Amenities of Swedish Forests

Attitudes and Values Among Stakeholders

Johan Norman
Faculty of Forest Sciences
Southern Swedish Forest Research Centre
Alnarp

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Abstract

The forests of Sweden provide many amenities (e.g. timber, outdoor recreation and biodiversity) that contribute to the welfare of forest owners and other stakeholder groups in society. The amenities have characteristics of private and public goods. In this thesis, measures of attitudes and values towards different forest amenities were studied by means of mail surveys and existing literature.

In paper I, the attitudes of private forest owners regarding different forest amenities (timber production, outdoor recreation and biodiversity) were investigated and compared with the forest advisors' interpretation of the forest owners' attitudes. The survey was conducted in three regions of Sweden (South, Central and North). The results indicated that the timber production was the most important amenity to the private forest owners, followed by outdoor recreation and biodiversity. The forest officers' understanding of what was important to forest owners did not consistently coincide with the attitudes of the forest owners.

Other aspects of outdoor recreation and biodiversity among stakeholder groups of the Swedish public were studied in papers II, III and IV. In paper II, a travel cost analysis was used to estimate the recreational value of the forests in the southernmost part of Sweden (Skåne and Blekinge). An analysis was also conducted to determine how this value would be affected by a change in the share of broadleaves in the region. It was shown that maintaining or increasing the share of broadleaves would positively affect the recreational value. In paper III, outdoor recreation was studied using data on health measures of recreationists from three different mail surveys, (outdoor recreationists among the general Swedish public, forest recreationists in southern Sweden and hunters in Sweden). The results showed that outdoor recreation activities in all three categories were expected to have a positive impact on self-rated health. In paper IV, the value of attaining the national environmental objectives of Sweden, including the protection of forest land for biodiversity purposes, was studied using data from a contingent valuation survey. The value varied between different levels of forest land protection, and the benefits of protection outweighed the costs by a small margin. The values of amenities in a typical broadleaved and a coniferous stand during a rotation period were reviewed in paper V. The results suggested that most amenity values developed in a similar way during the rotation period in the two stands. This was true for all amenities except for berries. Considering recreational values in forest management is unlikely to affect the timing of harvesting decisions, while considering biodiversity values as part of forest management would tend to prolong the rotation age.

Keywords : amenities, attitudes, biodiversity, contingent valuation method, human health, mail surveys, outdoor recreation, travel cost method, valuation

Author's address: Johan Norman, SLU, Southern Swedish Forest Research Centre, P.O. Box 49, 230 53 Alnarp, Sweden
E-mail: Johan.Norman@ess.slu.se

Dedication

To myself for finally arriving at the finish line…

To my family who always supports me in everything I do.

The days a man spends fishing or spends hunting should not be deducted from the time that he's on earth. In other words, if I fish today, that should be added to the amount of time I get to live. That's the way I look at recreation. That's why I'll be a big conservation, environmental President, because I plan to fish and hunt as much as I possibly can.

George H.W. Bush, quoted in Los Angeles Times, 30 December 1988

Contents

List of Appended Papers

This thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

I Kindstrand, C., Norman, J., Boman, M. & Mattsson, L. (2008). Attitudes towards various forest functions: a comparison between private forest owners and forest officers. *Scandinavian Journal of Forest Research,* 23 133-136.

II Norman, J., Ellingson, L., Boman, M. & Mattsson, L. (2009). The value of forests for outdoor recreation in southern Sweden: Are broadleaved trees important? *Ecological Bulletins,* accepted.

III Norman, J., Annerstedt, M., Boman, M. & Mattsson, L. (2009). Influence of outdoor recreation on human health: Comparing three categories of Swedish recreationists. Manuscript submitted to *Scandinavian Journal of Forest Research*.

IV Boman, M., Norman, J., Kindstrand, C. & Mattsson, L. (2008). On the budget for national environmental objectives and the willingness to pay for protection of forest land. *Canadian Journal of Forest Research* 38(12), 40-51.

V Boman, M., Bredahl Jacobsen, J., Strange, N., Norman, J. & Mattsson, L. (2009). Forest amenity values and the rotation age decision: A Nordic perspective. *Ecological Bulletins,* accepted.

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Abbreviations

CVM	Contingent valuation method
EUR	European currency, Euro (for exchange rates, cf Table 1)
EQ-5D	The five dimensional health measure of EuroQol
EQVAS	The visual analogous scale component of the EQ-5D
Ha	Hectares (1 hectare=100*100 metres)
MBDC	Multiple Bounded Dichotomous Choice
SEEA	System of Integrated Environmental and Economic Accounting
SEK	Swedish currency (Krona, for exchange rates, cf Table 1)
SEPA	Swedish Environmental Protection Agency
SOU	Swedish Government Official Reports Series
TCM	Travel cost method
USD	US currency, American dollars (for exchange rates, cf Table 1)
VAS	Visual Analogous Scale
WTP	Willingness to pay

1 Introduction

1.1 Background on forests and forestry in Sweden

Few countries in Europe are covered with more forests than Sweden, where about 56% of the total land area is forest cover (Statistical Yearbook of Forestry, 2008). The forest cover differs geographically, from about 80% in the North to about 20% in the South. In terms of standing volume, the percentage composition of tree species in Sweden is as follows: Norway spruce 42%, Scots pine 38%, birch, aspen and alder 14%, 'noble' broadleaved species (oak, beech, elm, ash, maple, lime, hornbeam and cherry) 2%, other broadleaved species 1% and dead trees 3% (Statistical Yearbook of Forestry, 2008).

Sweden is divided by three vegetation zones: the boreal zone, the nemo-boreal zone and the nemoral zone. The northern parts of the country belong to the boreal zone, the middle and the southern parts to the nemo-boreal and the southernmost part to the nemoral zone (Swedish forest agency, 2009). Most of the 'noble' broadleaved species are not able to grow north of the nemo-boreal zone, reflecting differences in growing conditions between the North and the South (Almgren, 1986).

Half of the forest land in Sweden is owned by private forest owners, while 30% is owned by other private owners and companies, and the remaining 20% is owned by the state or state-owned companies (Statistical Yearbook of Forestry, 2008).

The utilisation of forests has a long tradition in Sweden. In the agrarian society during the 17th century, the forests were used for cattle grazing, hunting, and collecting e.g. berries and mushrooms (Hytönen, 1995). Wood was harvested for heating, cooking, house building, and fencing. In the 17th and 18th century, tar, potash and charcoal were important products from an economic perspective. With the development of the sawmill industry in the

middle of the 19th century, the demand for roundwood increased while other forest-related uses decreased (e.g. tar, potash and charcoal) (Kardell, 2004). Cattle grazing was the only long established use that continued into the 20th century (Stridsberg, 1984; Holmberg, 2005). At the end of the 19th century, the forests of Sweden were used by the sawmill industry to a large extent (Kardell, 2004; Ekelund & Hamilton, 2001).

The main purpose of Swedish forest policy has evolved during the last 100 years. As a result, this put an end to deforestation at the beginning of the 20th century. During the middle of the century, strategies developed to supply the forest industry with roundwood. Since the end of the 20th century, timber production and the consideration of nature conservation and other social interests have equal importance in regards to Swedish forest policy (Ekelund & Hamilton, 2001). Through silvicultural measures and conscious forests policies the current growing stock of wood is about 85% larger than it was in the 1920's (Skogsdata, 2008).

The objectives of the first Swedish Forestry Act of 1903 were the replacement of harvested forests by new forests and the attainment of an even harvesting level. The ensuing Forestry Acts of 1923 and 1948 focused on the importance of efficient timber production (Ekelund & Hamilton, 2001). The 1960's was a time of environmental movement in the western world. Rachel Carson's book, "Silent Spring" (1962) was a hallmark in the debate on environmental issues. Criticism of unsustainable and inadequate environmental practices in Swedish forestry influenced formulation of the groundbreaking forest policy in 1979 (Ekelund & Hamilton, 2001). The Swedish Forestry Act of 1979 stated: "Forest land with its forest should be managed by an appropriate use of the soil capacity of wood production so that it gives a lasting high and valuable production of wood. Management should consider nature conservation and other public interests" (Swedish Forestry Act, 1979). This was the first time uses other than timber production were mentioned in the Swedish Forestry Act. In 1993, during the most recent revision of the Act, the emphasis on multiple values of the forests was strengthened, giving the timber production objective and the environmental objective equal importance in forest policy (SOU, 2005). The 1993 revision stated: "The forest is a national asset that should be managed to yield high and sustainable revenue and at the same time preserve the biological diversity. Other public interests should also be considered in the management". This pointed out the consideration to the values of social functions, cultural heritage and aesthetic value of the forests (Skogsutredningen, 2004). The forest policy of 1993 was less regulative than the policy of 1979, giving forest owners more freedom in their forest

management. Greater freedom also meant greater responsibility for the forest owners, who now became important actors in the implementation of forest policy. More emphasis was therefore put on the exchange of information and knowledge between forest owners and forest officers in advisory positions at the Swedish Forest Agency (Appelstrand, 2007).

Although the term multiple-use forestry was introduced to the forestry community in the 1950's and 1960's, the historical overview in Sweden shows that using forests for multiple purposes has been common practice. Forest use has consequently changed its character throughout history, shifting from multiple-use to single-use, to a situation today where forestry again is more multiple-use oriented. Notably, current multiple-use forestry places a greater emphasis on sustainability and includes a different suite of uses than in the past (Stridsberg, 1984).

A pioneering contribution on the economics of multiple-use forestry was made by Gregory (1955), who stated: "Multiple use of land means using a particular land area to produce more than one good or service" (Gregory, 1955, p. 6). A broader view on the concept of multiple-use forestry can be found in Klemperer (1996) including: Many outputs from each forest acre; A mosaic of single uses on separate forest areas; Various forms of multiple-use; with smaller but highly intensive management areas; Management for a "dominant use" and all other compatible uses; Many uses over time. In a Swedish context, Andersson and Hultman (1980) outlined the concept of multiple- use forestry by classifying the different forest functions and values into the following eight categories: existence value, ecological stabilisation, timber production, forage production, source of knowledge, culture, environment for recreation and potential for the future. Thus, multiple-use forestry is a broad concept with a common denominator: the management of forest land for production of different amenities.

Two amenities that have received increasing attention in both policies and research in Sweden are outdoor recreation and biodiversity, which are described more extensively in the following sections.

1.1.1 Outdoor recreation

Organised outdoor recreation in Sweden began about 100 years ago, and at that time outdoor recreation was considered a part of public health, rearing teens and the national identity of Swedes (Sandell & Sörlin, 2008). The urbanisation process influenced the development of outdoor recreation (Hörnsten, 2000). The percentage of the population living in rural areas was 89% in 1860 and had decreased to 17% in 1990 (Ylander, 1993). The

breakthrough for outdoor recreation as a leisure activity began in the early 1930's when work time and holidays in Sweden was regulated (Sandell & Sörlin, 2008). The idea of outdoor recreation as a tool to improve the physical and mental health of people has existed for many years in Sweden (Sandell & Sörlin, 2008; Tegnér, 1936). Recent research has shown that spending time in natural environments may have a positive effect on human health (e.g. Stigsdotter, 2005; Ottosson, 2007; Stigsdotter, 2004; Grahn, 1997; Ottosson & Grahn, 2005). Many outdoor recreation activities could not have been possible without the Right of Public Access. This allows people to freely roam the countryside and put up camp for one night, regardless of land ownership. The fundamental responsibility that comes with enjoying The Right of Public Access is "do not disturb or destroy". It is a customary law that was listed in the Swedish constitution in 1994. The wording, Right of Public Access, can be traced back about 100 years, but the principles of the customary right are much older than that (SEPA, 2009a; Sandell & Sörlin, 2008). The Right of Public Access originates from a time in history when roads in Sweden were poor or non-existent which made travelling slow. The natural way to travel was through others' land and put up camp when necessary (Åslund, 2008). Today the Right of Public Access is an essential condition for many outdoor recreation and nature-based tourism activities in Sweden (Bergfors, 1990; Aronsson, 1997).

Forests play an important role for environments of outdoor recreation activities (Fredman et al., 2008) and timber production. Studies have shown that a recreational forest should be easy to access and cleared of objects like dead branches and windthrows (Lindhagen, 1996). Forestry operations that increase the openness and visibility in the forests will, generally, make the forest more attractive for recreational purposes (Jensen & Koch 1997; Jensen & Skovsgaard, 2009; Lindhagen, 1996). Therefore, forestry and outdoor recreation can be seen as competing as well as complimentary forest uses (e.g. Kardell (1985); Hultman (1983). Extensive consideration to biodiversity values might have negative consequences for outdoor recreation, due to limitations placed on accessibility. However, a priori consideration of these issues should enable the strategic location of forests to minimize the potential for conflict (Hörnsten, 2000). Another kind of conflict that is discussed in outdoor recreation research is the conflict that can occur between recreationists performing different activities, e.g. between off-road vehicles and hikers (Manning, 1999)

The risk for conflicts between uses and the possibilities for supplying suitable outdoor recreation land differ depending on the geographical location in Sweden. The demand for land suitable for outdoor recreation is,

in general, higher in the South compared to the North due to the higher population density in southern Sweden (SOU, 1999). Specifically, the area of land suitable for outdoor recreation (ha per 1000 inhabitants within 5 km outside the town border) declines from the northern to southern parts of Sweden. For example, Umeå (northern Sweden), Uppsala (middle Sweden) and Lund (southern Sweden) have 315 ha, 100 ha and 11 ha, respectively, of suitable outdoor recreation land per 1000 inhabitants (Ylander, 1993). Hörnsten and Fredman (2000) found that over 40% of the Swedish population would prefer to reduce the distance between their dwelling and the closest recreational forest. The preferred distance was that which could be easily walked (<1 kilometre).

Research in recent decades has shown that economic values of outdoor recreation can be substantial. The National Institute of Economic Research has estimated the total economic value of the Swedish forests derived from outdoor recreation to be around 20 billion SEK per year (SOU, 1999). In a study by Mattsson and Li (1993) the value of forests for outdoor recreation in Västerbotten county (northern Sweden) were found to be about half of the timber production value. Fredman and Emmelin (2001) found the value of a recreational experience in the mountainous area of Sweden to be just under 2 000 SEK per trip which exceeded the actual trip expenses. For an overview of Swedish and international valuation studies on recreation and other non-marketed forest amenities, see Wibe (1994), Sundberg & Söderqvist (2004), Lindhjem (2007) and Zandersen & Tol (2009). The value of the recreational experience has also been shown to be dependent on how forestry actions are carried out. Mattsson and Li (1994) showed that the recreational value of visiting a forest could be increased by using natural regeneration rather than artificial regeneration (resulting in less clear-cut areas). Bostedt and Mattsson (1995) found that recreational values were positively influenced by smaller clear-cuts even if the number of clear-cuts would increase. Both Mattsson and Li (1994) and Bostedt and Mattsson (1995) showed that increasing the proportion of broadleaved trees would increase the recreational value.

Studies in Denmark have shown that broadleaved forests in particular are desired and highly valued by recreationists (Jensen & Koch, 1997; Aakerlund, 2000). Earlier Swedish studies on forest recreational values (e.g. Bojö, 1985; Kriström, 1990; Mattsson & Li, 1993; Fredman & Emmelin, 2001) have mainly focused on northern Sweden. Therefore, the lack of knowledge about these values is more pronounced in southern Sweden than in the North. Since southern Sweden has many similarities with Denmark it is possible that the recreational values of the forests in this part of the

country could be substantial compared to more forested and less populated regions in Sweden (Boman & Mattsson, 2005; Holgén & Bostedt, 2004; Löf, 2001; Mattsson, 2008).

1.1.2 Biodiversity and nature conservation

Forest environments provide essential habitat for many plant and animal species, threatened or unthreatened. There are approximately 3 600 red-listed species in Sweden and half of them are connected to forest environments (Söderström, 2008; Gärdenfors, 2005), which suggests that nature conservation for forest biodiversity reasons is important. Many of the red-listed species are specifically connected to broadleaved forests (Berg et al., 1994). Extensive timber-oriented use of the Swedish forests has led to a loss of biodiversity (Uliczka, 2003). Broadleaved forests of southern Sweden are prioritised for protection because of their biodiversity value. The Swedish government has an international responsibility to protect this specific forest type (Anon, 2005).

Biodiversity (or biological diversity) can be described as the "totality of genes, species, and ecosystems of a region". This definition includes the three different levels where biodiversity can be observed (genetic, species and ecosystem diversity). The concept was first coined by Dasmann (1968) but introduced on a bigger scale by Lovejoy (1980).

To develop a structure for the environmental work and ensure sustainable development, the Swedish parliament, in 1999, decided on fifteen environmental objectives. A sixteenth objective, "A rich diversity of plant and animal life", was added in 2005. All these objectives should be fulfilled by different measures by 2020, except for the "Reduced climate impact" objective which should be attained by 2050 (Swedish Environmental Objectives Council, 2000). The Swedish Forest Agency interpreted the objective of "Sustainable forests" as: "The value of forests and forest land for biological production must be protected, at the same time as biological diversity and cultural heritage and recreational assets are safeguarded" (SEPA, 2009b).

To reach the interim target of protecting biodiversity, 900 000 hectares of forest land will be excluded from forestry operations during the time period 1999-2010. About half of this area is expected to be set aside voluntarily by forest owners and the other half by federal measures, in which case the Swedish state will compensate forest owners financially (SEPA, 2009b). The private forest owners and their attitudes towards biodiversity

values are therefore important for successfully reaching the interim target of protecting 900 000 ha of forest land.

Several strategies for nature conservation exist in Sweden, such as: national parks, nature reserves, nature conservation agreements and biotope protection, and general conservation consideration (carried out in connection with all forestry actions that are made). The strategies should supplement each other to protect biodiversity values. About 10 % of the total land area of Sweden is protected today (SEPA, 2006), but only about 3% of the productive forest land (Statistical Yearbook of Forestry, 2008).

1.2 Current multiple-use forestry issues

The view on multiple-use forestry has changed during the last century. The scope has widened from the production of private goods (e.g. timber) to also include public goods (e.g. environments for outdoor recreation and biodiversity). Major amenities produced by the forests today are: timber, berries, mushrooms, hunting game, recreation environments, local climate regulation, soil erosion reduction, pollutant reduction in the atmosphere, global climate regulation and habitats for wildlife (Gong, 2002). Managing all these amenities requires considerable amounts of information in order to make efficient decisions. This task is problematic when it comes to amenities whose value cannot be observed in the market. Specific valuation studies must, therefore, be conducted to determine the values of these amenities. The values on a national level of a range of marketed and non-marketed forest amenities in Sweden can be found in the environmental accounts for forests (2001). For example, outdoor recreation alone is estimated to have an annual value in parity with the value of timber production (Environmental accounts for forests, 2001). Balancing the production of these amenities is a challenging task because it requires knowledge on attitudes and values held by different stakeholders in society at different geographical levels (from national level to stand level).

Among the most important actors in a multiple-use context are the owners of the forests. The supply of different forest amenities is to a large extent determined by the decisions of the forest owner. It is therefore important to understand the relevance of different amenities to the forest owners, and how this relates to the interests of other stakeholder groups. Forest officers often serve as a link between forest owners and public interests, as they advise the forest owners on how to manage their forests in the best possible manner given the conditions on the property, the Forestry

Act, and current forest policies. Forest management requires knowledge of physical and biological production relationships and costs of producing different amenities. However, efficient provision of forest amenities also requires knowledge of less tangible values, and attitudes held by forest owners and other stakeholder groups in society. It is important to make values of non-marketed amenities like outdoor recreation and biodiversity tangible to decision makers so that these values are not overlooked when decisions are made regarding forest management. Furthermore, this will aid in our understanding of how these values are translated along the chain of forest owners to forest officers and finally to the public. The main scope of this thesis is to increase knowledge of these values along the chain of stakeholders.

1.3 Objectives of the thesis

The objectives of this thesis were to assess measures of attitudes and values towards different forest amenities (timber production, different aspects of outdoor recreation, and biodiversity) among stakeholder groups, and also to study how consideration of the production of multiple forest amenities would affect management decisions. The specific objectives were to:

- Study the attitudes of private forest owners regarding timber production, outdoor recreation and biodiversity, and compare these attitudes with how forest officers in advisory positions perceive them (paper I)

- Estimate values of outdoor recreation and biodiversity to the Swedish public, i.e.

  - Estimate economic values of forest-based outdoor recreation in southern Sweden, and study how broadleaved tree species influence this value (paper II).

  - Estimate the expected health effects of outdoor recreation activities (paper III).

  - Estimate the economic value of attaining general sustainability objectives, and forest biodiversity in particular (paper IV).

- Explore how the economic values of outdoor recreation, biodiversity and other non-timber amenities vary during a rotation period, and also how these values would affect management decisions for a typical coniferous stand and a typical broadleaved stand (paper V).

2 Theoretical considerations

The main theoretical foundation of this thesis lies within economics, with extensions to other social sciences. Economics is the social science that studies the production, distribution, and consumption of goods and services. The science of economics is about the management of scarce resources for the purpose of satisfying human needs, and the choices between different alternatives (Dolan & Lindsey, 1988). In the management of scarce resources, three important questions arise: what kind of goods/services should be produced, how should these goods/services be produced and how should they be distributed among individuals in society?

Section 2.1 relates to paper I as it briefly describes the attitudes as one determinant of behavioural intentions and behaviour. Section 2.2 connects to papers II-IV by its overview of behavior and behavioural intentions in terms of demand and willingness to pay for public goods. Section 2.3 concludes the theoretical considerations with a description of efficient multiple-use, which is the focus of paper V.

2.1 Attitudes, intentions and behaviour

The theory of reasoned action was founded in a social psychology context by Fishbein & Ajzen (1975). There are three major components in this theory: attitudes, subjective norms and behavioral intentions. The core of the Fishbein-Ajzen model is: "The totality of a person's belief serves as the informational base that ultimately determines his attitudes, intentions, and behavior" (Fishbein & Ajzen, 1975, p. 14)

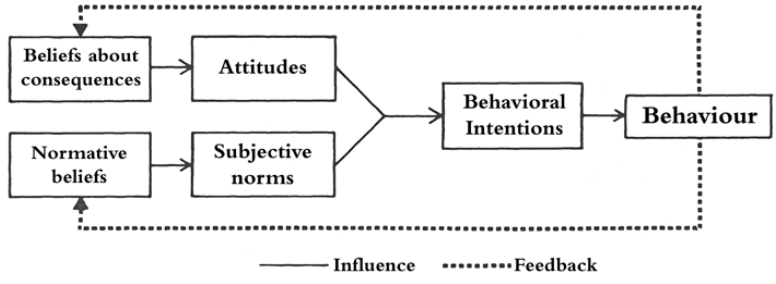

Figure 1. The Fishbein-Ajzen model (modified from Mitchell & Carson, 1989)

An attitude is a judgement of an object (e.g. good or bad) and this attitude is according to Fishbein and Ajzen formed by beliefs about this object. A belief is a judgement that links to concepts or attributes through information from earlier experiences (Mitchell & Carson, 1989). Beliefs can relate to the consequences of performing a specific behaviour. There are also normative beliefs formed by how a person thinks that one should behave according to the opinions of other people. The sum of normative beliefs held by a person forms the subjective norm. The behavioral intention is a judgement of whether to perform a certain behaviour or not and is a result of both attitudes and subjective norms. The behavioural intention will directly determine the behaviour. Beliefs, attitudes, subjective norms and intentions are all influenced by earlier experiences, so there is a feed-back function in this model (Fig. 1).

A basic idea in consumer theory is that individuals behave rationally and make choices that maximise their benefits and minimises their costs, i.e. the behavior of individuals are results of rational economic thinking and will form the demand for goods and services that is observed on the market.

2.2 Demand and supply

The first elementary assumption in consumer theory is that all individuals simultaneously are trying to maximize their utility (or satisfaction) with the resources they have available (e.g. income) (Varian, 1992). The choices (i.e. behaviour, cf Fig. 1) that consumers make according to their taste and budget constraints will form the demand for a certain good. The demand is derived from the principle of diminishing marginal utility which implies that

the larger the quantity of the good consumed, the lower the willingness to pay (WTP) for an additional unit of the good, i.e. the marginal WTP is decreasing with increasing consumption. The market demand curve is the sum of the quantity demanded of all individual consumers at each price level (Nicholson, 2002), cf Fig. 2. The gross value of a given quantity of the good is measured by the WTP of consumers for the good, exemplified by the area under the demand curve up to the quantity x. The net value (consumer surplus) of this quantity is estimated by analysing the difference between the WTP and the cost (Fig. 2). WTP for the quantity x is given by the areas a+b, where a is consumer surplus and b is costs (Brännlund & Kriström, 1998).

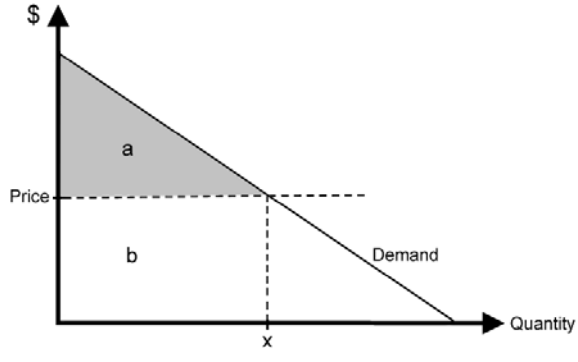

Figure 2. An illustration of the consumer surplus (shaded area).

Production is the conversion of inputs into outputs and this economic process uses resources to create a good or a service that can be traded in the market (Nicholson, 2002). The producers have to choose the quantity of the good to supply in the market. This is done given the market demand, the production costs and production possibilities for the good. The production function of the producer gives the maximum quantity of the good that can be produced given available inputs (e.g. labour). The producer is trying to maximise profits by finding the greatest difference between total revenues and total costs of production. The total cost function is determined by the input prices and the production function. The total costs for the producer will increase when the output level increases (Nicholson, 2002).

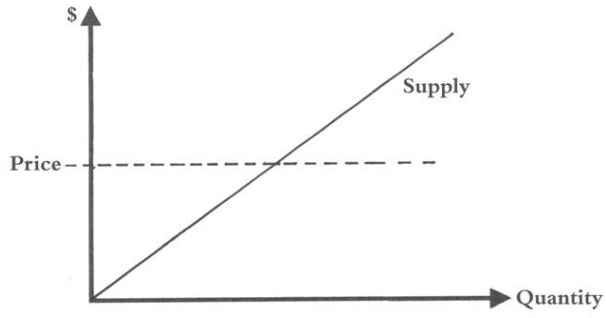

Figure 3. The supply curve.

The marginal cost is determined by the change in total costs for a change in the output level. Marginal revenue is the change in total revenue for a change in the output level. For a small firm, marginal revenue corresponds to the market price since this is the revenue that can be obtained for each unit of output. It can be shown that the profits of the firm are maximised when marginal revenue is equal to marginal cost (Nicholson, 2002). The marginal cost will give the optimal levels of supply given different output prices, known as the supply curve. It has a positive slope which means that the higher the market price, the larger the quantities supplied by the producer. Similar to demand, the market supply curve is the sum of the supply curves for all producers of the good (Fig. 3).

2.2.1 Private goods

Private goods are recognised by two main characteristics: they are excludable (consumers can be hindered from consuming the good, e.g. by property rights), and rival (the consumption of the good by one consumer reduces the possible consumption by another) (Varian, 1992). The general case of demand and supply (section 2.2) has considered private goods that can be traded in a competitive market, while the next section considers the opposite case, i.e. public goods.

2.2.2 Public goods

In contrast to private goods, pure public goods are recognized by being non-excludable and non-rival, meaning that nobody can be excluded from

consuming the good and that the consumption of the good by one person does not affect the possibilities for another to consume it (Nicholson, 2002). Public goods are not traded in competitive markets and they can, for example, include many types of environmental goods (e.g. biodiversity and outdoor recreation environments), and there could be problems for the supplier to provide the appropriate quantities of public goods in the market. Suppliers of public forest goods can be private forest owners and forest companies but also public entities like the state and municipalities that own forest land. The demand for a specific public good is usually not well known, but can be determined by different valuation techniques (Champ et al., 2003) (cf section 3.2). Surveys typically provide information regarding people's intention to pay for a public good (cf Fig. 1) and not the actual behaviour (Mitchell & Carson, 1989).

A main difference between public and private goods is how the market demand curve for the good is derived. In the public good case the individual marginal WTP's are added for each quantity to get the aggregate demand curve (since everyone can enjoy the same quantity of the good). This is in contrast to demand in the private good case, which was derived by summing demanded quantities at different prices. The optimal supply of the public good will occur when the aggregate marginal WTP for the good equals the marginal cost for producing the good.

A good does not need to have a price in a market to contribute to welfare; a demand for it is all that is needed. Since forest recreation environments are non-marketed goods, they have no visible price. Without sufficient information about the demand and the supply it is difficult to achieve efficiency in the allocation of such a good (Nicholson, 2002).

2.3 Efficient multiple-use

An efficient allocation of goods and services in a competitive market is reached when net benefits are maximised. Efficiency means that the resources are allocated in a way that no one can be made better off without someone else being made worse off (Varian, 1992). The point of intersection between the market demand and the market supply gives the equilibrium where the net benefits are maximised, because the marginal WTP equals the marginal cost of production (Varian, 1992; Nicholson, 2002). The price mechanism in a competitive market ensures this outcome (Fig 4).

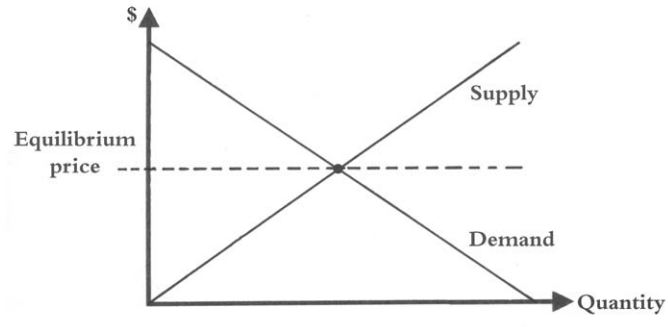

Figure 4. Market equilibrium.

Both consumers of private (e.g. buyers of wood products) and public (e.g. recreationists) goods, and producers of private and public goods (e.g. forest owners) must be considered in a multiple-use context. The theoretical review has illustrated that, in order to find an efficient multiple-use, one must know the values of the private and public (non-marketed) goods that are present (Bowes & Krutilla, 1989). If the values of the public goods are unknown there is a market failure, with inefficiency as a result. If the supplier of private and public goods (e.g. a forest owner supplying timber and outdoor recreation possibilities) is only aware of the demand curve for the private good and not aware of the demand for outdoor recreation, an efficient allocation will not be achieved. Achieving an efficient allocation of a public good often involves investigation of the demand for it and policy intervention (Baumol & Oats, 1988).

When considering multiple forest goods efficiency also requires awareness of the degree of inter-changeability between the different goods that the forest can produce (Saastamoinen, 1984), i.e. can the forest produce biodiversity and timber simultaneously, and what is the most efficient balance between the two? The harvesting decision (Faustmann, 1849) and thereby supply of timber is affected by the market price for timber, production costs (regeneration and management costs) and the production possibilities (forest growth). By his extension of Faustmann's original idea, Hartman (1976) analytically defined the optimum rotation age for a forest stand when including public goods in the management problem, by using outdoor recreation as an example for a public good.

3 Materials and Methods

This section contains descriptions of the data collection process that formed the empirical base for the analyses of papers I-IV. The results in paper V are not based on original data, but rather on a review of findings in existing literature. The basics of survey methods, economic valuation surveys and health surveys will also be presented in this section.

3.1 Data

The results in this thesis are largely based on data from five mail surveys that were conducted independently of each other. The surveys were designed for different purposes but all have a common underlying theme that is connected in this thesis. The decision of conducting mail surveys was made because large populations needed to be studied. The surveys were designed and carried out in cooperation with research colleagues at the Swedish University of Agricultural Sciences and at other Swedish universities. The questionnaires are found in appendices A-E, and the surveys are presented in Table 1.

Table 1. *Description of the surveys. The surveys are presented with their original Swedish titles translated into English.*

Survey titles	**A survey about private forest owners and their attitudes**	**The importance of forest nature in Skåne and Blekinge**	**Outdoor recreation and nature tourism in Sweden**	**A survey about game, hunting and forest**	**Our future environment, what do you think?**
	(Appendix A)	**(Appendix B)**	**(Appendix C)**	**(Appendix D)**	**(Appendix E)**
Year conducted	2002-2003	2006	2007-2008	2006	2002-2003
Sampled age interval (years)	18-74[a]	18-75	18-75	-[g]	18-75
Sample size	2 357[b]	3 000	4 700	2 500	600
Completed questionnaires	1 583	1 466	1 792	1 644	302
Response rate (%)	67[c]	49	38	66	50
Geographical distribution	Three regions of Sweden: north[d], middle[e] and south[f]	The counties of Skåne and Blekinge	Sweden	Sweden	Sweden
Target populations	Forest owners and forest officers	Residents of Skåne and Blekinge	Swedish residents	Registered hunters	Swedish residents
Investigated objectives of the thesis	Attitudes to timber production, outdoor recreation and biodiversity	Economic values of outdoor recreation + Health measures of outdoor recreation	Health measures of outdoor recreation	Health measures of outdoor recreation	Economic valuations of attaining the environmental objectives of Sweden
Exchange rate[h]:					
1 EUR=	9.1 SEK	9.3 SEK	9.4 SEK	9.3 SEK	9.1 SEK
1 USD=	8.9 SEK	7.4 SEK	6.7 SEK	7.4 SEK	8.9 SEK
Data used in paper no.	I	II, III	III	III	IV

Note:
[a] Sampled age interval of forest owners
[b] 2000 forest owners and 357 forest officers
[c] Average response rate. The response rate for forest owners was 65% and 77% for forest officers.
[d] North: the county of Västerbotten
[e] Middle: the counties of Södermanland, Västmanland, Uppsala and Stockholm
[f] South: the counties of Halland, Skåne and Blekinge
[g] A registered hunter can be 15 years old or older.
[h] Source: Central Bank of Sweden, 2009.

3.2 Surveying outdoor recreation and biodiversity

Surveys are a common way to gather data about, attitudes, preferences and behavioural intentions (values and demand). The decision on the survey technique to use is dependent on the research problem and the kind of data needed for the statistical analysis. Another important concern is the size of the budget for the survey, some methods are cheaper than others to use. Mail surveys and internet surveys are in general cheaper than interviews if larger amounts of data are needed (Dillman, 2007; Trost, 2007; Ejlertsson, 2005). Mail surveys always include a questionnaire to be filled in by respondents. Questionnaires are, according to McColl et al. (2001) "Structured schedules used to elicit predominantly quantitative information, by means of direct questions, from informants, either by self-completion or via interview".

There are several techniques of capturing data about the views, attitudes and valuations of respondents using questionnaires. The available question modes can be divided in two main groups: open-ended items (the respondent writes what he/she wants) and closed-ended items (presenting the respondent with alternatives, e.g. multiple choice or dichotomous choice). There are several measurement scales connected to different response formats, for example: ordinal scales (e.g. categorical responses that can be arranged in a certain order), nominal scales (qualitative categorical responses that cannot be ordered), rating scales (e.g. likert scales, different levels of agreement to a certain expression), ratio scales (e.g. visual analogue scales, VAS, i.e. a 0-100 "ruler" with clearly defined end-points) and interval scales (e.g. birth year). For a more extensive overview of survey methodology see Trost, 2007; Ejlertsson, 2005; Dillman, 2007; Rosengren & Arvidsson, 1997.

A widely accepted approach for conducting mail surveys is "the tailored design" by Dillman (2007). The five main elements in this approach are: 1. Design a respondent-friendly questionnaire (make it comprehensible and as short as possible), 2. Contact the respondent up to five times (including pre-notifying and reminding the respondent), 3. Use stamped return envelopes (free of charge for the respondent), 4. Try to personalise the contact with respondent and 5. Use financial incentives (if possible, not necessary). The surveys forming the empirical basis for this thesis are described in the next sections, as well as how the design issues were addressed in the different surveys.

3.2.1 Private forest owners and forest officers (I)

This survey focused on studying the views and attitudes of forest owners regarding the importance of their forests as a source for timber production, outdoor recreation and biodiversity. The attitudes were compared to how the forest officers perceived the attitudes of the owners. A mail survey was sent out to collect the empirical data needed for the study. The sample included 2000 forest owners and 357 forest officers in three different regions in Sweden (Table 1).

Likert scales were used in the questionnaire to elicit the importance of different forest amenities (timber production, outdoor recreation and biodiversity) up to now and in the future, respectively. For comparability, the same measurement scales were used for both the forest owners and forest officers. For comparability reasons the same type of scales were employed to find out what the forest officers believed was important for the forest owners. The data was analysed by calculating and comparing the percentage of respondents who had ticked different response alternatives. The analysis focused on the percentage of respondents who had ticked the response alternatives "Very important" (up to now) and "Much more important than up to now" (in the future). These percentages were then compared between forest owners and forest officers.

The survey was sent out in the autumn of 2002. The respondents had the option of filling it out the survey by mail or on the internet. The first mailing was followed by two reminders; the last reminder was accompanied by another copy of the questionnaire. The final response rate was 65% for the forest owners and 77 % for the forest officers, 2% of the respondents filled in the questionnaire on the internet. The questionnaires and the letters employed in this survey are in appendix A.

3.2.2 Stakeholders among the Swedish public (II, III, IV)

Outdoor recreation (II)

The main aim of this survey was to assess attitudes, habits and economic values of the general public in southern Sweden regarding forest-based outdoor recreation based on the Right of Public Access. A specific focus was to examine the recreational aspects of broadleaved forests in this region. The questionnaire contained questions regarding visiting frequency to nature in general and to forest-related nature, preferences regarding different types of forests, how the forest nature was experienced, what the purposes

and travel expenses of the visits were, various dimensions of their health status, and demographics.

A recreational experience based on the Right of Public Access is not traded in any market, which means that it does not have a market price. The recreational experience can be valued indirectly by using information from transactions of marketed goods or services that are made in connection with the recreational visit. The travel cost method (TCM) (Clawson & Knetsch, 1966; Ward & Beal, 2000) is an example of a method that is based on observing the costs in connection with travels to places with specific recreational qualities. The TCM approach in this survey was based on the individual travel costs of an average forest visit in the southernmost counties, Skåne and Blekinge. Recreational visits in travel cost data are often treated like non-negative integers and analysed in count data regression models (Creel & Loomis, 1990; Grogger & Carson, 1991, Hellerstein & Mendelsohn, 1993; Cameron & Trivedi, 1998; Champ et al., 2003). A demand curve for recreational visits is constructed from the estimations of the count data regression.

The design of the survey started in 2005 and the main survey was sent out in 2006 to a random sample of 3000 persons living in the counties of Skåne and Blekinge (in the southernmost part of Sweden) (Table 1). The distribution of the main survey was followed by four reminders. The response rate after the fourth reminder was 60%. The response rate in terms of completed questionnaires that could be used in statistical analyses was 49%. The questionnaire and the letters employed in this survey are in appendix B.

Health and outdoor recreation (III)

The effects on human health from outdoor recreation activities were studied in paper III. A comparison of recreationist categories was made by using data from three different mail surveys (Table 1 and appendices B, C and D). A common approach used in the surveys was to measure the self-rated health. The health measure was elicited by the EQVAS technique, which is a part of a "question set" called EQ-5D. EQ-5D is a commonly used method to measure health of large populations in Europe (Brooks, 1996; Räsänen et al., 2006). The visual analogue scale (VAS) in the EQVAS is appropriate to use in questionnaires and has been found to be user-friendly, easy to apply, valid and reliable (Brooks, 1996; Fernandez & Turk, 1992).

The respondents were asked about their current health state and their health state if there were no possibilities for the different types of outdoor

recreation activities. Both these measures were elicited by one VAS to each question. This scale was horizontal and graded from zero to hundred (with one hundred scale divisions), where zero represented the worst imaginable health state and one hundred represented the best imaginable health state. The health measures with and without outdoor recreation possibilities were then compared between the different categories of outdoor recreationists and between different age groups within the categories.

The survey on outdoor recreation in southern Sweden (appendix B) had a VAS component identical with the one that was included in paper III. Details of this survey are reported in the first paragraph under section 3.2.2.

The survey of outdoor recreation and nature tourism in Sweden was extensive. The main aim of the survey was to provide an empirical foundation for several different aspects of outdoor recreation in a bigger research programme. The questionnaire was sent out to 4 700 Swedes in 2007 (Table 1 and appendix C). The main survey was preceded by an information letter to the persons that had been chosen to participate in the survey. The main survey was followed by two reminders; consequently four contacts were taken with the respondents. The respondents were also given the possibility to answer the questionnaire on the Internet; this option was used by about 2% of the respondents. The response rate in terms of completed questionnaires was 38%. The questionnaire and the letters used in this survey are in appendix C.

The survey of Swedish hunters was aimed at the hunting season of 2005-2006. Specifically, the survey was designed to gain information about how the group of hunters was composed, and to investigate what the hunting activity and the game meant to different categories of hunters (Table 1 and appendix D). The survey contained questions about hunting habits and experiences, presence of game species, health status (the same VAS component as in the two previously described surveys) and demographics. The mailing of the main survey (directed to 2 500 hunters) was preceded by a notification letter to the persons that had been chosen to participate in the survey. The first mailing of the questionnaire was followed by two reminders. The number of returned questionnaires that were usable for analysis was 1 644, which corresponds to a final response rate of 66% (about four months after the first mailing). The questionnaire and the letters employed in this survey are in appendix D.

Biodiversity (IV)

The main focus of this survey was to find out the attitudes, preferences and valuations regarding policy relevant environmental issues in Sweden. The issues were in this case the 15 national environmental objectives decided by the Swedish parliament (Swedish Environmental Objectives Council, 2000). Marginal values were desired for a subset of these environmental objectives, formulated as five green indicators (greenhouse effect, acidification, urban air quality, eutrophication and biodiversity) (Anon., 1999). These green indicators were chosen for Sweden with respect to emission levels and the state of the environment, based on the Environmental Advisory Council and criteria laid out in the handbook Integrated Environmental and Economic Accounting (SEEA, 2003). The contingent valuation method (CVM) was used for value elicitation in this survey. This is one of the most common methods for valuing environmental amenities (Mitchell & Carson, 1989). CVM is based on giving the respondents direct questions connected to a hypothetical market with different scenarios. The respondent is asked to state his/her maximum willingness to pay (WTP) for the proposed scenario (or, when applicable, minimum willingness to accept).

The data was collected through a mail questionnaire survey that was conducted in 2002 (cf Table 1 and appendix E). A two-stage budgeting process was applied in the valuation scenario. All respondents were first asked about their WTP for attaining all the environmental objectives (the total environmental budget). This WTP was then disaggregated in four possible ways, depending on the survey version. In the first version, the respondents were asked to disaggregate the environmental budget on the green indicators. In each of the remaining three versions, respondents were asked to directly allocate a monetary share of the environmental budget towards a specified level of forest land protection. The proposed level of protection was different in each of the three versions. The WTP data was collected through a multiple bounded dichotomous choice (Welsh & Poe, 1998) question format that contained a range of bid amounts (a closed-ended format question with discrete choice response alternatives). There were eleven bids presented to the respondents: SEK 5, 10, 20, 50, 100, 150, 200, 300, 500, 1000 and "2500 or more". The respondents had the possibility to express their uncertainty connected to each bid in the question by ticking "Definitely Yes" (over "Probably Yes", "Uncertain", and "Probably No") to "Definitely No" at each amount. The payment vehicle was framed as monthly tax for the next ten years. A "spike" question (Kriström, 1997) was asked before each WTP question, in order to find out

whether the respondent was willing to pay anything at all for the proposed environmental change.

Experts at Statistics Sweden and the Swedish Environmental Protection Agency were consulted in the design of the CVM study, and the main survey was distributed by mail in 2002/2003 to a random sample of 600 Swedish citizens (Table 1). The total sample was divided into four different subsamples with 150 persons in each sample. Besides the valuation and budget questions the respondents were asked questions about their household characteristics. Of the 600 questionnaires sent out, 302 were returned completely or partially filled in. This share corresponds to a response rate of approximately 50%. The questionnaire and the letters employed in this survey are in appendix E.

3.3 Literature Review (V)

As was illustrated in the theoretical overview, information on the demand and supply of the forest amenities is needed to achieve the efficient multiple-use of a forest. In paper V, seven forest amenities (timber, outdoor recreation, game meat, berries, carbon, biodiversity and water) were incorporated in a qualitative analysis of the influence of non-timber benefits on the optimum rotation age of a forest stand. The amenity values occur jointly and are interlinked by their dependence on the age of the forest stand. The material consisted of 45 different literature references with emphasis on the Nordic countries that were studied to describe how production and marginal values of these amenities vary during a rotation period.

4 Results

4.1 Attitudes of private forest owners towards outdoor recreation and biodiversity (I)

In Sweden, privately owned forests provide timber as well as outdoor recreation opportunities and biodiversity. Forest officers from organisations, whose business is to serve private forest owners in accordance with the existing forest policy, often manage the forest owners' forests. Through survey data, paper I compared the attitudes of private forest owners towards various forest amenities to how forest officers understand these attitudes. The results showed that timber production was regarded as a very important forest function by the largest share of forest owners, followed by outdoor recreation and biodiversity. Timber production was considered as a very important forest function up to now by 35.4-39.9% of the forest owners (depending on region). A significantly larger share (62.1-73.2%) of the forest officers thought that timber production had been the most important forest function for the forest owners up to now. Considering outdoor recreation and biodiversity the share of forest owners that stated that these functions were very important were significantly larger than the corresponding share of forest officers. A small share (0.0-2.3%) of the forest officers estimated biodiversity to have been very important to the owners, while 9.7-15.8% of the forest owners considered it to have been very important. Recreational functions followed the same pattern; 1.1-1.8% of the forest officers estimated outdoor recreation to have been very important, while 21.9-28.3% of the forest owners regarded it to have been very important. A larger share of the forest owners in the South regarded biodiversity to have been very important, as compared to the forest owners in the North. No geographical differences were found regarding the importance of outdoor recreation.

Among forest owners in southern Sweden, the future importance of timber production was regarded as more important than forest officers believed. Considering the future importance of biodiversity and outdoor recreation there were no significant differences between the attitudes of forest owners and the views of forest officers.

4.2 Stakeholder values of outdoor recreation and biodiversity

4.2.1 Recreational values in southern Swedish forests (II)

Southern Sweden has less forested area per inhabitant than Sweden as a whole. The forests in the South are composed of a greater variety of tree species than forests in other parts of the country, especially with regard to broadleaved trees. The extent of 'noble' broadleaved forests (e.g. beech and oak) have been an object of competing interests for many decades. Paper II analysed the economic value of outdoor recreation in southern Swedish forests (Skåne and Blekinge), and whether this value is affected by the presence of broadleaved species. The analysis was made in two steps. First, a travel cost model was constructed to estimate the welfare economic benefits (consumer surplus) from an average forest visit. The consumer surplus from the travel cost model was then employed to calculate how the recreational value would change if the proportion of broadleaves would increase (double compared to the current situation) or decrease (half compared to the current situation).

The results from the travel cost model showed that the consumer surplus for an average forest visit in Skåne and Blekinge was 174 SEK. A variable for broadleaves was included in the travel cost model to study the effects on the consumer surplus derived from the visitors to the broadleaved forests. This variable provided weak evidence on the importance of broadleaves. Analysing the proposed scenarios with a hypothetical change in the area share of broadleaved forests in Skåne and Blekinge showed that the value of the recreational experience would be 23% higher (214 SEK) than the current value if the share of broadleaves would be doubled. The value of the visit would become 20% lower (139 SEK) if the share of broadleaves would be halved. Noteworthy is that almost half of the respondents thought that an increase of the share of broadleaves would not change the recreational value of the forest visit. The results were consistent with a diminishing marginal value of an increased percentage of broadleaved tree species (cf section 2.2).

4.2.2 Human health and outdoor recreation (III)

The concept of outdoor recreation involves a wide range of activities carried out in a variety of outdoor environments (e.g. forests, mountains, lakes/oceans, meadows, fields, beaches and gardens). The connection between good health and outdoor recreation received attention decades ago in Sweden (Sandell & Sörlin, 2008). In paper III, health effects from outdoor recreation activities were investigated for three categories of outdoor recreationists in Sweden. Comparisons were also made between age groups within and between the different categories. Data was obtained from three different mail surveys concerning various kinds of outdoor recreation activities in Sweden (Table 1). The influence of outdoor recreation on health was measured by comparing self-rated health in the current situation with a hypothetical situation where the possibility for outdoor recreation was removed. The surveyed hunters reported a significantly higher average score of the current health than the other two recreationist categories. The hypothetical scenario with a removal of the outdoor recreation possibilities had a significantly negative effect on self-rated health for all three categories. The relationship between the three recreationist categories was the same as in the baseline health state. Among the recreationist categories, the hunters had the best health without their outdoor recreation, followed by the other two categories, all three significantly different from each other.

The expected health effects differed between some age groups of recreationists, both within and between the three investigated samples. The older age groups (60+) of outdoor recreationists in Sweden and hunters expected a smaller effect than the younger age groups in the corresponding categories. No significant differences in health state change between age groups were found among the forest recreationists in southern Sweden. Comparing age groups across recreationist categories, the largest expected health effect was found in the age group 30-39 among recreationists in Sweden, and the smallest expected health effect was found among hunters that were 70 years old or older.

4.2.3 Biodiversity values of protecting forest land (IV)

A number of national environmental objectives were decided by the Swedish parliament in 1999, and the purpose of the study in paper IV was to estimate the willingness to pay of the Swedish public to attain these objectives. Based on a contingent valuation study, the average environmental budget was estimated, and then disaggregated on specific green indicators.

The green indicator for protection of forest land for biodiversity purposes was assigned an average budget share of 16.6% of the respondents' total environmental budget. That would correspond to a mean WTP of 22.6 SEK per person per month if using the mean estimated environmental budget of 136 SEK. That estimate also included respondents (16%) who were not willing to pay anything at all for the protection of forest land.

The average allocated budget share for the biodiversity alternative corresponded well to the marginal willingness to pay in the survey versions where the respondents were presented with a specific scenario for forest land protection. A marginal WTP estimate of 22 SEK was in line with both the estimate from the budget share question (22.6 SEK) and the estimate of the marginal WTP (21.5 SEK). Using the estimate of 22 SEK resulted in an annual WTP for protection of forest land of 264 SEK per person. Applying this estimate on the 6.3 million Swedes that were in the sampled age interval resulted in an aggregated WTP of about 1 661 million SEK per year. According to the Swedish Environmental Council (Anon., 2004), the budget assigned for the protection of forest land until 2010 is about 1 516 million SEK. This means that the estimated benefits of the project in paper IV would outweigh the costs by approximately 10%.

4.3 Management of multiple forest amenities (V)

A welfare maximising solution for a complex multiple-use problem poses challenging information requirements. Based on existing research, paper V addressed the harvesting decision by a land owner who considers non-timber services as well as timber production in the management of a single stand. Production relationships and shadow values were investigated for the non-timber services.

The incorporated amenities in paper V were: the commercial value of timber production, the composite recreational value (including outdoor recreation based on the Right of Public Access as well as hunting), the biomass value of berries, the biomass value of game meat, the value of sequestered carbon, the value of biodiversity, and the value of water supply. All these amenities were studied with respect to the production and value growth in different stand ages of the forest. Two different cases were constructed to represent plausible forest management scenarios in a Nordic context: a Norway spruce forest and a beech forest. The results from the literature review were used to qualitatively describe marginal changes in the amenity values over time. The results showed that the changes in amenity

values over time were quite similar for the beech and the spruce case (except for berries). Recreational values had a similar development over time as was the case for timber values. Considering recreational values would, therefore, result in a similar rotation age as for timber production alone. Carbon sequestration was increasing throughout the rotation time, and so was biodiversity from when the stand was middle aged and onwards. Considering these amenity values would prolong the rotation age of the forest (compared to timber production).

5 Discussion

Managing the production of multiple forest amenities is a complex task, both for state organisations, firms and non-industrial private forest owners. The different amenities produced by the Swedish forests are stressed in several Swedish policy documents and legislations. The Swedish Forestry Act states that "The forest is a national asset that should be managed to yield high and sustainable revenue and at the same time preserve the biological diversity. Other public interests should also be considered in the management", emphasising the consideration of the variety of amenities that can be produced. In the environmental objective "Sustainable forests" it is stated that the "possibilities for cooperation between ecological values and other values such as cultural values, recreational values and reindeer herding" (Statskontoret, 2007) should be considered. The ambitions reach even further in the most recent investigation of the Swedish forest policy. A revision of the Swedish Forestry Act is suggested so as to also include consideration of the welfare contributions from the forest and the amenities that it can produce, including public health aspects connected to outdoor recreation (SOU, 2006). The forests that produce this variety of amenities are to a large extent privately owned (~50%) and primarily managed for timber production. The timber produced by these forests is sold at a market price. There are no market prices reflecting forest values like environments for outdoor recreation and biodiversity. The non-marketed amenities of the forests could be impoverished by the absence of a well-functioning market, as they may be implicitly undervalued in decision-making processes. In recent years, there has been a trend among Swedish forest owners towards greater interest in environmental issues (Ingemarsson, 2004). This is also reflected in paper I where the attitudes of Swedish forest owners were studied to see how they considered the importance of different amenities (timber production, outdoor recreation and biodiversity) produced in their

forests. Not surprisingly, timber was still considered as the most important amenity, but outdoor recreation and biodiversity were also considered as very important by a large share of the forest owners. Interestingly, the forest officers underestimated the importance of outdoor recreation and biodiversity to the forest owners. This suggests that there might be a communication gap between forest owners and the people advising them on their forest management issues. The Swedish Forest Agency has not observed any improvement of the general environmental consideration during the last 10 years. According to the agency this may depend on problems with communicating the forest policy from the advisors to the forest owners (Lindberg & Möller, 2008). The results of paper I provided some support for such a conclusion. This might have implications for how forest owners react to existing and new forest policies if communication problems between owners and forest officers are present.

To determine a welfare enhancing provision of public forest amenities, it is important for forest managers to gain knowledge about the demand for these amenities. Forest owners in southern Sweden might face a high public demand for outdoor recreation because of high population density and degree of urbanisation in this region (SOU, 1999). The benefits of (and demand for) forest-based outdoor recreation in southern Sweden were addressed in paper II. The results indicated that the aggregate benefits derived from outdoor recreation were substantial. The recreational benefits (per forest visit) were about three times higher than comparable results for northern Sweden (county of Västerbotten) (Mattsson & Li, 1993). The influence of the share of broadleaved tree species on the recreational benefits was also studied, since it is a relevant forest policy issue in this region of Sweden, where the Forest Agency has a regional policy objective to increase the share of broadleaves on landscape level (Swedish Forest Agency, 2003). The results indicated a 23% increase of the recreational value if the share of broadleaved forest would increase to double the current area. The question is if the increase of the recreational benefits from more broadleaved forests are substantial enough to offset the costs of a change in the forest management to more broadleaved forests at the expense of coniferous forests. It could also be difficult to estimate the aggregate recreational benefits of such a project due to the lack of information on visiting frequencies for the majority of the forests in this region. The results in paper II were based on a travel cost analysis where the data was collected through a mail survey. An alternative way to conduct a travel cost study is to sample visitors at one or several recreational sites. Since recreational benefits in the whole region (the counties of Skåne and Blekinge) were of interest, it was

not a realistic option to conduct on-site sampling in all forests in this region. A larger share of the less frequent forest visitors and non-visitors could be reached by conducting a mail survey (off-site) instead of on-site sampling (Ward & Beal, 2000).

There could also be indirect benefits induced by outdoor recreation activities such as improvements of public health. It is stated as an important aspect from a welfare perspective in the latest investigation of the Swedish forest policy (SOU, 2006). The potential health effects connected to outdoor recreation activities were addressed in paper III and the results indicated that many people expected that their health would worsen if they were deprived of their outdoor recreation opportunities. These results were in accordance with a survey conducted by the Swedish Forest Agency (2005) where it was found that only 4% of the general public thought the forest did not have any influence on their quality of life. These results highlighted the importance of considering the natural environments (that can be utilized on the basis of the Right of Public Access) as potential cost saving instruments in the public health sector. It is however a challenging task to further study the relationship between outdoor recreation activities and health.

Protection of biodiversity has been an important forestry issue in Sweden for several decades, which is reflected in official policies. For example, SEPA (2009b) stated that: "People must have access to a good natural and cultural environment rich in biological diversity, as a basis for health, quality of life and well-being". This statement is part of the recently added national environmental objective "A rich diversity of plant and animal life". This is one of the objectives dealing with preserving biodiversity in Sweden. The interim target for the objective "Sustainable forests" is to set aside 900 000 ha of forest land to preserve biodiversity values. According to the Swedish Environmental Council (Anon., 2004) the costs for attaining this objective would require an estimated 1 516 million SEK per year until the year 2010. The benefit side should also be investigated to examine whether this investment is profitable from a societal point of view. The aggregate benefit of attaining this objective was addressed in paper IV where the Swedish public's valuation of reaching the national environmental objectives was studied. The willingness to pay estimates indicated that the benefits of attaining the objective outweighed the costs by a small margin. Results from valuation studies can provide valuable information for environmental policy-making processes (Pouta, 2003). Unlike travel cost studies, CVM studies like the one in paper IV can shed light on values that are not related to any direct use of the resource, such as the value of species existence

(Champ et al., 2003). Results from CVM studies are affected by how the valuation scenario is presented and interpreted by the respondents. This implies that the results should be used carefully outside of the original context, since conditions that apply in e.g. Sweden (as a whole) may not apply in other countries (or parts of Sweden).

Production of different amenities on the same forest land can be conflicting, as well as complementary (Gong, 2002). This issue was addressed in paper V which studied the production of several forest amenities in two typical Nordic forest stands, a beech and a spruce stand. The results showed that the rotation could either be shortened or prolonged, depending on which amenities were simultaneously considered. This raises the important question of which amenities should be produced in the same stand and which should be separated, in space or in time (Andersson, 2002). Swedish environmental policies and legislations stress the consideration of a variety of forest amenities in forest management. These considerations can, however, be difficult to carry out without sufficient information about the stakeholders' preferences at different demographical and geographical scales. Studies on attitudes, preferences and values are therefore needed to assess information about the demand for public amenities. These values can often be substantial and there is a risk that public amenities will be undersupplied if not explicitly valued. Measurement of attitudes, preferences and values are of limited relevance if they are not put into the wider framework of forest policy decisions and forest management planning.

First and foremost, the findings in this thesis have contributed to knowledge regarding attitudes and values of non-marketed amenities produced in the Swedish forests. These results have implications for how private and public land is managed to meet the demands of private and public stakeholders. In order to make efficient management decisions in a multiple-use context, further research is needed regarding the variety of benefits generated by the Swedish forests.

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Johan Norman, October 2009

Appendices

Appendices A-E are not attached in paper format in this thesis. The appendices are available as pdf-files via the link below.

http://diss-epsilon.slu.se/archive/00002116/

Appendix A
- A survey about private forest owners and their attitudes

Appendix B
- A survey about the importance of forest nature in Skåne and Blekinge

Appendix C
- A survey about outdoor recreation and nature tourism in Sweden

Appendix D
- A survey about game, hunting and forest

Appendix E
- Our future environment, what do you think?

All appendices (A-E)