct method is the Contingent Valuation Method (CVM). There are also a number of methods that are similar to CVM but differ in the way that the scenario is presented (Louviere et al., 2000; Adamowicz et al., 1998; Haefele and Loomis, 2001; Bennet and Blamey, 2001). In the sequel section, a brief description of the CVM and the Choice Experiment method (CE) will be given.

A contingent valuation experiment involves using a carefully structured questionnaire to elicit a person's CV or EV, (Mitchell and Carson, 1989). There are a number of different valuation questions that can be used in an experiment. The open-ended[7], iterative bidding[8] and the payment card[9] approaches have been replaced by binary type questions (yes or no to a suggested cost). More on this below.

CVM continues to be intensively debated. Some argue that the approach is prone to various types of errors, such as strategic, design, part-whole, and hypothetical bias (Perman et al., 1996). Strategic bias arises when respondents strategically do not reveal their true subjective value. Because the incentives to not report the true value are somewhat unclear, it is not clear what strategic bias entails; why lie (or tell the truth) if the question is hypothetical? Design bias occurs from badly described valuation scenarios. Part-whole bias occurs when the respondent places the same value on part of a resource as on the whole resource (Kahneman and Knetsch, 1992).

Bishop and Heberlein (1979) introduced the binary valuation question, also known as dichotomous choice valuation question, where, as noted, the respondent rejects or accepts a certain offer. Because one only knows that the individual's subjective value is lower or higher than a particular cost/bid, various statistical techniques must be used for estimating quantities like the mean and the median. See Cameron (1988) and Hanemann (1984) for basic econometric approaches. The NOAA-panel on contingent valuation (Carson et al., 1992) endorsed this approach to valuation questions, in their analysis of the CVM in US litigation. While the binary question now dominates the literature, the verdict is still out on the relative merit of different valuation questions.

[7] A direct question on WTP is often asked as the WTP above actual spent costs. This is seen as hard to answer and the respondent has no reference point (Hanemann, 1994).

[8] Iterative, simply by asking to state yes or no for a repeated number of stated bids. Starting point bias is a problem of iterative bidding (Mitchell and Carson, 1989).

[9] Letting the individual reveal his or her WTP after having seen a card showing the amounts that people at his/her income level have paid in the past (often through taxes) for various other connected goods, the starting point bias is a problem depending on what is shown on the card (Mitchell and Carson, 1989).

In this thesis, we will use a modification of the basic Bishop and Heberlein (1979) approach, the spike-model, which allows individuals to have zero WTP (McFadden and Ruud, 1994; Kriström, 1997; Reiser and Shechter, 1999). This circumvents at least one problem with the binary valuation question approach, as it cannot otherwise account for zero WTP responses. A number of other further generalizations of the technique are discussed in Hanemann and Kanninen (1999).

Two main approaches for statistical modelling of CVM can be found in the literature. One is to derive an appropriate statistical model by considering the characteristics and structures of the data. This approach is advocated by e.g. Cameron (1988) and Haab and McConnel (1998). Another approach is to derive a statistical model from economic theory for individual consumer behaviour. By starting from the utility maximization principle, a statistical model is obtained from assumptions of random components in the utility function. This approach is suggested by Hanemann (1984) for CVM experiments with binary data. A thorough discussion of the modelling of observational data on individual's choice behaviour is found in McFadden (1974).

The second approach has at least two advantages over the first one. One is that it provides a formal link between the statistical model and economic theory. A second advantage is that this way of modelling may provide new insights into the structures of the data. By careful inspection of the application of the random utility maximization (RUM) approach to experimental CVM data, it is shown in this thesis that the assumption of i.i.d. random individual specific components may be inappropriate. Instead, we suggest an approach where individual taste variation, omitted variables, etc, is modelled by using random coefficients in the utility function. The proposal here follows a rather long tradition in CVM-research, differing only in the way we interpret the way randomness enters the models. Many of the models applied with reference to the random utility difference approach are retrievable within our approach. In short, we assume that randomness arises from random sampling of respondents. This leads to an improved foundation for existing and new models of binary response CVM data.

Another and, compared to CVM, relatively new SP method is Choice Experiment (CE). CE has been applied in transportation research and marketing since the mid-1980s (Louviere et al., 2000). The basic idea is to describe a state of the world with a finite set (often 5-10) of attributes. By varying these attributes, it is possible, by using statistical methods, to estimate preference structures. A company may use this type of experiment to examine various configurations of its product and the expected market response. Such experiments have recently been considered, suitably modified, as a replacement for the CVM (Boxall et al.; 1996, Adamowicz et al., 1998; Louviere et al., 2000).

The principle of RUM, as derived by McFadden (1973, 1974, and 1978), is often used as a foundation of statistical models for CE data (Hanley et al., 1998). For an example, let X denote a vector of variables describing the characteristics of an object such as a hypothetical angling site. That is, the vector includes variables such as kind of fish, kind of water, and license fee. J vectors $(X_1, X_2, ..., X_J)$

describe the characteristics of *J* hypothetical angling sites. Each respondent in a random sample is presented with a subset of the *J* hypothetical sites and the respondent is asked which site he or she would select in a real life situation.

Suppose the subset of sites presented contains two alternatives: site *A* and site *B*. Let U_{iA} denote the utility of site *A* as perceived by the *i*th respondent, and let U_{iB} denote the utility of site *B*. Under the utility maximisation principle, the respondent selects the site with the highest utility. Define a linear utility function as $U_{ij} = X_{ij}\beta + \varepsilon_{ij}$, where X_{ij} is the vector of characteristics of the site *j*, β is a vector of marginal utility coefficients, and ε_{ij} is a random term. The random terms ε_{ij} ($j = 1,\ldots,J$) are in most applications assumed independent type I extreme value distributed (Louviere et al., 2000). It can then be shown that the probability that individual *i* chooses site *A* then can be modelled by the binary logit model.

The definition of attributes and attribute levels is an important step in the design of a CE. The following example, taken more or less verbatim from Kriström and Laitila (2003) provides an example of this issue. Consider a study on anglers' preferences for angling sites. Suppose that the attributes license fee, expected catch, and distance to site are studied. We could then ask the angler to choose between profiles built on that these three attributes can have different levels. Suppose now the researcher is interested in three different levels for the fee (e.g. \$8, 10 and 12), three levels of expected catch (e.g. 1, 3 and 5 fish/h) and two levels of distance to site (e.g. 20 and 40 km). The researcher can then construct $3 \cdot 3 \cdot 2 = 18$ different profiles. However, if the number of levels of distance is increased to three (e.g. 20, 40 and 60 km), the number of possible profiles is increased to $3 \cdot 3 \cdot 3 = 27$. It is evident that the number of possible profiles increases rapidly the larger the number of attributes and levels. For instance, six attributes specified at three levels each yields a total of $3^6 = 729$ different profiles. Four attributes specified at four levels each yields a total of $4^4 = 256$ different profiles. Given this kind of combinatorial explosion, a reduced number of profiles is required in practice. A number of possibilities have been scrutinized in the statistical literature (Louviere et al., 2000).

An advantage of using CE is that one can much more easily estimate the marginal values of characteristics (Louviere et al., 2000; Bennet and Blamey, 2001). For example, it is much easier to estimate the marginal value of improving a certain aspect of a fishing site using CE compared to CVM. Examples include Adamowicz et al. (1994) and Mathews and Desvousges (1997). The study by Adamowicz et al. (1994) shows that water quality and fish catch, significantly influence the choice of fishing site. The study by Mathews and Desvousges (1997) uses CE in the evaluation of restoration alternatives for recreational fishing at Lavaca Bay, Texas[10].

[10] There are several examples of CE that address activities other than fishing. Boxall et al. (1996) values moose hunting in the province of Alberta. Adamovicz et al. (1998) presents the first application of CE to estimate non-use values. This study focuses on the protection of old-growth forests in west central Alberta from the perspective of safeguarding the threatened caribou population. Hanley et al. (1998) report results from a

The CE method has quickly grown in popularity in environmental economics (Louviere et al., 2000; Bennet and Blamey, 2001). It is, however, not without its critics. Kriström and Laitila (2003) argue that it is based on more stringent assumptions that are not needed when using the CVM. Furthermore the analysis is often based on one particular probability model (the logistic). Indeed, much of the recent literature on the CVM examines the sensitivity of the results with regard to the assumption about the probability model, showing that such assumptions are critical for the results.

Moreover, the design of a CE is also quite complicated and, we have reason to believe that the outcome of an experiment depends on the success of the design (e.g. in terms of the precision of the estimates). CE applications often use designs based on the assumption of an underlying linear model, notwithstanding the fact that the underlying probability model is non-linear. The proper theory of optimal design has only recently been applied consistently to CE; see paper IV for a detailed discussion. We currently do not know much about how much difference this will make in practice; it is an area of active research. The important point is that a CE is more complicated, compared to use the CVM.

The SP literature is enormous. A recent bibliography of CVM presents more than 5000 references (Carson, 2004). There are numerous CVM studies of angling (Freeman III, 1995 (review); Navrud, 2001 (review)). The number of CE and other SP studies are not as many but are increasing rapidly (Hanley et al. (1998) reviews some studies). Sundberg and Söderqvist (2004) present a bibliography containing Swedish valuation studies connected to a data base (www.beijer.kva.se/valuebase.htm (Value base^{SWE}); 23-Aug-2004) with 200 studies. A small sample of international surveys on angling using SP methods is presented in Table 2.

CE study of landscape and wildlife protection in Scotland. Bergland (1997) uses CE for valuing changes in agricultural landscapes in Norway.
Some literature makes use of alternative conjoint analysis designs to CE, which include contingent ranking and rated pair approaches: Johnson and Desvousges (1997) on salmon preservation; Teisl et al. (1996) on Atlantic salmon restoration and management; Ditton (1996) on fishery management; Aas et al. (2000) on Brown Trout and European Grayling management.

Table 2. A small sample of empirical SP surveys on angling.

Author and year	**Title of study**	**Type, approach and source of data**	**Principal finding**
Adamowicz et al. (1994)	Combining Revealed and Stated Preference Methods for Valuing Environmental Amenities.	CM (RP), CE, and combined. Mail survey. The SP information reduces colinearity that may be present in the RP data. In addition, in cases where the actual data do not encompass the range of the proposed changes, SP can do so.	The results show that while independently estimated models appear to reflect different underlying preferences, joint estimation of the model parameters (including the relative scale parameter) provides evidence that the underlying preferences are in fact similar.
Carson et al. (1989)	A Discrete Choice Contingent Valuation Estimate of the Value of Kenai King Salmon.	Discrete Choice (DC) CVM. Mail survey. Two questions asking to choose a fixed alternative with a catch, each with a fixed bid attached (different between the two questions).	Mean and Marginal estimates of net values for catch. Finds also that there is a distinct kink in the marginal valuation function and that anglers may place a negative marginal value on fish permits exceeding their desired catch levels.
Dalton et al. (1998)	Estimating the Economic Value of Improved Trout Fishing on Wyoming streams.	DC CVM. Mail survey. CVM asking for WTP above actual costs.	Mean and marginal CS values for both twice the catch and also for 25, 50 and 100 % improved catch are estimated.
Duffield and Allen (1988)	Angler Preference Study Final Economics Report.	Open ended and DC CVM. Mail survey. Asking for the WTP for current conditions, increase in large fish and number of fish overall.	Finding net values for fishing and values for improved fishing (catch). Explores the issue of market definition (segmentation).
Freeman III (1995)	The benefits of water quality improvements for marine recreation: a review of the empirical evidence.	TCM, CVM and HPM. A empirical bibliography Review of marine recreation including fishing , boating and beach visits etc.	There is substantial variation in the estimated values. The link between policy and the attributes of the activity that people value (for example catch rate) have not been established.
Harpman et al. (1993)	A Methodology for Quantifying and Valuing the Effects of Flow Changes on a Fishery.	DC CVM. Mail survey. WTP for making an additional yearly payment to support improved management practises (two different scenarios and for status quo).	The relatively small changes in value predicted, were shaped by the small changes in catch predicted and the high number of fish caught under current conditions.
Johnson and Adams (1989)	Value of a Fish: Some Evidence from a Steelhead Fishery.	DC CVM. Interview. Marginal valuation based on three fixed improvement levels in number of fish.	The marginal values found are stated to be much lower than values currently used in the public debate, but similar to some marginal values reported in the

			recent literature.
Johnson and Walsh (1987)	Economic Benefits and Costs of the Fish Stocking Program at Blue Mesa Reservoir, Colorado.	Payment card CVM. On-site interviews. WTP above actual expenses and for changes in fish size and changes in number of caught fish.	Mean net values per day and marginal CS values per size of fish and marginal values for an extra caught fish. The result indicates that the size is more valuable than number.
Loomis (1997)	Panel Estimator to Combine Revealed and Stated Preference Dichotomous Choice Data.	DC CVM combined with TCM. Using panel estimators to appropriately join the decision to actually visit, the intention to visit at a hypothetical higher trip cost, and the intention to visit at proposed quality levels.	This model illustrates how the complementarity of revealed and stated preference data allows inclusion of instream flow as a covariate in the model and calculation of values under alternative flow regimes.
Pate and Loomis (1997)	The Effect of Distance on Willingness to Pay Values: a Case Study of Wetlands and Salmon in California.	CVM. Mail survey. Respondents were asked to value three programs. The effect of geographical distance was estimated on improvement programs for wetlands, contamination control and river (Salmon).	Results indicate that distance affects WTP for two out of three proposed programs. The results from the only program that contained fish showed that neither distance nor substitutes played a role in the determination of an individual's WTP.
Sorg and Loomis (1986)	Economic Value of Idaho Sport Fisheries with an Update on Valuation Techniques.	ZTCM with multi-site specification. CVM asking for WTP above actual costs (gradually increased bid). Mail and telephone survey.	Mean CS and WTP values per day and per trip. The CVM gave WTP values on double catch and double size of fish.
Staniford and Siggins (1992)	Recreational Fishing in Coffin Bay: Interactions with the Commercial Fishery.	Payment card CVM. Interview. WTP above actual expenses.	The analysis indicates that it may be desirable to reduce recreational fishing and increase commercial fishing in Coffin Bay. The results need further research to be confirmed.
Waddington et al. (1994)	1991 Net Economic Values for Bass and Trout Fishing, Deer Hunting, and Wildlife Watching.	DC CVM. Mail survey. Bid above actual expenses. Theoretically based on Cameron (1988; 1991).	Mean net values per day and also estimated per year are presented as well as marginal net values per caught fish. The net values are appropriate measures of economic value for use in CBA.
Willis and Garrod (1999)	Angling and Recreation Values of Low-Flow Alleviation in Rivers.	Open ended and DC CVM, and CE. Evaluates the benefits and costs from different uses from changing flows.	The benefits outweigh costs in some cases. The inclusion of recreational values in decisions on water abstraction would result in greater environmental protection.

Empirical Results

In this section I first summarize the Swedish studies available on angling. I then turn to the main empirical results of this thesis on the value of angling in Sweden.

In Sweden, there is currently a lack of information on the relative benefits and costs of recreational fishing and also of commercial fishing (Ds 1995:47). A few relevant studies analyse the demand for angling in Sweden. Table 3 summarizes the existing Swedish valuation surveys on angling. They include, for example, a survey of salmon angling by Paulrud (2000), a survey of salmon angling by Appelblad (2001), a survey of saltwater angling by Silvander (1991), a demand analysis for nature recreation including angling by Hultkrantz (1993), a study on improved Cod (*Gadus Morhua*) stocks by Olsson (2004) and a few other studies. The variation in the estimated benefit in the summarized studies is substantial; the values are highly site-specific, as is also noted from other studies in an international perspective by Krupnick (1993)[11]. The derived welfare estimates from each study are therefore not presented in Table 3.

There has also been some work, not summarized here, by Söderqvist (1996), Sandström (1996), Frykblom (1998), Sandström et al. (2000) and Soutukorva (2000) on water quality but not specifically on angling. Sundberg and Söderqvist (2004) present a bibliography containing Swedish valuation studies connected to a data base (www.beijer.kva.se/valuebase.htm (Value base^{SWE}); 23-Aug-2004) with 200 studies.

[11] For examples see Allen (1988), Duffield and Allen (1988); Bishop and Samples, 1980; Duffield et al., 1987; Duffield and Allen, 1988; Edwards, 1990; Connelly and Brown, 1991; Davies and O'Neill, 1992.

Table 3. A summary of existing Swedish Sport-Fishing surveys

Author and year	**Title of study**	**Type, approach and source of data**	**Principal finding**
Hjalte et al. (1982)*	Ekonomiska konsekvenser av vattenkvalitets förändringar i sjöar (eng. Economic consequences of changes in water quality in lakes).*	TCM. Partly fictitious data.* Estimation of economic consequences from three different scenarios.*	Net economic values were estimated.*
Silvander (1991)	Betalningsvillighetsstudier för sportfiske och grundvatten i Sverige (eng. Willingness to Pay for Sport-Fishing and Groundwater in Sweden).	Open ended CVM. Mail survey.	Measures angler's value for the survival of a number of fish species.
DS 1995:47	Hushållning med knappa resurser – Exemplet Sportfiske (eng. Economics of with scarce natural-resources –sport-fishing as an example).	Overview. Explains and analyses the problem from a socio-economic view point.	Points out the potential of sport-fishing for developing a tourist industry.
Weissglas et al. (1996)	Lax i strida strömmar – sportfisket som regional utvecklingsresurs (eng. Rapids Wild with Wild Salmon – Sport-fishing as a Resource in Regional Development.	Overview, discussion and empirical survey. Uses existing data and mail surveys. Open ended CVM (and biological analysis and impact analysis).	Shows the potential of developing sport-fishing based on sport-fishing in the Baltic Sea.
Finn and Snellman (1997)	Socioekonomisk undersökning – av fisket efter lax (eng. Socio-Economic Survey – of Salmon Fishing).	Overview, discussion and empirical survey. Uses existing data and on-site interviews. Explains and analyses the problem from a socio-economic view point. Qualitative interviews.	Shows that benefits are less than costs for commercial salmon fishing. The report states that the potential to develop angling tourism in Sweden is large.
Finn (1997)	Samhällsekonomiska förutsättningar för att utveckla sportfisketurism i Sverige (eng. The Socio-Economic Potential to Develop Sport-Fishing Tourism in Sweden).	Overview and discussion paper. Uses existing data. Explains and analyses the problem from a socio-economic view point.	Sweden has a large potential to develop a tourist industry from Sport-fishing.
Paulrud (2000a)	Samhällsekonomisk värdering av sportfisket I Byskeälv (eng. Socio-Economic Valuation of Sport-fishing in the Byske River).	ZTCM. Mail survey.	Estimates the total economic net value (CS) and values per day for angling in the Byske River.
Paulrud (2000b)	Ekonomisk analys av sportfiskarnas val av fiskeplats (eng. Economic Analysis of Angler's Choice of Angling Site).	CE. Mail survey.	Measures angler's value for different site quality characteristics (see also paper III).

Laitila and Paulrud (2000)	Random Errors in RUM Models of CVM Data.	Theoretical paper on statistical modelling of binary responses in CVM. CVM. Mail survey. RUM difference, taste variation, and spike model approach.	The taste variation approach as suggested has several interesting features. Empirical valuation estimates of WTP for improved catch is presented (see also Paper V).
Toivonen et al. (2000)	Economic Value of Recreational Fisheries in the Nordic Countries.	Open ended and dichotomous CVM. Mail survey. Survey, conducted in all the five Nordic countries.	Measures of mean net and gross values for different types of angling and quality changes.
SOU 2001:2.	Effektiv användning av naturresurser (eng. Efficient Use of the Natural Resources).	Overview with case study of existing data. Compares recreational and commercial angling.	Finds economic arguments in favour of recreational fishing.
Paulrud (2001)	Sportfisket i Bohuslän – samhällsekonomiska aspekter (eng. The Sport-fishing in the County of Bohus – Socio-Economic Aspects).	ZTCM. Mail survey.	Describes characteristics of the angler's and the angling. Total, as well as mean and marginal values, are presented (see also paper I).
Paulrud and Dalin (2001)	Sportfisket I Kaitum – en rapport om sportfiskarna, sportfisket och dess samhällsekonomiska värde (eng. Sport-fishing in Kaitum - a report on the angler's, the angling and its Socio-Economic Value).	ZTCM. Mail survey.	Presents characteristics of the angler's, the angling, and the socio-economic value of angling.
Appelblad (2001)	The Spawning Salmon as a Resource by Recreational Use. The case of the wild Baltic salmon and conditions for angling in north Swedish rivers.	CVM. Mail survey. Estimates WTP for quality changes. (Also includes an overview and impact analysis).	Presents net economic values and values for quality changes.
Laitila and Paulrud (2002)	Combining Conjoint Analysis and Choice Experiments for Valuation of Fishing Site Characteristics.	Theoretical paper with empirical example. A new CE approach, CVM and pooled approach is described. Mail survey.	Marginal values of improved catch and some other site characteristics. The new approach is usable (see also paper III).
Olsson (2004)	Two Essays on Valuation of Marine Resources: Applications to Sweden.	Open ended and dichotomous CVM. Mail survey. (Also includes a CE on marine amenities).	Estimates WTP for improved cod stocks. No significant difference in WTP between anglers and non anglers.

* Second-hand information.

This thesis is based on empirical studies of angling in a number of areas in Sweden. These are Bohus, a region in Southwestern Sweden, the Byske River in the north of Sweden, the Kaitum River in the far north, and Jämtland, a region in north-west Sweden. These areas represent many different types of fishing, ranging from the exclusive Kaitum River fishing to the ordinary fishing in the Bohus region. In the latter case, we include ordinary, put and take, river, coast and guide-boat fishing (see below for definitions).

In the Bohus study, angling is divided into five main types. The first type is called "ordinary angling"; i.e., angling in lakes for species other than salmonids (the most common catch is pike (*Esox lucius*) or perch (*Perca fluviatilis*)). The second type is "put and take angling"; i.e., angling in lakes with salmonids. The common catch is stocked rainbow trout (*Oncorhynchus mykiss*) and stocked (in some cases wild) brown trout (*Salmo trutta*). The third type is angling in streams, which is called "river angling". The common catch in streams is brown trout (*Salmo trutta*) and atlantic salmon (*Salmo salar*). The fourth type is ocean or coastline angling from a boat or the shore. This is called "coastal angling". The last type is angling from guide-boats on the ocean, "guide-boat angling".

The data for the Bohus study was collected using a mail survey addressed to anglers in the county of Bohus in Sweden in 1998. The data for the Byske study was obtained using a mail survey of sport-fishers who had visited the Byske River FVO (the part located in the county of Västerbotten). The data for the Kaitum study originates from on-site sampling at the river during 2000-2002. The data for the Jämtland study was collected from a register of buyers of fishing licenses for four different areas.

Table 4 presents welfare estimates as per day values from these three different areas. The estimates are divided according to the different types of angling. The per day value (CS) seems to be between SEK 50-170 for a day of angling (SEK 9 = US$ 1). From the table, we can also see that the values per day are quite similar, being highest for the most exclusive fishing area, Kaitum. This takes into account the fact that the cost per day varies substantially between the areas. The results show clearly that the CS increases in proportion to the costs.

Table 4. A summary of the empirical results on values per day from performed studies.

Area, method and ref.	Obs.	Type	Consumer Surplus (CS) per day (SEK)	Costs per day* (SEK)
Byske ZTCM in Paulrud (2000a)	203	River	108	361
Kaitum ZTCM in Paulrud and Dalin (2001)	106	River	166	465
Bohus ZTCM in Paper I	1220	Ordinary Put and take River Coast Guide-boat	53 83 127 56 115	99 231 494 240 503

* Excludes costs for food

In the Byske study (Paulrud, 2000a) which concerns the Byske River, well-known for its salmon fishing, we find that the average CS per day is about 108 SEK (for 1998). The total number of fishing days per year in Byske is approximately 10 000, with revenue from sold fishing licenses estimated at some SEK 442 000. The net social value of the site was calculated at about 1.1 million in 1998. Another ZTCM study was carried out at Kaitum in 1999 (Paulrud and Dalin, 2001). Kaitum is a high-profile river, famous for its exquisite fishing possibilities. The CS per day was found to be SEK 166. The mean expenses for a day of fishing were SEK 465.

The Appelblad (2001) study suggests that the value of salmon fishing per day in Byske was SEK 9 (1993) and SEK 18 (1996). The figures from Appelblad are derived through CVM. The differences between our estimates are large but fishing in the Byske River has also changed between the years. The mean size of the salmon catch has increased from 5.3 kg in 1993 to over 8.0 kg in 1998. The popularity of the river and the number of long distance anglers has increased. Another possible cause of the large difference is that Appelblad's used CVM.

In the ZTCM in the Bohus study, which covers a historically important area for sport-fishing, the values from five different types of angling are derived. The results suggest that the value of angling and fish caught depend on the type of fishing. The CS of a day's angling ranges from SEK 53 to SEK 127 (1998). The highest value was found for river angling with SEK 127 per day. Ordinary angling and put and take angling implies a value of SEK 53 and SEK 83 per day, respectively. The coast angling had a value of SEK 56 per day and guide-boat angling a value of SEK 115 per day.

The figures found in other studies are lower than the figures found in the Bohus study. Toivonen et al. (2000) estimate the total WTP of recreational fishing (not just sport-fishing) in the Nordic countries. Their survey estimates that the total number of Swedish recreational fishers is around 2.1 million individuals with mean expenses of SEK 1 460 per year. The CS is estimated to be SEK 550 per year. The number of fishing days per year is estimated to be 13 days which means that the mean CS per day can be calculated to be just above SEK 40.

In an early study, Silvander (1991) estimates the value of recreational fishing using a CVM survey. The estimated value is SEK 25 (CS) per day's fishing. The payment vehicle used in the question was in form of tax. The question asks the respondent's opinion about how much he and everybody else should pay to keep the status quo. Compared to the figures found in this thesis, Silvander's (1991) figures are lower.

This thesis also presents marginal values of the fish caught and considers changes in catch as one of the quality characteristics of sport-fishing. The results cannot be compared with other Swedish studies. However, there are estimates of marginal values from international studies and the values are similar[12].

Table 5 presents estimates of marginal values, derived in this thesis, of catch as a quality attribute of an angling site. Catch is a quality attribute that can be valued both in terms of number and kilos. Table 5 is supplemented with the mean values from studies in which it was possible to derive them. The estimated marginal values from the present study are lower than most other estimated mean values.

[12] Cameron and James (1986) estimate the marginal values of a day's fishing. Carson et al. (1989) estimate the marginal values for salmon. Johnson and Adams (1989) estimate the marginal values for trout. Olsen et al. (1991) estimate the existence values for salmon. Harpman et al. (1993) estimate the value flow changes to a fishery. Waddington et al. (1994) estimate the values for bass and trout fishing. Johnson et al. (1995) estimate the benefits and costs of stocking rainbow trout. Dalton et al. (1998) estimate the value for improved trout fishing. Wheeler and Damania (2001) estimate the value of recreational fishing, including catch in New Zealand. Freeman III (1995) presents studies with marginal benefits in his review of studies about different benefits from water improvement.

Table 5. Marginal values and mean values of catch in number and in kilo (observe that the table includes measures in both CS and CV, and that marginal values depend on the specific level of catch at that site).

Area, method and ref.	**Value**	**Type**	**Marginal values (SEK)**		**Mean values (SEK)**	
			No.	**Kilo**	**No.**	**Kilo**
Bohus ZTCM in Paper I	CS	Ordinary Put & take River Coast Guide-boat	9-14 41-51 260 7 10	18-24 44-55 150 9 16	7-22 34-73 304 8 12	13-87 40-72 182 10 23
Bohus CVM in Paper II	CV	Ordinary Put & take River Coast Guide-boat	8 42 531 5 8	17 58 172 11 15	N/A	N/A
Jämtland MACVM and CVM in Paper III	CV	River	MACVM 16 +32 in Bag CVM 47	N/A	MACVM 16 +32 Bag CVM 47	N/A
Kaitum CE in Paper IV	CV	River	17 (<30cm) 109(30-40cm) 333 (>40cm) +44 in Bag	N/A	17 (<30cm) 109(30-40cm) 333 (>40cm) +44 in Bag	N/A

Note: MACVM = Multi-Attribute CVM. This method is explained in detail in paper III.

The ZTCM, used in the Bohus survey, has been used mainly for measuring the value of environmental change rather than for valuing marginal changes in environmental quality such as improved catch. The ZTCM in the Bohus survey, however, includes the valuation of fishing success as one of the quality characteristics of angling. The estimates from the Bohus survey of the marginal values for catching an extra fish range from SEK 7 for coast angling to SEK 260 for river angling. The marginal values for an extra kilo range from SEK 9 to SEK 150, depending on the type of angling. One important feature of the marginal values, estimated in this study, is that they decrease at the margin as the catch increases.

The estimated values from the Bohus survey can also be calculated as mean values per number of caught fish or per kilo of fish. The weakness of this type of measure is that there is a bag-limit on some of the sites and that there is also catch and

release behaviour[13] among the anglers. The number of fish caught is not equal to the number of non-released (killed) fish.

The highest mean value per caught fish and kilo of caught fish comes from river angling with SEK 304 per caught fish and SEK 182 per kg (mainly salmonids, Atlantic salmon and Brown Trout). The lowest value per caught fish is in ordinary angling, coast angling, and guide-boat angling, with values between SEK 7-22 per fish. This can probably be explained by a low average weight per caught fish (i.e., many fish per kilo). For lake angling of game fish, the value range is between SEK 34 and 73 per number of caught fish and between SEK 40 and 72 per kilo caught fish. Usually, large salmonids give higher values both per number and per kilo.

The Bohus study also presents estimates of the marginal willingness to pay to improve sport-fishing conditions. The results are as expected and show that the value of improved catch conditions depends on the type of angling and decreases at the margin when the catch increases. The marginal willingness to pay for catching an extra fish ranges from about SEK 5 (SEK 12 per kilo) for coast angling to about SEK 530 (SEK 172 per kilo) for river angling (USD1 ≈ SEK 9).

The aim of the Jämtland survey was to measure angler's valuations of a number of different angling site characteristics; information that is potentially useful for developing the recreational angling industry in Jämtland. The CVM results show that the overall marginal WTP for more catch in the form of an extra fish is SEK 46 compared with SEK 16 from the Multi Attribute CVM (MACVM). The marginal WTP for not having a Bag-Limit at all is SEK 155 and the marginal WTP for an extra allowable fish is SEK 32. An interesting fact is that the MACVM estimate (with bag) is about the same as the CVM estimate. Another interesting fact is that the WTP for not having a Bag-Limit is nearly the same as having a Bag-Limit of 5 fish. A simple conclusion from this result is that a Bag-Limit of more than 5 fish does not affect WTP.

The estimated coefficient for nature experience, expressed in terms of walking distance to car-road, shows that the angler prefers shorter walks to the site. The marginal WTP for travel distance is insignificant and estimated to be SEK 0.5 per kilometre. An interesting result is that anglers in southern Sweden are estimated to be willing to pay SEK 190 extra for a new angling site, according to the estimate for the regional dummy variable in the model. This value is zero if the new site is situated at a distance of 380 kilometres. Now, 380 kilometres is more or less the average distance from the south of Sweden to reach this type of fishing, (Jämtland), at least for the sample of respondents considered.

The final empirical study, the Kaitum study, presented in this thesis provides a first step in developing dynamic fish management models. The study collects information on angler's attitudes to and preferences for angling site changes by

[13] Angling where the catch is immediately released after they have been caught, meaning no killed fish.

using CE. An angling utility function is estimated based on data obtained from visitors to the Kaitum River, data that is used for economic valuation of management scenarios.

In addition to making a choice in the CE question, the respondent was also asked how many times and days he or she would visit the Kaitum River over the next two years, given that the conditions are as in the alternative chosen. These additional data were used for estimating a visit frequency model where the stated number of days of visits was related to the estimated utilities of the sites selected.

In our application, we find that the marginal value of trophy-fish is relatively high. The results show the importance of the number and size of the catch. There is, however, no significant difference in the valuations of the different species. The CV relations of the three size groups are 18:3:1 (smallest to largest), indicating that one large fish is valued 18 times more than one small fish. The CV for one large fish caught during one day of angling is estimated to be SEK 333. For a medium-sized fish, the estimate is SEK 109. The estimates of the CV for bringing home a fish are estimated to be SEK 44. Thus anglers prefer catching fish, whereas the potential for bringing home and eating the fish is less important.

The results also show that changing policies can lead to welfare gains or losses for an individual. In one scenario, the estimates imply that a zero bag-limit increases the total welfare to SEK 16.6 million (over two years). On the other hand, a no bag-limit scenario is estimated to decrease the total welfare by SEK 5.8 million over two years. The results show that there is a potential to develop the tourist industry by improving angling conditions. In addition, the relatively small estimated decreases in visit frequencies for the “Over-Fished” and the “Naturally-Restricted” scenarios imply that anglers value other characteristics of the site than those directly linked to angling.

The results reported in the thesis and summarized in the tables have a number of important policy implications. Firstly, we see that policy-makers and managers need to focus not just on the catch but also on other attributes associated with the fishing sites. Papers III and IV provide further details. Secondly, the results also show the usefulness of obtaining detailed data about anglers and the attributes of the site. With information of the kind reported in Table 5 we see, for instance, the value that anglers place on “trophy-fish” relative to “ordinary” catch.

Conclusions

This thesis makes two contributions to the literature on recreational angling in Sweden. First, it provides estimates of the value of angling and angling characteristics for various types of fishing and in various regions in Sweden. According to the studies reported here, the total value of angling may be higher than previously thought. Furthermore, we find that the marginal value of catch varies substantially across the type of fish and the location.

Policy-makers usually want marginal values and information on the relative value of multiple sites or, for example, fish species. The traditional valuation methods do not normally produce these types of estimates. This thesis shows that it is possible to derive marginal values from both ZTCM and CVM. However, the RUMTCM is found to be a, perhaps, even more useful analytical tool to estimate both marginal values for quality attributes and relative values. The need for a better understanding of the behavioural relationship between the individual, the resource and the derived benefits from angling will remain a focus for future research in the valuation of non-market priced resources.

Because the estimates are specific to a particular site or area, there remains the question of extrapolation; can we transfer such values to other sites than the ones studied? The literature on benefit-transfers gives mixed results and it is an area where further research is needed.

Growing demand for analyses of the benefits of environmental improvements (or the costs of damages) has increased the interest in benefit transfer. This is the use of past empirical benefit estimates to assess and analyze current management and policy actions[14]. Benefit transfer is a practical way to evaluate management and policy impacts when primary research is not possible or justified because of budget constraints, time limitations, or resource impacts that are expected to be low or insignificant. Benefit transfer is, after primary research, the "second-best" strategy and the "worst-best" strategy is to not account for recreation values, like angling, and thus implying that they have a zero value (Rosenberger and Loomis, 2000).

Ward and Beal (2000) point out a couple of future research topics for revealed preference methods driven by policy questions. Improved information about; household decisions, the characteristics of the site, and information on the interaction between the visitors and the characteristics of the site are useful for policy makers. Other important topics mentioned are the testing of results and evaluation of policy decisions driven by valuation studies. The value of travel time, definition of visits and utility theoretic behavioural models that account for zero consumption (corner solutions) are other issues that need further research.

Stated preference methods are continually being developed and remain the most intensely studied empirical methods in environmental economics. A number of technical improvements to CEs are needed, c.f. the new design approach suggested in this thesis. However, we also need further work together with natural scientists to develop stated preference methods further.

[14] The benefit transfer is helped by databases like the one prepared by Industrial Economics Incorporated (Sport-fishing Values Database), IEc contracted by U.S. Fish and Wildlife Service (www.indecon.com; 23-Aug-2004).

This thesis sheds some new light on the value anglers place on recreational fishing in Sweden. It also provides some steps towards improving the current methods to measure such values. In the end, it might help to better the ways in which we manage our fish resources in Sweden.

Contribution to co-authored papers

The two first papers in my thesis were prepared purely by myself, including project planning, to final product. These papers are results from the so called Bohus project operated by me. The survey instrument for the project is presented in Appendix 1-4. Note that the instrument, the questionnaire, is an example. The questionnaire varied between types of respondents and over the projects different time periods.

The other three papers were prepared in co-operation with my supervisors, Bengt Kriström and Thomas Laitila. Paper III and IV were prepared together with Thomas Laitila. Paper V was written with both Bengt Kriström and Thomas Laitila.

Paper III

This paper is part of the results from the so called Jämtland project financed by the council of Jämtland planned and operated by me. The survey instrument is presented in Appendix 2. The methodological issues in the paper were developed together with Thomas Laitila. My input was larger in the economics and fishing parts. I did all the implementations with the data, models and also analysed the results. We wrote the paper together.

Paper IV

This paper presents results from a project called the Ecologically Managed Angling Tourism on the Kaitum River. The project was a multi-disciplinary project and the economic part was organised and operated by me and Thomas Laitila. The methodological issues presented in the paper were developed together with Thomas. My input was larger in the economic and fishing part. I did all the implementations with the data, models and also analysed the results. We wrote the paper together.

Paper V

This paper is, as paper III, a part of the so called Jämtland project, operated by me. Ideas and the model structure were discussed and the text was developed together with Thomas Laitila and Bengt Kriström. The paper is derived from a series of working reports (developed and refined).

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