ACTA UNIVERSITATIS AGRICULTURAE SUECIAE

SILVESTRIA 136

Environmental Valuation and Policy:

Applications in the management of endangered species, recreation, and tourism

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Doctoral thesis
Swedish University of Agricultural Sciences
Umeå 2000

Acta Universitatis Agriculturae Sueciae
Silvestria 136

ISSN 1401-6230
ISBN 91-576-5870-6

Printed by: SLU, Grafiska Enheten, Umeå, Sweden, 2000

Abstract

Fredman, P. 2000. *Environmental Valuation and Policy: Applications in the management of endangered species, recreation, and tourism.* Doctor's dissertation.
ISSN 1401-6230, ISBN 91-576-5870-6.

This thesis applies the contingent valuation method (CVM) to endangered species, forest recreation and mountain tourism. The subjects addressed are benefits of environmental amenities, non-response bias and choice of policy instrument. The thesis consists of two parts: an introduction to environmental valuation and policy, and five separate papers.

The first paper estimates the benefits of preserving the endangered white-backed woodpecker (*Dendrocopos leucotos*) in Sweden. The absence of a positive marginal value of an increased population density is considered an indication of an existence value, which is given a theoretical illustration using the notion of a minimum viable population.

The second paper studies non-response bias in the willingness-to-pay estimate of the first paper using two different follow-up surveys. No indications of a non-response bias are found, and non-responses are believed to occur because of general reasons rather than survey specific ones.

The third paper focuses on the distance between recreational forests and places of residence in Sweden. Almost half of the Swedish population would prefer a shorter distance than they currently have, and it is argued that residential areas should be planned to have a recreational forest within walking distance (<1 kilometer) in order to meet the preferences of a majority of the population.

The fourth paper combines a segmentation of visitors, using a wilderness preference index, with a contingent valuation study of environmental and management attributes at a mountain tourist destination. Increased benefits following from a spatial differentiation of the management regime are estimated to approximately one million SEK.

The fifth paper analyses the choice between Pigouvian taxes (fees) and quantitative permits when the marginal benefit of endangered species protection is known and the cost uncertain. The best policy is to set a quantitative regulation equal to the minimum viable population, and from the choice of an inappropriate policy measure may follow extinction.

Keywords: contingent valuation, policy, management, benefits, endangered species, minimum viable population, existence value, non-response, public goods, forest, recreation, wilderness purism, nature tourism.

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Contents

Appendix

Papers I-V

This thesis consists of the following papers, which will be referred to by their Roman numerals.

I. Fredman P. 1995. The existence of existence value. A study of the economic benefits of an endangered species. *Journal of Forest Economics*, 1(3): 307-328.

II. Fredman P. 1999. A test of nonresponse bias in a mail contingent valuation survey. In: Boman, M. Brännlund, R. & Kriström, B. (Eds.) *Topics in Environmental Economics*. Kluwer Academic Press, Dordrecht, 175-186.

III. Hörnsten, L. & Fredman, P. 2000. On the distance to recreational forests in Sweden. *Landscape and Urban Planning* (accepted for publication).

IV. Fredman, P & Emmelin, L. 2000. Wilderness purism, willingness to pay and management preferences. A study of Swedish mountain tourists. (Submitted manuscript)

V. Fredman P. & Boman, M. 1996. Endangered species and optimal environmental policy. *Journal of Environmental Management*, 47, 381-389.

Introduction

When Thoreau built his cabin in the woods of Walden he searched for a place where nature could offer meaningful experiences to life. Living at the shoreline of the little pond gave him benefits greater than any work by hand could do (Thoreau, 1845). This is one among many examples of nature experiences being beneficial to the human mind. The step from Thoreau, and the early American literature, to modern life is probably not that big. What Thoreau achieved in Walden current generations may experience during their stay in the mountains, their hikes in the forest, or simply as a corollary of the mere knowledge that some rare species exists.

Natural resources are often thought of as tangible goods derived from extraction of timber, fish, minerals, etc. Such uses are known as an on-site consumption of the resource and typically feature market prices established by supply and demand. Market prices, however, seldom encapsulate the entire value humans derive from the use of natural resources. What Thoreau experienced in the woods does indeed have a much larger scope. Divided into use and non-use categories, the total value of a natural resource can be separated into several factors (Randall, 1991). *Use values* comprise consumptive uses (e.g. hunting, forest harvesting or berry picking) and non-consumptive uses (e.g. forest hiking or mountain climbing). *Non-use values* comprise off-site indirect uses (e.g. reading a book about polar bears) and benefits that take place independent of direct or indirect use of the resource (e.g. preservation of endangered species). Except for the consumptive use category, a market mechanism that could establish prices is often lacking for the other value components[1]. Hence, they are referred to as non-market or non-priced goods.

This thesis deals primarily with estimates of non-consumptive use and non-use values. Protected areas, like national parks and reserves, can here serve as an illustration. As a policy instrument they may help save endangered species where human impact would otherwise result in extinction, and when open to the public, such areas often provide opportunities for outdoor recreation. In the latter case, visitor benefits are not only dependent upon those natural resources available, but also upon the social and managerial environments of the site (Emmelin, 1997; Loomis & Walsh, 1997; Manning, 1999). However, in both cases it is easy to see the close connection between implemented policy and environmental benefits, which is a second main topic of this thesis.

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[1] Some goods, such as hunting and fishing, are partly marked priced goods since the value of the catch has a market price while the experience of nature during the hunt is an unpriced non-consumptive use value. In a study by Mattsson (1990a) the meat value of moose hunting in Sweden was estimated to one third of the total hunting value. A tourist trip to a beautiful national park may also be considered a mixture of market and non-market goods.

Outline of the thesis

This thesis consists of two parts: an introduction to environmental valuation and policy, and five scientific papers. The first part introduces the reader to the economics of environmental benefits in the realm of endangered species, forest recreation and nature tourism. The contingent valuation method, which is applied in three of the papers, is then outlined including discussions on methodology and validity. The environmental policy analysis discussed in the next section briefly examines how negative externalities can be dealt with by means of different policy measures. Papers I through V are then summarized, followed by a discussion. The second part contains the five papers. The first paper reports on some of the findings from a study of the economic benefits of the endangered white-backed woodpecker, followed by a study of non-responses in the second paper. The third paper focuses on the issue of distances to recreational forests in Sweden, while paper four combines a contingent valuation study of mountain tourists with a wilderness purism index. The last paper focuses on the choice of policy instrument when uncertainty enters the marginal cost function of species preservation. Since the empirical data used in this thesis comes from several different sources the attached Appendices include a short section about the design of the various studies followed by reprints of the questionnaires.

Objectives

The objectives of this thesis are to address some of the problems involved in applied contingent valuation research and to arrive at a body of knowledge, which will be of use to policymakers who have to deal with environmental matters whilst taking account of natural, social and managerial considerations. This includes: (1) empirical studies of the benefits of preserving an endangered species, changes in distances to recreational forests, and changes in management at a mountain tourism destination, (2) the use of empirical results to determine policy and management recommendations, and (3) the improvement of validity of contingent valuation estimates.

The economics of environmental benefits

In economic theory, a main criterion for allocating resources is efficiency. This implies that resources in a market economy are used in the best possible way, i.e. when net benefits (benefits minus costs) are maximized for a particular allocation. One measurement often used for efficiency is the *Pareto criterion*. An optimal allocation of resources in a Pareto context, uses society's resources efficiently in the sense that there is no alternative way to organize the production and distribution of goods that makes some consumer better off without making some other consumer worse off (Mas-Colell et al., 1995). This criterion was introduced by the Italian economist Vilfredo Pareto in 1906, and has since then formed the basis for modern welfare economics. The relationship between the

allocation of resources in a market economy and Pareto optimality is summarized in the two theorems of welfare economics. The first theorem states that any allocation of resources generated as a general equilibrium of a perfect competitive economy is Pareto optimal. The second theorem states that the converse is also true: any Pareto optimal allocation of resources can be achieved through a general equilibrium in a competitive economy (Boadway & Bruce, 1984). There are three basic assumptions that must be satisfied in order to ensure that the two theorems hold - the absence in an economy of: (1) monopolies, (2) public goods and externalities, and (3) information asymmetries. If any of these assumptions is not satisfied, there is said to be a market failure. For the purpose of this thesis, the second failure is of greatest concern: the presence of public goods and external effects.

A *public good* is a commodity for which the use of the good by one agent does not preclude its use by other agents (Mas-Colell et al., 1995). This implies that public goods exhibit non-rivalry and non-excludability in consumption. The first condition means that one person's consumption does not reduce the availability of the good to anyone else, while the latter means that once the good is provided the producer is unable to prevent anyone from consuming it. Examples of natural resources characterized as public goods are clean air, a beautiful landscape and biological diversity (Tietenberg, 1992), many of which typically feature non-consumptive use and non-use environmental values. Public parks may also feature public good characteristics since one person's visit will most likely not hinder other people from visiting the park, neither will any visitor be capable of hindering the use of the area by others. The possibility does however exist that too many visitors will cause crowding, in which case the area is then regarded as being a "common" since the non-rivalry condition is partly violated (Bostedt, 1997). Areas used for public recreation and nature based tourism are often good illustrations of this "common" class of public goods[2]. Also note that one person can value the park simply because of its existence, even though he or she does not intend to visit it, in which case the park can be looked upon as a "pure" public good.

If one person's presence in a park or recreational forest has a negative impact on other visitors (crowding, destruction of vegetation etc.), economists will talk about negative *externalities*. More generally, an externality is present whenever the well-being of a consumer, or production possibilities of a firm, are directly affected by the actions of another agent in the economy (Mas-Colell et al., 1995). Other kinds of externalities commonly referred to are air pollution and loss in biodiversity. Hence, it is easy to see the close connection between the existence of public goods and the presence externalities.

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[2] In his seminal paper, 'The Tragedy of the Commons', Hardin (1968) brought attention to this issue, illustrated with a pasture open to all. Hardin also cites the US national parks as an example of the tragedy of the commons. Yet another popular illustration, frequently used in the literature, is open access fishing grounds (Tietenberg, 1992).

The above discussion raises several important questions: (1) how to estimate environmental benefits in monetary terms, (2) to what extent are reductions in social welfare brought about by negative externalities, and (3) by what means should society try to reduce these? First, monetary values and loss in social welfare can be estimated using different valuation techniques. An introduction to one of them, the contingent valuation method is provided in a later section. Second, environmental authorities must decide upon suitable policy measures in order to reduce the effects of a negative externality, a topic discussed in the following section. But before this is done, benefits associated with the three topics with which this thesis is concerned - endangered species, forest recreation and nature based tourism - are further characterized below.

Endangered species

The preservation of *biodiversity* has been a major environmental issue during the last decades. Motives for sustaining a high level of biological diversity in the ecosystems of the Earth are easily recognized, including both direct benefits (e.g. biomass production, food and medicines) and indirect benefits (e.g. solar energy and water cycles) to the human population. Also future and unknown benefits of biodiversity can be substantial (Ehrlich & Ehrlich, 1992; Gowdy, 1997; Polasky et al., 1993).

Biodiversity is a collective term for diversity at three levels: within species (genetic diversity), between species (species diversity) and of ecosystems (ecosystem diversity). Since different areas feature great variations in ecosystem and species composition, any effort to preserve or measure biodiversity becomes a multidimensional problem, which may best be dealt with by means of ecosystem approaches (Grumbine, 1994), and less emphasis on administrative borderlines. Attempts by ecologists to produce functional diversity measures have often proven difficult, and instead, biodiversity is thought to be best monitored by such indicators as degrees of inbreeding, population densities, variations in age and sex, and the occurrence of endangered species (Eriksson & Hedlund, 1993; Solow et al., 1993). In the latter case, single species may serve as indicators of a certain ecosystem type, and as such, saving the species in the wild also implies protecting the ecosystem.

An important concept when dealing with endangered species is the *minimum viable population* (MVP). As defined by Gilpin & Soulé (1986), the term implies that there is a threshold for the number of individuals needed to ensure that a population will persist in a viable state for a given interval of time. It is easy to see the importance of this notion in terms of preserving species in the long run, and the topic is further discussed in Papers I and V of this thesis. In Paper I, focus is on the benefits of the endangered white-backed woodpecker in Sweden. This species is a specialized bird, nesting and feeding in old growth deciduous forests and intensive forest management in such areas has had a negative impact on its survival (Aulén, 1988).

When recognized by the public, many endangered species are appreciated solely for their existence since no direct or indirect uses of the species are involved. This non-use value, also known as an *existence value*[3], is often found to be an important aspect when estimating the benefits of endangered species[4]. Stevens et al. (1991) found that a substantial existence value is associated with bald eagles, wild turkeys and Atlantic salmon; and Stoll & Johnson (1984) estimated the existence value of the whooping crane to be in the range of $1.03 to $9.33. Existence values are also reported for more obscure species, e.g. the striped shiner (Boyle & Bishop, 1987).

Outdoor recreation

Research in outdoor recreation dates back to the beginning of the twentieth century. Many of the early studies were ecologically oriented, but an increasing number of participants in outdoor related activities after the Second World War raised concerns about crowding and conflicting uses, which in turn brought about a large number of social studies. At this time, it was also recognized that the socio-economic characteristics and preferences of the participants were of interest to managers of outdoor recreation areas (Manning, 1999). Problems in outdoor recreation were then approached from a variety of disciplines, including sociology, geography, political science and economics.

Social aspects of outdoor recreation research include a large body of literature emphasizing the study of *motives* rather than activities (Wallsten, 1985; Schreyer, 1990; Manning, 1999). Individuals are driven by different motives looking for outdoor experiences consistent with their preferences. A rationale for studying motives is the identification of visitor categories with similar motive domains, which can be of great value as regards better understanding visitor behavior and improving the management of recreational areas. This is also the point of departure for Paper IV where visitors to a mountain area are categorized by their preferences about wilderness management.

Economic techniques were introduced in outdoor recreation research by Clawson & Knetsch (1963, 1966), including the travel cost method that is widely used in later research. An early Swedish application of this method was carried out by Bojö (1985), who studied the value of preserving an old growth forest in the mountain valley of Vålådalen. The demand for outdoor recreation is often determined by the attractiveness of the site and natural qualities. A large number

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[3] There is no uniform naming of this value, but examples from the literature include: existence value, altruistic value, bequest value, stewardship value, vicarious consumption, inherent value, and intrinsic value (Bishop, et al., 1987; Brookshire et al., 1986; Madariaga & McConnell, 1987; Stoll & Johnson, 1984; Walsh, et al., 1984). Existence values were originally proposed by Krutilla (1967) illustrated by the American wilderness.

[4] A list of recent empirical studies of non-use values in contingent valuation is provided in Bjornstad & Kahn (1996).

of studies have tested the effects of willingness to pay in terms of air quality, visibility, weather conditions, forest characteristics and congestion (Loomis & Walsh, 1997). Daniel et al. (1989), for example, found a linear relationship between perceived scenic beauty at forest campsites in Arizona and willingness to pay for camping.

In Sweden, a number of recent studies have focused on the interactions between forest management practices, forest characteristics and visitor experiences (Bostedt & Mattsson, 1995; Lindhagen, 1996; Mattsson & Li, 1994). Benefits from outdoor recreation primarily comprise of different on-site values. Mattsson & Li (1993) studied general forest recreation in Northern Sweden and estimated the on-site consumptive use value to 21 percent of the total non-timber value, while the on-site non-consumptive use value accounted to almost 50 percent. In another study by Mattsson (1990a), it was estimated that two-thirds of the total hunting value of all game in Sweden refers to recreation (an on-site non-consumptive recreational value). In a review of the economic literature on non-wood benefits in forestry, Wibe (1994) estimated one day of recreation in forests (hiking, camping, etc) to be worth approximately 200 SEK.

While much of the literature on forest recreation has focused on site characteristics, an additional subject of interest is the location of forests. Few studies have been produced on this topic, but researchers and managers have nevertheless often pointed out the importance of a close proximity between residential areas and the countryside (Kaplan & Kaplan, 1989). In economic terms, the value of nearby natural environments can simply be understood by studying the housing market, which usually features higher prices in areas close to the countryside or beautiful scenery. Two examples of studies dealing with this theme are Willis & Garrod (1992) and Tyrväinen (1998) who both found significant and positive relationships between environmental characteristics and property prices. Paper III of this thesis takes a more direct approach in studying one aspect of accessibility to forests, by surveying changes in the distance between places of residence and the closest recreational forest among Swedish citizens.

Nature based tourism

Parallel to outdoor recreation, research in tourism is a complex phenomenon crossing a large number of scientific disciplines (Cooper et al., 1998; Echtner & Jamal, 1997). Studies of tourism have also developed during the twentieth century, but there is still a lack of agreement about definitions and what actually comprises the tourism industry. Statistics on tourism in Sweden count all overnight trips, including both leisure and business, and one-day trips of 100 kilometers or more. Neither is the distinction between tourism and recreation clearly defined. While a distance criterion can be imposed, other possible distinctions include length of stay, the presence of commercial activities (monetary payments) or dependence of facilities (McKercher, 1996; Turistdelegationen, 1998). When dealing with outdoor recreation and nature

based tourism any attempt to make such a distinction is difficult and seldom serves any practical management purpose since participants in both categories often share the same natural resources, facilities and exert similar impacts on the environment. McKersher (1996) argues that the delineation point between tourism and recreation rather falls along a continuum based upon perceived differences among participants.

In Sweden, the turnover of the tourism sector accounts for 3.3 percent of the GNP and the industry employs about 200 000 individuals. Approximately 80 percent of all tourism in Sweden is domestic, the larger foreign groups being German, Norwegian, Danish and Finnish (Pearce, 1996; Swedish Tourist Authority, 1999). While most overnight stays take place in urban areas, marketing of Sweden as a tourist destination often features natural environments and associated activities. Large wilderness areas, free access to land and a clean environment are important reasons for foreign tourism in Sweden, and the demand for nature based tourism activities is thought to increase in the future (Boverket & Turistdelegationen, 1997; Turistdelegationen, 1998).

Many destinations around the world use natural environments as a primary resource in tourism supply, and as nature based tourism becomes increasingly important to local and regional economies analyses of tourism production also need to incorporate non-priced inputs (Marcouiller, 1998). Several studies among the environmental valuation literature have revealed economic measures of such benefits. León (1997) estimated the willingness to pay by visitors to four natural areas in the Gran Canaria Islands to be in the range of 50 to 200 SEK for dayvisits[5]. The use-value of two national parks in Australia (Dorrigo and Gibraltar Range) was estimated by Bennett (1996) at 110 SEK per visit. Horak (1998) found that forests have an economic value for Croatian coastal tourism in the range of 10 to 50 SEK per visitor day.

In Sweden, Bostedt & Mattsson (1995) estimated the value of forests for tourism at two locations, one in the north (Arjeplog) and one in the south (Harasjömåla). The approximate value per visit in these studies ranged from 50 to 3000 SEK. Hence, tourism in the mountain region of Sweden is yet another good example of non-priced amenities playing an important role. Here a substantial proportion of the land area is protected under the Nature Conservation Act, it is publicly owned and access is free. One method capable of assessing environmental values under such conditions is the contingent valuation method. This method is further examined in the section below, and in Paper IV it is applied to visitors of a Scandinavian mountain tourism destination.

[5] The monetary estimates presented in this section are converted into Swedish crowns (SEK).

The Contingent Valuation Method

Three of the most frequently used methods of environmental valuation are contingent valuation, travel cost, and hedonic pricing methods. Both the travel cost and the hedonic pricing methods are known as revealed preference methods, which are based upon assumed relationships between a market good and the environmental good subject to valuation. The *contingent valuation method* (CVM) does not have such a dependency, since it instead is based upon a valuation of the commodity in a direct manner, and is known as a stated preference method. This also enables estimates of existence values, which is not possible through the use of the other two techniques.

Environmental valuation was originally developed in the United States to deal with "intangibles" in cost-benefit analyses in a more systematic way (Navrud, 1992). The history of CVM dates back to the 1950s but it was not until the late seventies that the method gradually became accepted among researchers. During the last couple of decades the number of studies undertaken with this method has dramatically increased. Some of the more noticeable applications are in natural resource damage assessment (Imber et al., 1991; Kopp & Smith, 1993), including the study of lost passive use values resulting from the Exxon Valdez oil spill in Alaska during 1989 (Carson et al., 1992). While contingent valuation has most extensively been used in North America, other countries employing the method are Australia, Germany, the United Kingdom, and Scandinavian countries (Navrud & Pruckner, 1997). Bibliographies of CVM studies are included in Braden & Kolstad (1991); Mitchell & Carson (1989); Navrud (1992) and Wibe (1994).

This section includes a brief presentation of the theory behind the contingent valuation method followed by a selection of methodological issues with bearing on the papers included in the thesis. For a comprehensive presentation of this topic see Mitchell & Carson (1989) or Bjornstad & Kahn (1996) for a discussion of some important methodological issues. The economics of CVM is examined in several works (e.g. Boadway & Bruce, 1984; Johansson, 1993; or Braden & Kolstad, 1991).

The economic framework

Define the household utility function as $u=u(x,z)$, where $x=[x_1,x_2,...,x_n]$ is a vector of market goods and z is an environmental good provided at no cost. The utility function is considered a representation of preferences possible to assign a set of indifference curves, each one characterized by combinations of goods and services that yield the same level of utility[6]. Given the budget constraint y and a

[6] The microeconomic theory used here is based on rational choice: individuals have preferences that are indexed by a utility function and measured in terms of consumer surplus. Any textbook in microeconomics will discuss this topic - See, for example, Mas-Colell et al. (1995).

set of prices $p=[p_1,...,p_n]$ of the market goods, the household chooses the combination of goods and services that maximizes utility. The utility maximization problem produces a set of Marshallian demand functions $x_i=x_i(p,z,y)$ and by substituting these back into the original utility function we derive the indirect utility function $v=u(x_i(p,z,y),z)=v(p,z,y)$, which expresses the maximum utility that can be achieved given p, z, and y.

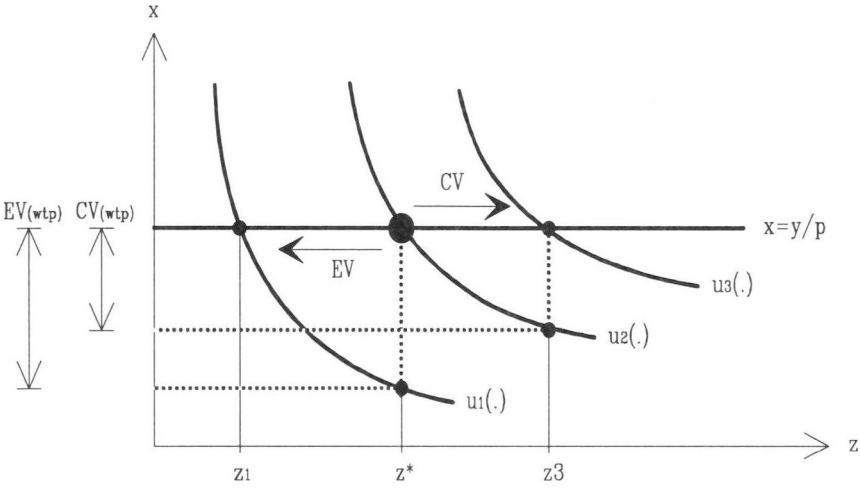

Figure 1. The *CV* and *EV* willingness to pay measures of an environmental change.

Then, how is utility affected by a change in the provision of z, the environmental good? Assume we have three levels in the provision of z: the current one, z^*, and two alternative levels, z^1 and z^3, where z^1 is smaller than z^* and z^3 is larger (see Figure 1). Then, if z changes from z^* to z^3 (environmental improvement) there follows a change in utility equal to

$$\Delta v=v(p,z^3,y)-v(p,z^*,y) \qquad (1)$$

To find out how much a household values this change in z we may ask about the *willingness to pay* (WTP) for the change

$$v(p,z^*,y)=v(p,z^3,y-CV) \qquad (2)$$

Here *CV* is known as the *compensating variation*, which is the maximum amount of money that can be taken away from the household in the final state in order to

leave it at the same utility level as in the initial state. Next, consider the change from z^* to z^1 (environmental deterioration). The change in utility is then

$$\Delta v = v(p,z^*,y) - v(p,z^1,y) \quad (3)$$

The willingness to pay to avoid this change is defined in terms of the *equivalent variation, EV*

$$v(p,z^*,y-EV) = v(p,z^1,y) \quad (4)$$

In this case, *EV* is the maximum amount of money that can be taken away from the household in the initial state in order to leave it at the same utility as in the final state.

Methodology

In order to correctly estimate monetary values using CVM one must proceed with the design and implementation of a survey. First of all, it is necessary to decide between three major approaches by which individuals can reveal their preferences: mail, telephone, and in person surveys. All the surveys used in this thesis were carried out as mail surveys, which are relatively inexpensive to carry out for large samples and do not require administratively cumbersome fieldwork. Since mail surveys typically have lower response rates than telephone and in person surveys, a major criticism of the method concerns its potential for non-response bias. Paper II of this thesis deals with this problem in the form of a follow-up survey distributed to non-respondents of the survey of Paper I.

Another important decision the CVM researcher must take is how to frame the economic elicitation question. The choice depends upon the implied property rights and which welfare measure (*EV* or *CV*) one wants to use, but also how the respondent will perceive and understand the wording of the question. In this thesis, both welfare measures are used and questioned in a willingness to pay format. In Paper I, for example, *EV* is used to measure WTP to avoid extinction of the current woodpecker population, while *CV* is used to measure WTP for an increase in the population density. Consequently, the elicitation questions were "straight forward" and easy to understand. In addition to question framing, one must also choose among four principal elicitation methods: open-ended, payment card, take-it-or-leave-it offers, and take-it-or-leave-it offers with follow-ups. While the open ended and payment card methods directly render the maximum amount the good is worth to the respondent, the other two yield a discrete indicator of willingness to pay. Both the open-ended and closed-ended formats are applied in this thesis.

The *open-ended* (OE) format is the most obvious way of eliciting the money value of welfare variations as long as the respondent is aware of his or her maximum WTP. The advantages of this method are that willingness to pay levels are directly elicited and that inference is not required. A major drawback is the

unfamiliar situation that faces the respondent when directly asked about their maximum WTP, which may make the open-ended question more stressful to answer. To overcome this problem, Bishop & Heberlein (1979) developed the *closed-ended*[7] (take-it-or-leave-it) approach. The obvious advantage of this format is the more "market like" situation the respondent will experience when a bid (posted price) is accepted or rejected. Drawbacks of the closed-ended format are the assumptions needed to be made about the distribution of yes-no answers. Also, in cases with high acceptance of the largest bid, the restrictions imposed about the tail of the frequency distribution will have a large influence upon the calculated mean willingness to pay (Hanemann, 1994; Li, 1994). In the woodpecker study reported in Paper I, 22 percent of the respondents accepted the highest bid. The estimated mean WTP of 406 SEK did, however, imply a downward shift in the empirical survival function assuming a zero acceptance at the highest bid. Compare this figure with the untruncated mean of 10600 SEK, and it is easy to see some of the problems involved (Fredman, 1995). This is also a reason to report median estimates that are less sensitive to the "fat-tail" problem.

Studies where the two question formats have been compared often find that closed-ended questions produce higher WTP estimates compared to open-ended. The difference in means ranges from zero up to approximately five times in favor of the closed-ended format (Brown et al, 1996; Johnson et al., 1990, Kriström, 1993; Kelay & Turner, 1993; León, 1997; Loomis et al, 1997). When comparing hypothetical CVM questions with actual payments, different experiments have found the former to be significantly higher (Frykblom, 1998; Schulze et al., 1996)[8]. Brown et al. (1996) concluded that, in relation to actual payments, the open-ended format did produce a more accurate estimate than the closed-ended question format. Considering that both formats over estimated real WTP by 4 to 6 times, the ratio between actual and hypothetical payments was about 1.5 times higher for the closed format. Brown also found that the response format mattered far more for hypothetical questions than for actual payments, and in a study by Loomis et al. (1997) no difference were found between the two question formats for actual payments. In the latter study, it was concluded premature to abandon the use of open-ended WTP questions in contingent valuation (cf. the recommendations of the NOAA report below).

Validity and criticism

After the extensive oil spill by Exxon Valdez in the Prince William Sound of Alaska in 1989, the U.S. Department of Commerce and National Oceanic and Atmospheric Administration published an evaluation of CVM including general guidelines known as the NOAA report[9] (Carson et al., 1992; NOAA, 1993). This

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[7] Also known as a discrete choice or dichotomous choice question format.

[8] This is not always the case. Hanemann (1994) reports a number of studies where no significant differences are found between real and hypothetical commitments.

[9] See Hanley et al. (1997) for a short summary of the NOAA guidelines.

document has formed a benchmark for much of the subsequent CVM research. The report confirms that contingent valuation is applicable under certain restrictions, and it acknowledges the use of CVM to estimate non-use values. Among its main recommendations, the use of WTP measures, closed-ended question formats and reporting conservative results is recognized[10]. While the NOAA document has certainly improved later CVM applications, there are still many questions related to the validity of the method that remain an issue of contention among researchers in the field.[11] Mitchell & Carson (1989) present a typology of 20 potential measurement biases in CVM, grouped into three categories: "incentives to misrepresent responses", "implied value cues" and "scenario misspecification". Sampling and inference bias is another important issue raised in relation to CVM, including different non-response biases. Susceptibility to different biases will vary depending on the good being valued and the elicitation method used, and accordingly, different biases are discussed in the papers of this thesis as they become potentially troublesome. This section will outline some of those current issues in terms of sensitivity to scope and embedding effects, which have important implications to Papers I and V.

Economic theory suggests that if an individual is willing to pay a given amount in order to protect a certain population size of an endangered species, then the same individual should be willing to pay more for the protection of a larger population. The responsiveness of WTP to the quantity of the environmental good provided is known as a *scope effect*, while the absence of scope is recognized as embedding (Giraud et al., 1999). Results from different valuation studies are inconsistent as regards this issue. For example, the study by Boyle et al. (1994) which estimated WTP to prevent three different levels of waterfowl deaths (2000, 20 000, 200 000) did not show sensitivity to scope. Neither did the study by Lindberg et al. (1997) dealing with rural tourism development in Oregon. They used CVM to estimate WTP for a 25 percent and 50 percent reduction in traffic congestion. Other recent tests of scope in contingent valuation do, however, contradict these results[12]. Loomis & Ekstrand (1997), who studied the difference between mean WTP for protecting the endangered Mexican spotted owl and figures for protecting an additional 61 threatened species, identified a scope effect of 0.1 significance level. Smith & Osborne (1996) did a meta-analysis of five studies estimating benefits from air visibility changes in U.S. national parks and found sensitivity to scope. Rollins & Lyke (1998), who studied remote wilderness parks, found that people distinguish between goods of different scope at a diminishing marginal rate. Hence, when

[10] NOAA recommends a reduction of the estimated WTP by 50 percent to correct for hypothetical bias.

[11] The validity of a CVM estimate is the degree to which it measures the maximum amount of money the respondent would actually pay for the public good if the appropriate market for that public good existed (Mitchell & Carson, 1989). If the elicited values are unbiased, the instrument is said to be valid (Hoevenagel, 1994).

[12] Hanemann (1996) argues that most tests found in the literature (some 130 studies) find that WTP varies with scope.

the population of an endangered species increases each increment is worth less and less, and if measurement is not exact enough it will be difficult to identify significant changes in WTP. In the white-backed woodpecker study of Papers I and V, it is possible that the range of measurement is in the upper region of the WTP curve, which would explain the insignificant differences in WTP[13].

Based on the studies above, it is easy to see that problems involving embedding are primarily an issue when estimating non-use values. This, in turn, thus raises the question whether people are able to trade off between such values and "other goods" along indifference curves at all? Seen in these terms, the merits of estimating existence values have been especially questioned (Common et al., 1997; Johansson-Stenman, 1998). This question focuses attention on a debate concerning contingent valuation and ethics. Sagoff (1988), for example, argues that willingness to pay measures obtained in a CVM survey are not considered a measure of change in happiness, pleasure or utility in any substantive sense. Natural resources are to be allocated using ethical, cultural, and moral decision rules rather than economic efficiency criterion (Booth, 1992; Olsen & Gowdy, 1994). To some extent, these arguments also question the appropriateness of modern welfare economics and the fundaments of neoclassical theory. This is obviously not a simple matter, which is undoubtedly worthy of attention but beyond the scope of this thesis.

Environmental policy

By means of democratic decisions, society sets goals for public undertakings. As a rule, some form of controlling force is needed to achieve these goals and in order to direct behavior towards designated objectives different policy instruments can be utilized (Molander, 1994). One reason for the initiation of public undertakings is in response to the negative effects of a particular activity on the environment, which was recognized above as a common feature among public goods. Here *negative externalities* will be examined more formally using the graph in Figure 2.

Assume a situation of forest cutting in an area, which hosts an endangered species sensitive to habitat deterioration. If q is the harvest intensity carried out by the forest firm, the amount of forest cut will be q^0, where the marginal benefits equal the private marginal costs (MC_p). Now, consider the negative effect this cutting has upon the endangered species, which is considered a positive good by individuals in the economy. Internalizing these costs by the

[13] In a discussion on the embedding problem using the survival of different bird populations as an example, Fisher (1996) derives similar conclusions. His approach also depends crucially upon the definition of a "minimum viable population", as outlined in Paper I of this thesis.

firm imply a shift in the marginal cost function of Figure 2 up to the left (MC_s), and the new optimal cut is q^*. The size of the externality in this case is q^0-q^* (excess cutting).

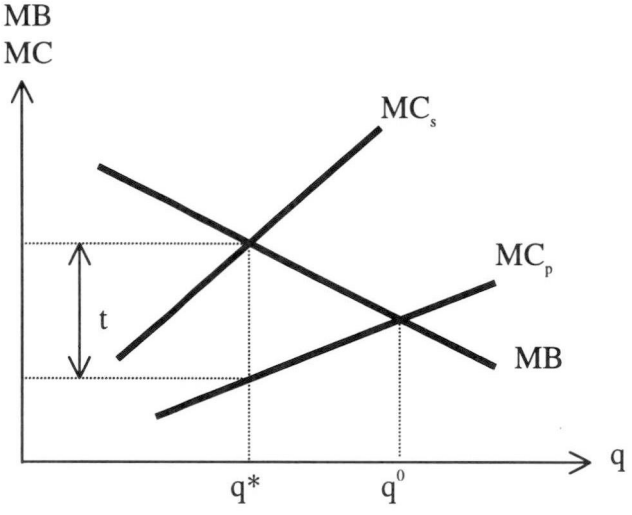

Figure 2. Negative externalities in production and consumption.

The graph above can also be used to illustrate externalities in a recreation or tourism context. Consider a tourist destination where q is the number of visitors and that each visitor causes external costs in terms of sewage production or damage to vegetation. If the market for visiting the area is competitive and unregulated visitors will balance the marginal benefits against the private marginal costs (MC_p) and the number of visits will be q^0. But if each visitor took account of the negative effects he or she caused the cost curve would again shift up to the left, reducing the total number of visitors to q^* which is socially optimal. In this case q^0-q^* measures the excess use of the area.

The choice and use of policy measures

If some form of public undertaking is needed to optimally balance benefits and costs from a social point of view, then by what means can this be done? One possible categorization of policy and legislative control is to distinguish between *standards*, *economic incentives* and *informative measures*. The usefulness of different approaches includes judgements of effectiveness, efficiency, equity and flexibility, and is also a matter of what context they are to be applied in (Hanley

et al., 1997; Swedish Environmental Protection Agency, 1997). This section briefly discusses the three categories presented above, followed by examples related to the topics of this thesis[14].

Standards typically include certain quantitative limits, directives for specialized technologies or the implementation of a complete ban. In the forestry case above, we may think of a restriction limiting the amount of forest cut or prescribe the use of certain silvicultural practices to ensure that harvests does not exceed q^*. In a similar fashion, the number of visitors to the tourist destination might be limited by issuing q^* entrance permits.

As is suggested by *economic incentives*, an economic transaction takes place for the purpose of achieving a desired objective. By influencing markets and their price mechanisms with fees or taxes, authorities can limit environmentally hazardous activity or conversely, by the use of subsidies, promote activities of a positive nature. In Figure 2, a tax equal to t imposed on the forestry firm or visiting tourists will internalize the negative external effects and in theory, yield the same optimal solution as with the quantitative limits above. Another economic incentive is to issue a quantity rationing through marketable permits. The number of permits distributed will ensure a certain environmental quality, while permit trade will result in a cost-efficient solution among producers.

Informative measures (environmental codes, information, education etc.) rest upon voluntary acceptance of responsibility by those who are adversely affecting the environment. Authorities may, for example, undertake information campaigns directed at forestry firms about the threatened species and what measures will promote its survival. Ideally, voluntary action will then result in a cutting intensity equal to q^*. Analogously, information can be directed at tourists in order to change travel patterns or behavior within sensitive locations, in order to reduce the risk of negative environmental impacts.

Endangered species

The 1992 United Nations Conference on Environment and Development declared the "precautionary principle" in order to reduce the risk of loosing biodiversity. This means that preventive measures should be taken if there is a chance of serious or irreversible damage (UNCED, 1993). One suggested approach, when focus is on endangered species, is to work with *safe minimum standards* (SMS). This implies a quantitative decision rule to preserve a species at a minimum quantity as long as the opportunity costs are not unacceptably high for society (Bishop, 1978; Perrings & Opschoor, 1994). Once a minimum standard is obtained and the species is no longer in danger of extinction, other policy measures, if appropriate, may of course be used. Because of the trial-and-

[14] There is no uniform classification of policy measures, and the categorization done here is to facilitate the presentation. See for example Hanley et al. (1997) or Tietenberg (1992) for typologies of environmental policy measures.

error process often involved when searching for the suitable tax or fee rate (Tietenberg, 1992) and since the outcome of informative measures can be hard to recognize in advance, it is easy to see the advantages of using quantitative standards within an endangered species context. These conclusions are also supported by Paper V of this thesis.

Outdoor recreation and tourism

Standards used in outdoor recreation include limits on group sizes, restrictions on wild camping and campfires, reservation requirements and the rotation of land use (Jubenville et al., 1987). Analogous to threshold effects in endangered species protection, managers of recreation areas make use of the term "limits of acceptable change", which identifies the carrying capacity of a recreational area (Manning, 1999). In North America, the *recreation opportunity spectrum* has been developed as a management tool that provides a continuum of recreation opportunities spatially separated in different zones (Clark & Stankey, 1979). The rationale behind this concept formed the initial ideas developed in Paper IV.

The use of economic instruments is considered a powerful tool as regards influencing the level and timing with which recreational areas are used. (Loomis & Walsh, 1997). Smeral (1996) discusses the use of fees or taxes to reduce the environmental impact of tourism, and proposes combinations of different measures with a gradually increasing impact on behavior in order to obtain public acceptance. Charges are used extensively in North American recreation policy as well as for public sites. However, the objectives determining pricing are often cost recovery and revenue rather than the internalization of some non-priced negative external effect (Laarman & Gregersen, 1996).

Also studies of informative policy measures in outdoor recreation and tourism indicate a significant impact on visitor behavior (Manning, 1999). Simple methods such as signs and trails may prove useful here. Wilderness statistics from the lower forty-eight states in the U.S. show that 99 percent of all use is via the trail system (Jubenville et al., 1987).

Summary of the papers

I. The existence of existence value. A study of the economic benefits of an endangered species

This paper explores two findings from a contingent valuation survey estimating the benefits of preserving the endangered white-backed woodpecker in Sweden (Fredman, 1995). Firstly, the absence of a positive marginal value for an increased population density, and secondly, the large proportion of the respondents who rank species existence as their number one priority for preservation. These findings are considered evidence of an existence value, a

concept introduced to natural resource valuation by Krutilla (1967). While no uniform definition of this concept can be found in the literature, several studies valuing wildlife find different non-use values to be important value components.

In this study, the total value is divided into five components: consumptive use value, non-consumptive use value, indirect value, existence value, and altruistic value. It is argued that existence value is limited to the existence of a species, and in terms of wildlife valuation this is best illustrated by the concept of a minimum viable population. The non-use value, defined by this population level, is equal to the existence value. For larger population densities, the total value may increase as a consequence of an increase in other non-use values, except for existence value, and/or various use values.

Using the notion of weak complementarity, existence value is given an interpretation in economic terms. Weak complementarity implies that there is some market good consumed together with the environmental good, and that the use of the latter can be measured by the degree with which the former (i.e. the complementary good) is consumed. The equivalent and compensating variation measures are then used to derive different expressions for use, non-use, and existence values. This is done for a decrease in the population density below the minimum viable (extinction), and for an increase in the population density to some level above the minimum viable. Analysis of empirical CVM data confirms the existence of an existence value in an endangered species context as defined above.

II. A test of nonresponse bias in a mail contingent valuation survey

Most contingent valuation surveys will be subject to nonresponses because sample members do not return the questionnaire (unit nonresponse), or respondents fail to answer the economic elicitation question (item nonresponse). This paper analyzes nonresponse bias in the WTP estimate of the CVM survey of Paper I, in which item nonresponse amounted to only 1 percent of the total sample, while the remaining 39 percent were unit nonresponse.

The analysis was undertaken by means of two follow-up surveys, distributed approximately three months after the original CVM survey. The first follow-up, which included a sample of both respondents and nonrespondents to the CVM survey, featured two attitude questions concerning endangered species. The second included only a sample of the CVM nonrespondents and asked for the reason for not returning the original CVM questionnaire. The response rate of the two follow-ups was 42 and 22 percent, respectively. The data from the first follow-up survey was used to test for a relationship between WTP and attitudes among those of the respondents who answered both the original CVM survey and the follow-up survey. This relationship was then used to test for differences in WTP between CVM respondents and nonrespondents. If CVM respondents and

nonrespondents differ with respect to their attitudes, we can also expect them to differ with respect to their WTP.

The results from this study suggest that there is no difference in WTP between the two categories, and consequently, nonresponse bias should be a minor problem in the original CVM survey. This finding is to some extent verified by the results derived from the second follow-up survey, which indicated that nonresponses occur because of general rather than survey specific reasons.

III. On the distance to recreational forests in Sweden

While much research has focused on the relationship between forest characteristics and recreational benefits, this paper addresses the issue of distances to recreational forests. In terms of visitor frequency, shorter distances to forests are found to be of more importance than changing forest characteristics. The study is based on two mail-outs distributed as a part of a larger survey studying forest recreation in Sweden. A sample of 1000 randomly chosen Swedes was asked about their present distance, and what they considered to be the preferred (ideal) distance between their residence and the closest recreational forest. The second mail-out also included questions about opinions toward an increased distance to the closest recreational forest, followed by an open-ended willingness to pay question to avoid such a change.

Almost half of the respondents in this study were satisfied with their present distance to the closest recreational forest. On average, this group has a distance of 0.70 kilometers and median of 0.30 kilometers to the closest forest (southwest of Sweden excluded). The corresponding measures for the preferred distance among those who would like to live closer (40 percent of the respondents) were 0.66 and 0.30 kilometers. Since a majority of all travel to recreational forests located within a kilometer of the respondents' residence were undertaken by foot or on skis, it is suggested that the preferred distance to the closest recreational forest for a majority of Swedes should be within walking distance (<1 kilometer). It is also recognized that there is a housing shortage within one kilometer of recreational forests in Sweden, in general.

Forty-five percent of all respondents considered an increased distance (twice that of the present distance) to the closest recreational forest as negative. This conclusion holds primarily for those who already live far from a forest. The probability of giving a positive willingness to pay bid to avoid such an increase in the distance also increases with the respondent's present distance to a forest.

IV. Wilderness purism, willingness to pay and management preferences. A study of Swedish mountain tourists

This study combines a visitor-segmentation, by means of a wilderness purism index, with a contingent valuation of environmental and management attributes of a mountain tourism destination. Visitors to Femundsmarka, Rogen and Långfjället in central Sweden and eastern Norway were surveyed during the

summer of 1998. An on-site self-registration procedure was used, yielding a sample of 3342 Swedish visitors, out of which 1016 individuals were selected for a mail survey. A set of questions about general preferences towards wilderness issues grouped the sample into three segments: purists, neutralists and urbanists. While purists prefer unmanaged wilderness, urbanists favor developed areas with facilities. These segments were used as a basis for the following economic analysis. An open-ended willingness to pay question was applied to measure expected maximum WTP and the consumer surplus for the tourist trip.

The average willingness to pay for a visit to the area is estimated at 1756 SEK, out of which almost one third is a consumer surplus. A valuation function is fitted to WTP data, which is best explained by various quantitative predictors (days spent in the area, distance from home, etc.) rather than by the reported quality of the wilderness experience. Purists are found to increase their WTP for the trip, if a change in the management regime implies less facilities, and less restrictions on campfires and camping. In contrast, urbanists will increase their WTP if facilities are more developed and more restrictions on campfires and camping are applied. It is shown that total benefits to be gained among Swedish visitors can be increased in the magnitude of one million SEK by means of a visitor segmentation and spatial differentiation as part of the current management strategy.

V. Endangered species and optimal environmental policy

In this paper the choice between two policy instruments, a Pigouvian tax (fee) and a quantitative permit, is analyzed using a theoretical model for an optimal environmental policy designed to protect endangered species. It is assumed that the endangered species is a public good and that operations by a firm (in this case forestry and hunting) have adverse effects upon the species population density. Focus is on the situation where the marginal benefits of species protection are known, while the marginal costs of modified operations by the firm are unknown to the environmental authority. Under such conditions, the environmental authority cannot be sure which of the two policy instruments will perform best, and a potential loss of social welfare, following from an incorrect assumption about the marginal cost function, depends upon which policy instrument is used. The design of an optimal environmental policy requires knowledge about the slope of the marginal cost function relative to the slope of the marginal benefit function, both of which are assumed to be linear. The general theory used here was first developed by Weitzman (1974) and has become a well-known proof in environmental economics[15].

Empirical data used in this study are from benefit estimates of preserving the endangered white-backed woodpecker (Fredman, 1995) and wolf (Boman & Bostedt, 1999) in Sweden. The marginal benefit function of both species is found to be vertical at the minimum viable population and zero for increases in the

[15] Weitzman's proof can also be found in Baumol & Oates (1988).

population levels[16]. Applying Weitzmans proof to this result, it is easy to show that the optimal policy is a quantitative permit set equal to the minimum viable population. It is argued that serious consequences may follow from the choice of wrong policy instrument when the marginal benefit function is vertical. If the environmental authority wrongly decides upon a fee, and the marginal cost turns out to be larger than expected, this policy will cause extinction. More generally, the choice of policy instrument depends upon what species is under consideration, but for endangered species, which primarily involve non-use values, quantitative regulations are recommended.

Discussion

Most environmental problems are not questions of "yes" or "no", they rather feature changes on the margin. Biologists focus on maintaining biodiversity, urban planers on the development of green areas, and park managers on limiting vegetation decline or congestion. In economics, the main criterion when allocating environmental resources is the achievement of efficiency, i.e. maximize benefits minus costs. Also, in such exercises, it is seldom the total sums that are relevant, but rather how values are influenced by changes in the provision of environmental goods (Bulte & Van Kooten, 1999; Dixon & Sherman, 1991; Mattsson, 1990b). The studies of this thesis apply the contingent valuation method to different environmental issues, using marginal economic analysis. As several of the papers show, this approach yields useful policy insights. Also, considering the uncertainty involved when estimating total values from contingent valuation studies, there are reasons to believe that marginal values are more informative in an applied context. If, for example, the WTP estimates of all three population densities considered in Paper I are equally upward biased, the total value function is also biased while the estimated marginal values remain unbiased. This doesn't mean that total values necessarily have to be biased or uninformative. The WTP estimates of Paper I were based on once-and-for-all payments, and spread out over a lifetime, the annual payment per person is quite reasonable[17].

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[16] In the woodpecker case the marginal value was found to be negative in an upper population interval among a certain category of the respondents (see Paper I). However, for the purpose of this study, where respondents are treated as an aggregate, the benefit function is considered horizontal throughout (see Fredman, 1995).

[17] Johansson & Zavisic (1989) estimated the mean WTP at SEK 1200 per household per year in order to improve the environment in Sweden. This figure is an estimate of the total budget for environmental improvements. If we convert the estimated conditional mean WTP (~SEK 400) for saving the white-backed woodpecker in Sweden to the same unit as used above (i.e. per household per year) we get approximately (400*2)/40=20 SEK. A reasonable amount in view of Johansson & Zavisic's result.

Several possible sources of bias in contingent valuation estimates have been identified above. In applied CVM research, data is typically used to estimate benefits for a larger population than those actually interviewed, in which case *nonresponse biases* are especially troublesome. Comprehensive follow-up approaches, such as the one reported in Paper II, are nevertheless far from conventional practices. One possible reason for not returning a mailed questionnaire (unit nonresponse) follows from its length and scope. While the length itself may not be the sole factor determining response rates, a shorter survey will on average perform better than a substantially longer one, other things equal (Mangione, 1995). The survey of the white-backed woodpecker in Paper I included eleven questions and besides socioeconomic variables, focus was only on the species subject to valuation. This enabled a rather advanced survey design and respondents' attention was kept on the species throughout the questionnaire. In contrast, data used in Papers III and IV was collected as part of larger surveys having more than one objective. While this enabled more diversified analysis, it limited the possibility for more customized survey design with respect to the economic sections and respondents may have found it more mentally strenuous to complete the questionnaires. Yet another noticeable difference between the three surveys was the economic elicitation question format. The relatively low response rate of the WTP question used for paper III (item nonresponse) may follow from the use of an open-ended format. There is also reason to believe that some of the zero bids reported in this study are protest responses, which is the most troublesome form of item nonresponse. A more conclusive effort to distinguish these from true zeros should have been applied here.

While many issues still need to be dealt with in contingent valuation methodology, an important focus for future research will be the improvement of the validity of the method. A question CVM-researchers often face concerns the validation of hypothetical CVM estimates against actual economic commitments. A key to the future success of CVM outside the academic world is to find answers to this question. Contingent valuation applied to endangered species, recreation and tourism is still a rather young and unexplored area of research in Sweden. When approaching these topics, knowledge is required not only of economic theory, but also of topics such as ecology, forestry, sociology and political science. Much information can also be gathered from related studies in other countries, but different cultural contexts, including the "right of common access" to the countryside and landowner structures will inevitable affect the Swedish research agenda.

When analyzing environmental problems in greater depth, property rights often turn out to be a fundamental aspect. Does Agent A have the right to enjoy an unpolluted or virgin environment or is it Agent B, employing some alternative land use involving forest cutting, air pollution or reduced accessibility, who has the right to exploit the natural environment? Any CVM scenario implies a perceived property right regime. This issue also involves the question of

willingness-to-pay versus willingness-to-accept compensation measures. In the studies of this thesis, the WTP format is used, which means that the implied property right is extinction of the white-backed woodpecker in Paper I and the alternative (longer) distance to the recreational forest in Paper III. While the realism in the woodpecker scenario can be questioned, the latter scenario is more likely to be approved since individuals generally are not compensated for an increased distance to the closest recreational forest.

Although this thesis does not deal with the implementation of environmental policy or management, it has been possible to identify several useful recommendations from the economic results derived. Since the data used originated from empirical surveys, this also emphasizes the significance of public involvement in the decision making process. The analysis of existence value presented in Paper I, shares several similarities with those other studies in the field which emphasize the significance of such value components when dealing with rare species. There is also reason to believe that the proposed quantitative regulation suggested in the following policy model of Paper V is not only valid for the white-backed woodpecker and the wolf populations studied, but also for endangered species in general. Boman (1997) also shows that the results of Paper V will hold for the most conservative benefit estimates of the wolf population as well, which is promising. The suggested walking distance to the closest recreational forest cited in Paper III is comparable to standards used by urban planners in the Nordic countries (Tema Nord, 1996). Also, the estimated benefit gain following from a differentiated management regime at the mountain tourist destination of Femundsmarka, Rogen and Långfjället (which is suggested in Paper IV) has some direct policy implications. While the opportunity spectrum and zoning approaches based on wilderness preferences have not been widely employed by the Swedish environmental administration, the results presented here both support and invalidate the existing management strategies. However, if future policy and management can more effectively take into consideration visitor diversity, it can be concluded that there is an economic gain lurking out there.

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Sammanfattning

I denna avhandling tillämpas betingad värdering (contingent valuation method, CVM) för att uppskatta ekonomiska värden av bevarandet av en hotad art, förändrade avstånd till rekreationsskogar samt en mer diversifierad förvaltning av ett område med fjällturism. Avhandlingen består av två delar: en introduktion till miljövärdering och miljöpolicy, samt fem vetenskapliga artiklar.

I den första artikeln uppskattas värdet av att bevara den utrotningshotade vitryggiga hackspetten (*Dendrocopos leucotos*) i Sverige. Eftersom inget positivt marginalvärde erhölls för en ökning av populationen antas arten i huvudsak representera ett existensvärde. Detta värde illustreras teoretiskt med hjälp av begreppet "minsta livskraftiga population".

Den andra artikeln bygger på en uppföljning till den första artikeln. Två enkäter sändes ut för att se om de individer som inte svarade på den ursprungliga enkäten skiljer sig från respondenterna avseende betalningsvilja. Inga sådana indikationer erhölls, och orsaken till att man inte svarade på enkäten hade för de flesta inget med enkätens utformning eller dess innehåll att göra.

I den tredje artikeln studeras svenskarnas avstånd mellan bostaden och närmaste rekreationsskog. Cirka hälften av respondenterna i studien föredrar ett kortare avstånd än vad de har idag. För att tillgodose önskemålen hos flertalet svenskar bör bostadsområden planeras inom gångavstånd (< 1 kilometer) från närmaste rekreationsskog.

I den fjärde artikeln kombineras en tänkt segmentering av turister i ett fjällområde med en studie av betalningsvilja. Segmenteringen baseras på besökarnas åsikter om bevarande och skötsel av vildmarksområden. Värdet av att införa en mer diversifierad förvaltning av fjällområdet uppskattas till cirka en miljon kronor.

I den femte artikeln analyseras valet mellan en skatt (avgift) och en kvantitativ reglering när marginalnyttan av att bevara en hotad art är känd medan kostnaden är okänd. Det bästa styrmedlet är att kvantitativt reglera ett bevarande av arten motsvarande den "minsta livskraftiga populationen". Om fel styrmedel används kan följden bli utrotning.

Acknowledgements

Writing a thesis is not a one-man show. Over the years many colleagues and friends have been helpful in several ways. First of all, Professor Leif Mattsson who supervised me during the final years of work. He has been a highly knowledgeable colleague and good friend throughout the process. The intellectual virtuosity of Professor Lars Emmelin, the sharp-sighted critics of Professor Sören Wibe and the mathematical knowledge of Professor Peter Lohmander have also contributed to the process in a very rewarding way. They have all served as supervisors during stages of this thesis.

Paper III was co-authored with Ph.D. candidate Lisa Hörnsten, Paper IV with Professor Lars Emmelin (again) and Paper V with Dr. Mattias Boman. They also deserve special thanks. Looking back, it is easy to see the advantages of co-operative work. I hope we can do more of this in the future.

Professor Chuan-Zhong Li provided excellent support in econometric matters. Lic. Dick Carlsson assisted in the data processing stage behind Papers I and V, and Ph.D. candidate Robert Pettersson helped to draw some of the maps.

Valuable comments about the different parts of this thesis were delivered by: Professor Tommy Andersson, Dr. Gustaf Aulén, Dr. Mattias Boman (again), Dr. Göran Bostedt, Lic. Ola Carlén, Dr. Peichen Gong, Professor Tom Heberlein, Dr. Per Holgén, Professor Bengt Kriström, Professor Chuan-Zhong Li (again), Dr. Anders Lindhagen, Professor Per Lundberg, and Ph.D. candidate Ulla Romild. Thanks! You all contributed to improvements of large and small matters.

But, there is no research without data. There are some people around who know what this means: Dr. Fredrik Klang (who got his Ph.D. faster than I), Carlotta Kämpe, Anna Gudmundsson, and Christine Lundberg. Wonder if someone has ever estimated the value of readily and responsible processed empirical data? Thank you for an excellent job.

Solveig Edin and Helen Stiegler helped with many practical matters, which makes life easier as a researcher at a university department.

Dr. Chris Hudson and Sacha Lategan checked my English.

Financial support for my work was obtained from the Swedish University of Agricultural Sciences (SLU) and the European Tourism Research Institute (ETOUR). This support is gratefully acknowledged. Parts of this work are also associated with the Mountain Mistra Program: Towards Harmony Between Humans and Nature in the Mountain Region, and the EU financed program: The Use of the Boreal Forest.

Many thanks also to my parents Lennart and Inger, my brother Björn, Anneli, and my grandmother Signe for always being supportive. Can you imagine, the long curvy road finally took me here.

At last, a special thought goes to my family. To Louise for always being by my side, to Hampus and to Clara. Dad will be home for supper now.