Review of benefit transfer studies in the forest context

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1. Abstract

Non-timber benefits (NTBs) are increasingly being compared with timber values in the crafting of multifunctional forest policies. Since most NTBs are non-marketable goods, special valuation methods are developed for their evaluation. Due to cost and time requirements, it is neither feasible nor desirable to conduct primary valuation studies in each policy relevant case. As an alternative, the benefit transfer (BT) approach is used to transfer benefits estimated by previous studies in a similar context to the policy context of interest. We take stock of the growing literature applying BT techniques for NTBs, to answer two main questions: How have BT methods been used to date in the forest context? What are the main lessons from NTBs transfers? We found 12 studies dealing with BT between forest sites and a few others in which forest sites were among other analyzed environmental resources. The majority of them transferred recreation benefits using the BT function based either on contingent valuation or travel costs estimations. They mainly focused on four areas: physical attributes of forests, time aspects, methodological improvements to increase the estimated accuracy and reduce surveys costs. Our results get closer to answering the question of "how and under what circumstances can NTBs be reliably transferred?"

Key words: non-timber benefits, benefit transfer, forest

2. Introduction

An important part of the environmental economics profession is to value environmental goods in monetary terms, i.e. estimate how much people are willing to give up of other goods and services they consume in exchange for a better natural environment. The rationale is to make the benefits of a better environment transparent and comparable with other costs and benefits in private and public decision-making that typically have market values, such as timber, working hours, harvesting machines etc. In forest management, values of so called non-timber benefits (NTBs) have increasingly been recognized as an important decision-making support in developing multi-functional forest policies that gradually shift the emphasis from traditional timber values to a broader spectrum of societal benefits from forests (Cubbage et al. 2007). The use of such values in policy-making is already common in the USA (e.g. by the US Forest Service), and is becoming so in Europe. Increased use is fed by demand from public agencies as well as growing academic interest. However, conducting new, expensive and time consuming primary studies to value NTBs in each policy relevant case may not be feasible or even desirable. Therefore, many practical applications by different public agencies and consultancies use information about values from existing studies and transfer to unstudied, similar sites of policy interest. This is called "benefit transfer" (BT), or more generally "value transfer". A parallel literature in environmental economics has developed to investigate the validity and reliability of different BT methods, starting from the early 1990s. Common areas where BT is used and studied are for health benefits (e.g. value of statistical life), water quality and recreation benefits. The use of BT methods in the forest context originated more recently, but has also been seen as a potentially useful tool for decision-making. The topic is also of growing academic interest, as it is sometimes questioned whether BT can be reliable for more complex and site-specific goods, such as forests. The aim of this paper is to take stock of the BT literature in the forest context, and to investigate two main research questions: (1) How have BT methods been used to date for non-timber benefits?; and (2) What are main challenges and lessons learned from transferring non-timber benefits to date? To answer these two questions we first give a brief overview in the next section of classifications of forest functions and economic values, and types of primary valuation methods. In section four, we explain the types of BT methods in use, while we review the BT literature in section five. Section six attempts to distill some of the main experiences and challenges in using BT in the forest context. The conclusion suggests key areas of future research and gives an assessment of the circumstances (if any) under which NTBs can be reliably transferred.

3. Forest functions and values

Forest ecosystems generate a wide range of goods and services, in addition to timber. Broadly defined, these forest functions are the benefits people obtain from forests (Barbier and Heal, 2006, Pearce, 2001). Many classifications of them have been used at times at different geographical levels: regional, national and international.[1] We follow the division suggested by Navrud and Brouwer (2007) and distinguish, apart from timber production, four other main forest functions: recreation, non-timber commercial products, ecosystem services, and non-use values of forests (Figure 1.). We call them non-timber benefits (NTB).

[1] For example: Costanza et al. (1997) and De Groot et al. (2002) propose a classification of ecosystem functions, and summarize ecosystem services into no less than 23 major categories that are all relevant to forest ecosystems.

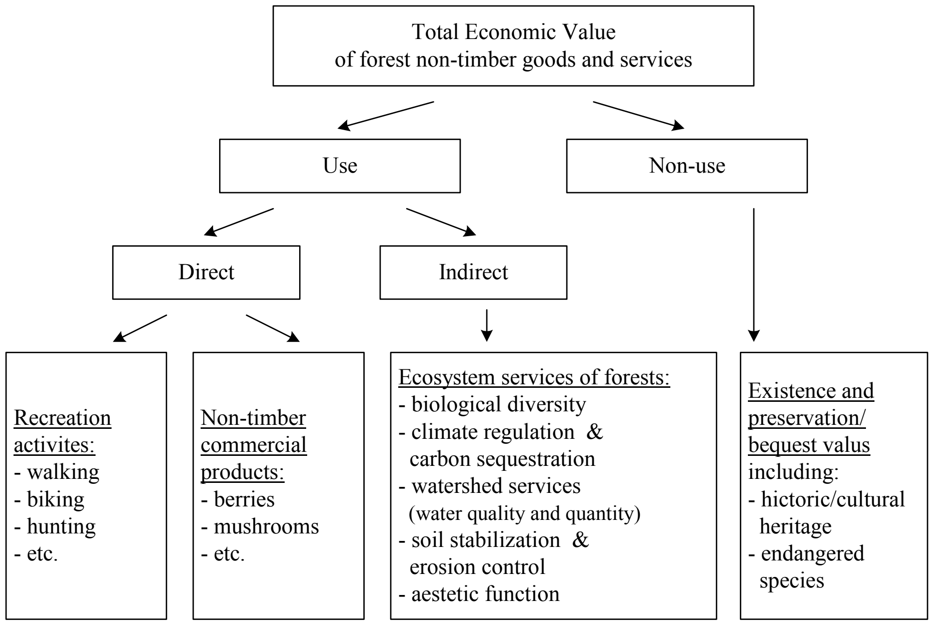

Figure 1. Total economic value of forest non-timber goods and services.
Source: Adapted from: Navrud and Brouwer, 2007.

There could be different interactions between particular forest functions such as complementarity (for example it could be a case between aesthetic function and recreation) or excludability (forest production vs. ecological diversity). In the case of complementarity, it is a difficult task to analyze functions separately and sometimes a more general approach is needed. Some of the functions are hard to define in a unique and general way, since usually it varies depending on sites.

With forest functions, different economic values could be related. It depends on the way individuals may benefit from them. The main distinction is between “use” and “non-use” (passive use) values. Use values relate to actual, planned or possible use. These use values put together direct and indirect forest values, indirect values being more associated to forest services, like ecosystem services. An example of actual use is a visit to a forest site for recreation. The non-use value refers to the willingness to pay to maintain some good in existence even though there is no actual, planned or possible use (Bateman et al., 2002). This subset can be divided into existence, altruistic and bequest values. Existence value expresses the case where the value has no use to anybody. Altruistic and bequest values arise when the individual is concerned about preserving this good for others (not for her/himself). In the case of forests the example illustrating the non-use value could be the preservation of endangered species.

While several goods such as timber have market prices, or are at least partially traded in markets (such as berries or mushrooms), for most of the forest services mentioned in Figure 1 such markets do not exist. The latter group we call non-market goods and services (NMG&S). Since prices cannot reflect the benefits they provide to society, there are other methods to estimate their values.

Capturing these values is possible using economic valuation methods. Two main groups of valuation techniques have been used in the forest context. The first includes methods based on revealed preferences (RP) such as the travel cost method (TCM) and the hedonic price method (HPM). The second group is based on stated preferences (SP), and includes the contingent valuation method (CVM) and Choice Modeling (CM).

RP methods derive a measure of consumer surplus (CS) based on existing markets and demand curves of some private goods. When expenditures on a private good vary with levels of environmental amenities, under certain conditions a value of the environmental amenity can be derived (Young, 2004). SP methods use constructed/hypothetical markets. Based on specially prepared questionnaires, it is possible to obtain in a direct way the respondents' willingness to pay (WTP) for non-market goods and services. Shrestha and Loomis (2002) state that because SP and RP estimations are derived from differently constructed demand functions

(CVM is based on the Hicksian demand function, whereas TCM is based on the Marshallian function), SP measures would be larger than RP even when there is no measurement error.

Whereas the application of RP methods is restricted to particular forest functions connected with use values (TCM for recreation, HPM for e.g. aesthetic functions), the SP methods have no such limitations. SP methods can estimate both use and non-use values related to a variety of functions. What is in general valued by those methods are environmental changes (in quality or quantity) but not total economics values.[2]

Studies that are designed and carried out for selected forest sites which use either RP or SP methods we call primary studies. Many primary studies exist on recreation, biodiversity, watershed benefits or climate benefits. There are several literature reviews on the use of environmental valuation in forestry (Bishop, 1999, Holmes and Boyle, 2003, Pearce, 2001a, b). However, the majority of valuation studies concentrate on just one forest function – forest recreation. Much of the literature is recorded in environmental databases such as EVRI (Environmental Valuation Reference Inventory), ENVALUE, RED and Ecosystem Services Database. There are also a few which deal only with forest NMG&S, mostly on the national level (France, Germany, Austria, Switzerland and Italy). The majority of studies have been carried out in Western Europe and North America, though primary research in developing countries is growing fast. Given the large and growing body of valuation research, a separate discipline has developed

[2] In the past there were attempts to value total economic values of environmental services (for example Costanza et al. 1997), but this approach has been criticized and is not useful for Cost-Benefit Analysis which is typically related to environmental changes from proposed policies. One of the main points of critics is that to value (marginal) changes it is possible to assume that supply and prices of other goods are constant. For large changes and totals, such assumptions generally do not hold. However in some forest planning calculations, the total economic value of sites is present, for example in cases of afforestation projects or clearing of whole sites to give space for investment.

within environmental economics using existing information in new contexts – or so-called benefit transfer (BT), which we turn to next.

4. Benefit transfer in the forest context

Benefit transfer (BT) uses existing values as an approximation for a new study. The specific site from which information or data are derived is typically called the "study" site, while the site to which they are transferred is called the "policy" site.[3] The two main advantages of performing BT instead of conducting new valuation studies are the lower cost and the shorter estimation time. This is why BT techniques are of great interest to practitioners and have contributed to rapid growth of BT applications over the last two decades. However, the use of BT introduces additional uncertainty about welfare estimations to the level already present in primary valuation results. Because of this, BT is regarded as a "second-best" strategy, compared to primary valuation surveys conducted to address valuation needs for specific resources and policies in terms of space, specific target population and time.

In an economic theory framework, for the two populations of the study and policy sites to have the same utility derived from increased provision of an environmental good, it requires the same form of utility functions,[4] prices (of market goods), income levels, and vectors describing both the change in environmental qualities/quantities and the environmental situation before and after the change. In the indirect utility function, individual's A and B willingness to pay (WTP) for a change in forest quality/quantity can be presented in equations (1) and (2), which are equal if equation (3) is true:[5]

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[3] There are also possibilities to transfer values regarding a particular policy (for example – national preservation policy of X% of forests) that may or may not be related to specific sites. We use the terms "study" and "policy" sites for the sake of simplicity.

[4] Which are typically assumed to be constant over time (or to vary with time in the same way) for both. In practice, individuals' preferences are typically not stable over longer periods (depending for example on cultural changes or technological developments).

[5] This follows the standard neoclassical environmental economics approach.

(1) $V^A(p, I, Q_o) = V^A(p, I - WTP, Q_1)$

(2) $V^B(p, I, Q_o) = V^B(p, I - WTP, Q_1)$

(3) $V^A(p, I - WTP, Q_1) = V^B(p, I - WTP, Q_1)$

where: p – vector of prices of goods and services, I – the individual's income, Q – vector describing forest quality/quantity, indices: 0, 1 – before and after changes, respectively.

For forests the Q in the indirect utility function is quite difficult to specify, but several dimensions of forest characteristics may be important (see Figure 2.). Which forest attributes influence individuals' utility function, and their WTP or CS, are not fully understood. Matthews et al. (2007) claim that, for example, in the forest recreation context, WTP may plausibly be related to measurements of site quality, forest size and other attributes, such as the percentage of woodland area covered by broadleaf trees; but in fact, there have not been many data collection exercises that allow the pooling of data across a sufficiently large number of sites to safely establish such a relationship.

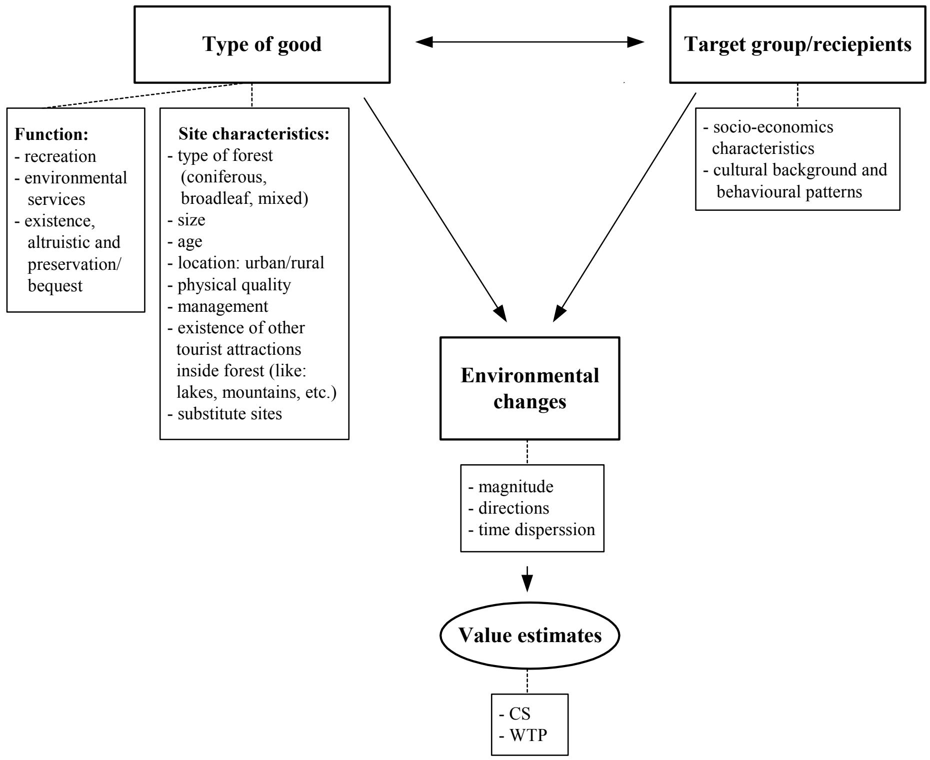

Figure 2. Valuation elements in the forest context.

Depending on the exact aim and the utilization of a BT application we can deal with an evaluation of the change in quality or quantity of: (a) a particular forest service/good, (b) a particular value, e.g. a non-use value or (c) a set of functions and values, when a complex policy scenario is presented. The latter case could be depicted by a scenario describing an increase in the natural protection system, where respondents can value either biological diversity or improvement in recreation due to more interesting surroundings or endangered species or other factors.

Economic theory has developed a number of BT approaches that try to adjust values for the differences that typically exist in practice between study and policy sites. Therefore, in some of these approaches the requirement of similarities can be relaxed if we have sufficient data from several sites or studies allowing us to adjust for existing differences between "study" and "policy" sites.

BT approaches can be divided into two main groups: unit value transfer (UVT) and benefit function transfer (BFT). Unit value transfers can be divided into: naïve (unadjusted) and adjusted benefit transfers (see Table 1). The naïve unit transfer is simply a single point estimate transfer which could be based on one or more valuation surveys (in the former case we can pick a study of the most similar site following "expert judgment"). The term "adjusted" is usually used to describe income adjustment. When transferring a point estimate from study site to policy site, it is assumed or implied that the two sites are identical across the various factors that determine the level of benefits derived from environmental goods or services. With a range of values from several studies the central tendency (mean, median) is typically transferred to the policy site. In the case of an average value transfer, it is assumed that the benefits of the policy site are around the mid-level of benefits measured for the study sites incorporated into the average value calculation (Rosenberg and Loomis, 2001). Yet there is an assumption that, apart from the income level, the analyzed populations do not vary in terms of other characteristics. In forest BT literature, however, there are attempts to apply another means of adjustment - site-adjustment (i.e. adjusting for the differences in forest attributes between sites (Matthews et al. 2007, Scarpa et al. in Navrud and Ready, 2007).

Table 1. Unit value transfer approaches.

Unit value transfer	
Naïve $WTP_p = WTP_s$	Income adjusted $WTP_s = WTP_s\ (Y_p/Y_s)^{\beta}$

Where: WTP – willingness to pay, s – the study site, p – the policy site, Y – income level and β - income elasticity of demand for the non-market commodity evaluated.

A more technically advanced approach instead of transferring just unit values is to transfer entire functions allowing the use of more of the information at the policy site (i.e. in addition to income at the policy site, other socio-economic characteristics describing population may also be plugged into the function). In this case we can distinguish three subcategories. The first category is the benefit or demand[6] function transfer from a single site (for an example of BTF based on SP see Table 2.). In this case, unlike UVT, more information is taken into account in the transfer. The first step in an implementation of the BFT approach is to find a study which reports the regression function for a welfare estimate (information about parameters). To calculate benefits at the policy site, the information about parameters from the "study" site should be combined with data from the "policy" site such as a set of environmental characteristic of the place including information of substitutes and population characteristics. In the case of the demand function transfer, not welfare estimates, but number of visits to the site from TCM models are transferred, and based on that, CS is calculated. The main problem with this method arises from using estimates just from a single site, as this leads to omissions of some possibly important variables due to the lack of variation.

The second method – a meta analysis (MA) function – is based on several studies, where the result from each study (i.e. mean WTP) is treated as a single observation in a regression analysis. This allows an estimate of the statistical relationships between values reported in primary studies to explanatory variables capturing heterogeneity within and across studies (e.g.

[6] In some cases, when the TC method is used in the primary study.

differences in value construct measure, populations and methodology within and across studies) (Bergstrom and Taylor, 2006). In general the MA regression differs from a BFT by one explanatory variable – characteristics of the study (i.e. primary surveys methodology – see Table 2.)

Both those techniques, but especially MA, allow the similarity requirements between sites, goods, studies and populations to be relaxed and they enable a test of the methodological choices of primary studies if the heterogeneity is appropriately captured in the models. The main advantage of transferring whole functions to a policy site or building a regression based on estimates from many primary surveys (MA) is the increased precision of tailoring a benefit measure to fit the characteristics of the policy site. MA has been concerned with understanding the influence of methodological and study-specific factors on research outcomes (Rosenberger and Loomis, 2002). This is why the MA-BT approach could be used to evaluate some environmental functions – e.g. outdoor recreation – based on different environmental resources which provide this service (forests, lakes, beaches etc.). Because of the possibility of the inclusion of multiple population and site characteristics, MA can adjust for differences – but such variables should be available in the first place.

Table 2. Function transfer approaches.

Value functions	
Based on a single survey (Benefit function transfer)	Based on multiple surveys (Meta-analysis)
$WTP_i = a + bX_{ij} + cY_{ik} + dS_{il} + e_i$	$WTP_r = a + bX_{rj} + cY_{rk} + dS_{rl} + fZ_{rm} + u_r$

Where: WTP_i – willingness to pay of a respondent (i), X_{ij} – site and good characteristics (j), Y_{ik} – respondent characteristics (k), S_{il} – substitute site characteristic (l), e – random error, WTP_r – mean willingness to pay for a study (r), Z_{rm} – study characteristics (m), u – random error and a, b ,c , d are parameters.

Apart from these two groups of functional BT techniques, we can also distinguish the structural benefit transfer based on calibration of preferences. This approach requires selection of a preference specification capable of describing individual choices over a set of market and associated non-market goods to maximize utility when fencing budget constraints. Then the analytical expressions for tradeoffs being represented by the set of available benefit measures are established. The next step is to use the algebraic relationships with the estimates from the literature to calibrate the parameters of the model. These models offer the basis for new tradeoffs, i.e. for developing "transferable" benefit measures (Smith et al., 2006). A method belonging to this group is the Bayesian Approach (BA) which has been implemented recently to transfer environmental values (Leon-Gonzales and Scarpa, 2007; Leon et al. 2003, Leon et al. 2002). BA is based on the Bayes theorem that involves the combination of prior information with sample information in order to derive a posterior distribution from which an inference can then be made. It assumes that there are some data or known quantities from earlier valuation surveys and prior beliefs (e.g. expert opinions) about unknown parameters (e.g. mean CS). BT estimates in this case can be obtained by assuming a joint probability function that describes how the unknown quantities and data behave in conjunction. This method makes it possible to reduce sample size or to choose the proper set of sites (i.e. in terms of forest characteristics) from which information is transferred.

Obviously BT results can only be as accurate as the initial estimates, since transferring values from a study site to a policy site necessarily increases the uncertainty in those values. When BT is used, the assumption is made that the cost incurred by carrying out a primary study at the policy site of interest would have been greater than the incremental value added from the improved accuracy of this primary study (Brookshire and Chermak in: Navrud and Ready, 2007). To check to what extent the estimation uncertainty is increased, so called "transfer experiments" could be performed. In "transfer experiments", original value estimates at the policy site are compared with transferred values. In this case, it is possible to test the reliability and validity of the BT estimates. Validity requires that the values or the value functions generated from the study site be statistically identical to those estimated at the policy site. This can be checked by applying various convergence tests. Kristofersson and Navrud (2004) recommend in this case using equivalence tests where the null hypothesis states the existence of differences between the original and transferred value estimates. Reliability requires that the differences between the transferred value estimates and the values estimated at the policy site be small, for example around 20-40% (Navrud and Ready, 2007). It could be tested by the so-called transfer error (TE) measurement in two ways: within-sample and out-of-sample:

$$(4)\ \ TE = \frac{|WTP_e - WTP_t|}{WTP_e}$$

where: e – estimated/transferred value, t – true value (benchmark value at policy site, it is often approximated by conducting a primary survey at the policy site).

There could be different sources of transfer errors. Bergstrom and Civita (1999) define 5 categories:

- commodity measurement errors (e.g. when the commodity at the “study” site is different from that at the policy site, which could be reflected by different attributes),
- population characteristic measurement error (differences in socio-economic characteristics between “study” and “policy” site population),
- welfare change measurement error (refers to differences between welfare changes across studies, e. g, passive vs. active use, WTP vs. willingness to accept) ,
- physical-economic linkage measurement error (economic value estimated in a particular location and time may depend on linkages between biophysical functions or economic services)
- estimation procedure and judgment error (statistical estimation error, experts’ mistakes).

Some of these errors can be avoided at the stage of choosing the “study” sites to perform BT, e.g. by collecting all “study” sites where the same survey instruments were used or by choosing primary studies conducted more less simultaneously among similar population in terms of socio-economic characteristics.

But testing reliability and validity does not determine when the results of an implementation of BT can lead to a wrong policy recommendation. The level of BT accuracy required may differ depending on what the results will be applied to (see Figure 3).

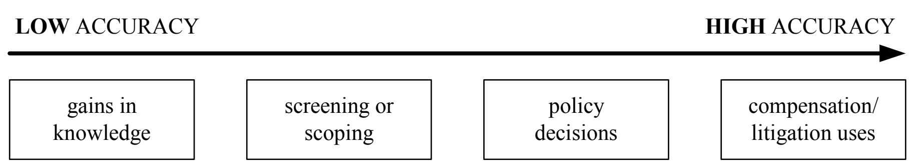

Figure 3. Level of accuracy required in BT analysis.

Source: Filion et al. (1998).

Bergstrom and Civita (1999) argue that inaccuracy in general knowledge gains costs society relatively little, whereas using biased estimations for determining compensation levels in the context of natural resource damage could lead to potentially irreversible losses of extremely scarce environmental attributes, such as endangered species.

5. How have non-timber forest benefits been transferred to date?

In Europe, unlike in the United States, BT is not so widely used by government agencies connected with forest management. The applications of BT are usually reported for internal purposes and not published in scientific journals.

In our review we focus on so-called forest "BT experiments" which examine the accuracy of BT estimates. We collected 19 studies – "transfer experiments": In 12 of them transfer only between forest sites is conducted, in the rest of them, many different environmental sites – including forest ones – are used to transfer value of either recreation or landscape.

Analyzing the first group – this based only on forest sites – we found that most of them deal with recreation, and therefore with use values (see Table 3). Two studies also transfer non-use values. Lindhjem and Navrud (2008) transfer values related to "changes in forest practices" (i.e. leaving more broadleaves trees, leaving dead wood etc.) and "forest protection programs" (i.e. full protection like a reserve). Some of the values transferred in this case are related to recreation and some to non-use, e.g. related to biodiversity protection. The other paper which transfers both use and non-use values is Loomis et al. (2005) where the values of a whole set of goods and services from "forest fire prevention programs" are transferred.

The studies cover a period of 11 years and all but two were conducted in northern European countries (Denmark, Great Britain, Republic of Ireland, Norway, Sweden and Finland). Three studies deal with international BT; however, the selected countries are similar in terms of geographical characteristics and cultural background (BT among Scandinavian countries – Lindhjem and Navrud (2008), and British Islands – Matthews et al. (2007) and Scarpa et al. (2007)).

Table 3. Summary of forest benefit transfer studies.

Reference	**Country**	**Function**	**Value**	**Study sites method**	**No. study sites**	**BT Method**
Lindhjem, H., S. Navrud (2008)	Norway, Sweden, Finland	recreation/ changes in forest management	use/ non-use	CV	26	IAVT, MA
Moons E., B. Saveyen, S. Proost, M. Hermy (2008)	Belgium	Recreation	use	TC (GIS)	32	BFT
Leon-Gonzalez, R. and R. Scarpa (2007)	UK	Recreation	use	CV	42	BA+BFT
Matthews, D. I., W. G. Hutchison and R. Scarpa (2007)	Ireland, Great Britain	Recreation	use	CV	42	BFT
Scarpa R., W. G. Hutchinson, S. M. Chilton, J. Buongiorno (2007)	Ireland, Great Britain	Recreation	use	CV	26	CSAVT
Zandersen, M., M., Termansen, and F.S. Jansen (2007a - LE)	Denmark	Recreation	use	TC (GIS)	52	BFT
Zandersen, M., M. Termansen, and F.S. Jensen (2007b - JFE)	Denmark	Recreation	use	TC (GIS)	52	BFT

Loomis, J. B., Le, H. T. and A. Gonzales-Caban (2005)	USA	changes in forest management	use/ non-use	CV	3[7]	BFT
Leon, J. C., F. J. Vazquez-Polo and R. L. Gonzales (2003)	Spain	Recreation	use	CV	2	BA
Leon, C.J, F.J. Vazquez-Polo, N.Guerra and P. Riera (2002)	Spain	Recreation	Use	CV	3	BA
Bateman, I. J., A. A. Lovett and J. S. Brainard (1999)	Great Britain	Recreation	Use	CV + TC (GIS)	1	DFT
Lovett A. A., J. S. Brainard and I. J. Bateman (1997)	Great Britain	Recreation	Use	CV + TC (GIS)	1	DFT

Notes: CV – contingent valuation, TC – travel cost, GIS – geographical information system, IAVT – income adjusted value transfer, CSAVT – conditional on site attributes value transfer, MA – meta analysis, BFT – benefit function transfer, DFT – demand function transfer, BA – Bayesian approach.

All the reviewed papers use primary studies based either on CV or TC methods. In most cases primary studies were carried out on-site. In the CV surveys, a payment vehicle is introduced as an entrance fee, and the elicitation method is the single or double bounded dichotomous choice (apart from Lindhjem and Navrud, 2008, the MA study). TCM is supported by the Geographical Information System (GIS) tool. In most studies the benefit functional transfer is used based on quite a large number of analyzed sites (in 7 articles, the number of sites varies from 26 to 52, and in the remaining 3 cases there are 1 to 2 sites). The authors of all studies from this group in which the TCM approach is used in primary surveys, carry out

[7] This number in this case means the number of analyzed populations (3 states: California, Florida and Montana) . Number of sites was unspecified. Respondents were asked about 2 different forest fire protection programs undertaken in their county and state.

demand function transfer rather than benefit transfer. There are also examples of the Bayesian approach (2 studies: Leon-Gonzales and Scarpa (2007) and Leon et al. (2003)). In two articles, unit value transfer was applied (Lindhjem and Navrud (2008) and Scarpa et al. (2007)).

The BT forest literature which we collected varies very much in terms of the objectives of the research being presented, in spite of a relatively small number of articles and an investigation, in almost all cases, of the same type of good – forest recreation. Generally, the collected literature can be grouped into four broad categories according to the focus of study (some of the articles deal with more than one of these subjects):

(1) time aspect in transferring values,

(2) BT site adjustment for differences in forest physical attributes,

(3) the role of population characteristics in forest BT, and

(4) methodological improvements (GIS, Bayesian Approach).

Apart from BT, carried out purely for forest sites, we found a few studies investigating environmental value transfer in a wider natural recourse context. Mainly in these studies the value of outdoor recreation has been transferred (see Table 4) using MA regression. In all cases information was gathered from the United States and covers valuation studies in more or less a 30-year period. The main focus was on use value estimates for recreation activities defined by USDA Forest Service documents (21 activities[8]). The environmental sites distinguished other than forests were: lakes/reservoirs, estuaries/bays, river-based sites and parks (incl. mountains). This wide range of recreation categories can be linked with particular environmental sites (i.e. rock climbing, fishing) or seasons (i.e. cross-country skiing) or can refer to multiple sites (i.e. camping,

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[8] Camping, picnicking, swimming, sightseeing, off-road driving, motor boating, float boating, hiking, biking, downhill skiing, cross-country skiing, snowmobiling, big game hunting, small game hunting, waterfowl hunting, fishing, wildlife viewing, horseback riding, rock climbing, general recreation, other recreation.

picnicking). Depending on the recreation activities, forest recreation had higher or lower estimates than other sites (e.g. biking lower). Since forest sites specifically were not the main area of interest in carrying out MA in these cases, forest characteristics were not collected in the database and therefore not analyzed (apart from broad categories such as wilderness areas, public vs. private lands).

Table 4. Summary of outdoor recreation BT studies including forest sites.

Reference	Country	Sites	No. studies	No. of estimates	Primary study methods	BT Method
Shrestha, R. K., R. Rosenberger, and J. Loomis (2007)	1) USA 2) internat.[9]	forests, lakes/ reservoirs, estuaries/ bays, river based sites, parks	1) 145 2) 159	1) 726 2) 765	CV, TC	MA
Shrestha, R. K. and J. B. Loomis (2002)	USA		131	682		
Rosenberger, R. S. and J. B. Loomis (2002)[10]	USA		131	701		
Shrestha, R. K. and J. B. Loomis (2001)	international		159	765		
Rosenberger, R. S. and J. B. Loomis (2001)	USA		131	682		

BT results were compared based on different aggregation levels showing for example that the national benefit transfer outperforms the regional one. Two international BT were conducted using a USA database and transferring values to each of the international studies collected (studies from 28 countries differ significantly in terms of economic and cultural

[9] Out-of-sample transfer based on MA for USA studies to "abroad" (28 studies from 14 countries, 83 estimates).
[10] Single point and average value estimates from the literature for hypothetical mountain biking were transferred as well.

situations as well as geographical location: Canada, Australia, New Zealand, Italy, UK, Belgium, Finland, Spain, Madagascar, South Africa, Kenya, Costa Rica, South Korea). In most cases the explanatory power of the meta regression function was relatively low, around 0.3. Some other studies were aimed at methodology and, for example, were investigating different convergent validity tests.

In addition we found two studies dealing with landscape value transfer based on different environmental sites, including forest sites (see Table 5.). These studies were based on CV estimates (Santos in Navrud and Ready, 2007) or on CE estimates (Colombo and Hanley, 2008). Both were carried out for a UK "policy" site.

Table 5. Summary of landscape BT studies including forests sites.

Reference	**Country**	**Sites**	**Primary study methods**	**BT Method**
Colombo, S. and N. Hanley (2008)	UK	heather moorlands and bogs, rough grasslands, broad and mixed woodlands, field boundaries, cultural heritage	CE	VT, BFT
Santos, J. M. L (2007)	UK/ international	Flower rich meadows, broadleaf woods, stone walls	CV	VT, I&FAVT[11]*, BFT, MA

* Income and CV format adjusted value transfer

Reliability and validity in all collected studies are tested in various ways by using different convergence tests or measuring marginal or average transfer errors. The authors usually perform a few subset transfer experiments, dividing collected studies according to the methodology used and estimations used in primary studies (e.g. median vs. mean, single bound

[11] I & FAVT based either on estimations from a single best study or multiple studies.

vs. double bounded format), differences in BT methodology (e.g. different forms of BT functions, different BT approaches, an acknowledgment of forest characteristics vs. lack of it, updating information on the demand function in temporal transfer vs. unchanged information) in environmental programs (i.e. mechanical fuel reduction vs. prescribed burning), differences in forests attributes (i.e. most valuable vs. less valued, closer to cities vs. further away), or information concerning target groups (e.g. socio-economic differences between inhabitants of three states). To test the accuracy of estimates, most authors used different convergence validity tests to check the equality of BTF predicted and original mean WTP/CS values, and to test correlation and regression. No one performed the equivalence test recommended by Kristoferson and Navrud (2002) (hypothesis zero – there is a difference between surveys). In a few cases, analyses were performed using percentage differences (transfer error measure) within or out of sample.

6. Experiences and challenges from the transfer of non-timber benefits.

6.1. Why has the value of recreation so far been mostly transferred in the forest context?

Looking at articles dealing with BT in the forest context, it is easy to note that in most of them the value of recreation has been transferred and other non-timber goods and services have been omitted, with the small exception of biological diversity. There could be several alternative explanations for this:

(1) Recreation is the most important non-timber forest function for practitioners and planners, since individuals value this function the highest. This statement can be supported by some evaluation results, for example Willis et al. (2003) where in a British national forest survey, recreation was found as the most precious item in terms of annual value

among forest non-market goods and services (the other functions considered were landscape value, biodiversity, carbon sequestration and air pollution absorption). However this ranking can vary in different countries, since for some countries historical and social circumstances may imply higher frequencies of forest visits or higher values placed on these visits than in the others.

(2) Recreation is the easiest to value of all non-timber goods and services using valuation methods based on either RP or SP. Recreation belongs to the group of direct-use forest NTBs values, whereas the rest of forest non-market functions have either indirect use values (ecosystem services) or non-use values. Apart from that, outdoor recreation, unlike the rest of NTBs (especially biological diversity[12]), is not so controversial to define. Both of these factors indicate why it is relatively easy to construct valuation survey and estimate values, in this case comparing with the rest of forest non-market functions. But at the same time there could be strong linkages between recreation and the other forest functions, such as aesthetic value or biological diversity. Additionally, with recreation, the values can be achieved by carrying out TCM surveys and, as mentioned before, RP functions characterized by higher explanatory power in general than SP ones, and it could be another argument for basing BT experiments on recreation instead of other NTBs.

(3) The third reason can be derived from the previous ones: the majority of forest non-market primary studies concentrate on recreation, so if one wants to do BT experiments here is the biggest set of surveys to choose from. For example, Elsasser et al. (2008) state that from 86 data sets for France, Germany, Austria and Switzerland more than half refer to recreation. In the case of some forest functions like watershed services,

[12] For the discussion see e.g. Nunes and van den Bergh (2001).

the evaluation methods like avoided, damage or substitute costs are often used, which are not so costly and time consuming as methods based on RP or SP and in this case conducting BT would not be justified.

It is an important issue to be aware of different interactions between forest functions (substitutable or complementary) but above all, clear definitions of them are needed. Sometimes – in primary valuation surveys the whole "package" of different forest functions is valued – there is no way for a reasonable division of achieved outcomes into subcategories. In this case, coding results in non-market valuation databases according to all categories could be subject to interpretation of results and then it could make later BT outcomes biased. If we deal with non-use values – e.g. an evaluation of endangered species – it is more difficult to conduct BT due to problems with establishing the proper unit measurements which can in many cases be strongly linked to the initial level of environmental quality.

6.2. How to deal with the time issue in forest BT context

In BT, the time aspect is often present since in most cases is based on using historic data to transfer present values – so we actually deal with a temporal transfer. The problem of time differences between study site and policy site can only be avoided when both of them take place in the same period – which is rare. While in BFT and a value transfer based on one survey the time adjustment would refer only to one period of time, with MA-BT and value transfer based on many surveys there would be more time differences to deal with.

The time aspect is important for at least three variables: differences in income level, differences in consumption preferences and behavioral patterns, and changes in environment. All these aspects are linked with each other. Where the first issue can be relatively easy to correct (using the elasticity index between environmental value and the income level[13]), the other two constitute big challenges for researchers since:

- preferences are known to be unstable over time. This concerns the forest in terms of individuals' preferences towards some forest attributes such as species diversity and age over a long period (Zandersen et al. 2007a). However, Loomis (1989) finds that WTP is relatively stable over the period of nine months which he investigated,
- behavioral patterns depend on many factors – one of them could be technological development (e.g. visiting more distant places because of the change in transport modes allowing faster travel and time saving),
- changes in environment and their welfare estimates vary in time and a lot of environmental projects – including forest – have long-term durations (40-80 years after project start, for example: afforestation, wilderness preservation, or ecosystem restoration).

When future projects are considered, an evaluation of their benefits is not possible by applying the revealed preference methods such as TCM. Navrud and Brouwer (2007) claim that in general, WTP functions based on SP surveys – especially CV – have much lower explanatory power than functions using RP methods, so it could be more relevant to use revealed preference primary studies than transfer estimates. So if one places more trust in RP estimations than stated preference methods, the only solution in this case is to transfer welfare estimates from primary TC or HP studies. This issue in the forest context is very important, for example when BT estimates are going to be used in CBA for establishing new recreation sites. And since many of forest projects are characterized by a long duration, the correct capture of changes over time in a relationship between

[13] Navrud and Brouwer (2007) claim that income elasticity of WTP for different environmental goods are typically smaller than 1, and often in the 0.4-0.7 range.

environmental value and individuals' income and preferences remains a crucial aspect.

There is an impression that in forest BT exercises, not enough attention has yet been devoted to the time aspect. In most of the reviewed papers the data used comes from the same period (e.g. Scarpa et al. (2007) test BT based on almost simultaneous – a period of a few weeks– collections of CVM data from 26 forest sites) or there is an assumption regarding the lack of time differences (e.g. Moons et. al (2008) assume in their model of optimal allocation of a new forest site that all projects started at the same point in time). Lindhjem and Navrud (2008) consider the time aspect only as a change in income levels and adjustment values in their MA and unit value transfer according to the inflation (implicit price deflator) and addining a time trend (year as an explanatory variable) to the regression function. The same approach is used in all outdoor recreation BT papers collected.

But there are a few studies testing temporal transferability. The time aspect in a forest recreation transfer is the main topic of two Danish papers (Zandersen et al. (2007a) and (2007b)). They test the reliability of benefit transfer of forest recreation values over a 20-year time horizon. Both studies are based on a survey carried out in 1977 among respondents visiting 52 selected forest sites. The benefit function is used to estimate a recreation value of one these forests in 1997. In the first paper (Zandersen et al. (2007a)), the authors conduct two different transfers based on two different models: in one of them only the information collected in the 1977 survey is used to assess the recreation value in 1997, whereas the other one includes updated information about demand structures using information from a national household survey in 1994 (but keeping trip patterns from 1977). The authors find that preferences for some forest attributes, such as species diversity and age as well as transport mode, have changed significantly over this period and updating transfer models by including more recent information about demand for forest recreation allows significant reduction in transfer error (improvements in error margins by an average of 282%). They conclude that the BT over time can be reliable (may produce acceptable errors[14]) as long as it is adjusted to changes in preferences and behavioral patterns.

In the other paper (Zandersen et al. (2007b)), the authors concentrate on changes attributed to forest recreation values along with a time flow. They find that the recreation value over a 20-year period of a large, newly established fringe forest increased 70 times, mainly due to the maturing of the forest. The second reason is related to a change in the patterns of visitors' behavior. The benefit transfer estimations over time give results of between 57% underestimations and 349% overestimations depending on the sampling of the choice set used as the study site.

6.3. Heterogeneity of forest sites and environmental changes

It is hard to find two environmental goods which are identical, and forest sites are no exception. In BT methodology, the important issue is how the physical differences between forests sites affect the accuracy of a value transfer. Even though we know fairly well which types of forest attributes people generally prefer from many quantitative surveys (Gundersen, V. S. and L. H. Frivold (2005), Lindhagen and Hørnsten (2000), Ribe R. G. (1989)), people's WTP for such attributes are less well known. So the first question is: what forest characteristics influence individuals' WTP for forest non-market good and services? Another would be: how to deal with forest heterogeneity when performing BT? Regarding the first problem, there is still no sufficient evidence about a relationship between forest attributes and the WTP or CS of certain forest functions (recreation, ecological services etc.) The results from primary studies are usually based on one or a few sites, which is not enough to establish such general relationships reliably.

[14] Average error of the best transfer model was around 25%.

Size of forest site is a good example here. Some authors claim that it could be positively related with WTP for forest recreation (Mattews et al, 2007), but others (Lindhjem, 2007) find that there is no such dependence. Moons et al. (2008) say that small forests (less than 20ha) attract few to no visitors and in the case of large forests (more than 300ha) an increase of 1 ha causes negligible change in visitor numbers. But their statement is based on a forester's opinion, not on empirical research. Even less attention in the literature is devoted to the forest management role and to the existence of other natural tourist attractions inside forests, like lakes or mountains, and their impacts on outdoor recreation. At the same time it is worth noting that a single forest might not be homogenous itself. A single site can consist of different parts which could vary in terms of biological diversity or management regime (this could be a case of either study site or policy site or both), making BT an even more complicated task.

Colombo and Hanley (2008) point out that the inclusion of three similarity indicators (disposable income, land cover and geographical distance) in the selection of study site may lead to a reduction in transfer errors, although no clear pattern emerged. However, they also note that there are no clear criteria that define the concept of required "similarities" between study and policy sites. They show that adding more information to BT does not always reduce transfer error (the experiment of adding new sites which are more different in disposable income and landscape abundance makes transfer error worse). Santos (2007), applying different BT approaches and models, finds that the most accurate transfers are the VT based on single best study (chosen by experts – qualitative landscape change is similar in "study" and "policy" case, and additionally the visual presentations in both cases are almost identical) adjusted to DC format and meta-analytic models when predicting the DC format.

In part of our reviewed studies, forest characteristics are neglected in the analysis (Moons et al. 2006, Bateman et al. 1999, Lovett et al. 1997), however they are the main subject of a few others. Scarpa et al. (2007) and Matthews et al. (2007) investigate site-adjusted benefit transfer in a forest recreation context. In the first case, it is a site-adjusted value transfer (the transfer takes place after an adjustment which accounts for differences between attributes relevant to recreation across study and policy sites). The other study focuses on the site-adjusted benefit transfer function approach (this approach attempts to explain variations in WTP for forest recreation on the basis of variations in forest attributes).

Scarpa at el. (2007) claim that unlike the unconditional value transfer, value transfers conditional on site-specific recreation attributes are mostly transferable (reliable when forest attributes are used as predictors). They found that forest attributes show significant and plausibly signed coefficients. The forest attributes analyzed in this case were size of forest, conservation regime (nature reserve vs. others), age and share of tree coverage. Matthews et al. (2007) notice that insufficient data collection explaining the relationship of benefits to change in site attributes remains the main limitation of BT studies so far. They conclude that for a benefit function to perform well, the function must capture differences in welfare values between sites and if the site attributes are poorly chosen, or the BTF is poor, than the pool of sites needs to be large enough to incorporate the range of available sites. Scarpa at el. (2007) also point out that when benefits are determined by site attributes their omission from the econometric specification of BT results in mis-specification errors: but on the other hand, the inclusion of these attributes may cause co-linearity since all observations from the same site are associated with the same set of value attributes and for this reason the BTF estimation in this case should be achieved with data from a sufficiently large number of sites. Leon-Gonzales and Scarpa (2007) also note that reliable estimates in BT can be obtained when the heterogeneity between sites is appropriately captured by the model but at the same time they propose a Bayesian Model Averaging Approach which, if the sample size for a particular site is small, provides credible intervals by combining a BT estimate with a site specific estimate. Zandersen et al (2007a) and (2007b) implemented the Random Utility Model (RUM) in their calculation to solve the problem of non-similarity across sites since it can include multiple site characteristics.

Not only can differences in physical forest attributes influence the credibility of BT results, but also the environmental changes described in "study" and "policy" sites. And again in rare cases analyzed, environmental changes can be expected to do the same. They can vary in terms of magnitude and direction. Navrud and Brouwer (2007) claim that people place a higher value on keeping the original/undisturbed environmental good than on restoring it. Particularly, this problem can apply to "study" estimates collected from many studies such as a MA-BT case.

6.4. Spatial consideration

Benefit transfer is intrinsically concerned with space, because it consists in taking into account two different sites, the study site and the policy site, which differ by their location. This issue is particularly present when we consider international transfers, since there is a higher probability that in this case we will find more difficulties connected with the different geographical locations of analyzed sites. Firstly because of differences in forest characteristics such as density, dispersions, types of forest, the quality of forest ecosystems etc., and secondly because of cultural differences and forest use traditions (including the distribution of public and private forests and their availability to the public), and thirdly because of differences in income levels between countries.

This last factor is relatively easy to correct by using Purchase Power Parity (PPP) corrected exchange rates. The first one refers to the problem of the relationship between WTP or CS and forest characteristics including forest location and the existence of substitute sites (forest dispersion). Geographical Information Systems (GIS) can be a helpful tool to analyze this aspect.[15] The GIS approach put together spatial data, software applications and quantitative analysis and represents a means to organize and to store information that is referenced to the earth. Troy and Wilson (2006) note that this tool allows comparisons between study sites and policy sites considering three critical factors: the biogeographical similarity of the two sites, the human population characteristics and links with the environmental service, and the level of scarcity of the service (existence of substitutes). Viewing forest ecosystems on a spatial dimension allows analysis of them in terms of location, distribution and characteristics, in other words better accuracy in the site description. Elaboration of spatial scales when valuing ecosystem services also seems important to understand WTP in primary studies.

In the forest context, an estimation of the recreation demand function using GIS has been developed by Lovett et al. (1997) and Bateman et al. (1999). Their results show that an application of GIS in BT improves efficiency and consistency. In Lovett et al (1997) the analysis is extended by including such factors as availability of substitutes to the demand function. In both papers, the analysis is limited to establishing one forest site. Moons et al. (2008) transfer the estimated forest recreation demand function to the multiple new forest sites. They also check how recreation benefit depends on substitute sites, concluding that the availability of substitutes has a significant effect on the recreation value of a forest.

[15] GIS can be used to collect information concerning a traveled distance using e.g. registration plate numbers of cars parked near forest sites.

Troy & Wilson (2006) note a difference between spatial data and economic valuation data, the first being more and more precise and of high quality and the second not being sufficiently representative of a large variation. The consequence of these inadequacies in quantity and quality does not allow any relevant transfer.

The last factor – cultural differences and differences in traditions of using forest - seems to be an unsolved problem, however. Not considering this issue can lead to wrong inferences. An example could be the UNECE/FAO [2005] report which concludes that the value of a recreational visit to forests in Eastern Europe is 0.25 EUR, based on simple unit value transfer adjusted only to income level from estimates from Western Europe. Bartczak et al. (2008) find this value to be around 7 Euro from a TCM primary study administered on-site, in ten selected forest areas in Poland. It seems reasonable to restrict environmental value transfer between countries to those that are similar in terms of geographical location, cultural and social background, as well as in forest management methods.

6. Conclusions

The benefit transfer approach has become an increasingly practical way to assist in decision-making when primary data collection is not feasible due to budget and time constraints, or when resource impacts are expected to be low or insignificant. However, the academic debate on the validity of the methods still continues. We decided to investigate the BT application in the forest context analyzing "transfer experiments" where original benefit estimates at the policy site were compared to estimates transferred from other sites. Evaluating different environmental services – not only timber production – is an important aspect of multifunctional forest policy.

Although the forest delivers many environmental functions, reviewing forest BT studies we found out that recreation is a topic of most of them whereas less attention is devoted to other forest function– especially those connected with non-use values. Because all primary valuation estimates but one came from either CV or TC surveys. The only study using Choice Experiment benefit estimates concentrates on landscape value and performs a transfer among different environmental sites, one group of which constitutes forest sites. In the context of "pure" forest transfers, the preferred technique was functional transfer based on estimation from many sites, although some authors (Colombo and Hanley (2008), Lindhjem and Navrud (2008)) find that value transfers are not consistently outperformed.

In some cases, collecting a wide range of data helped to deal with site heterogeneity, which is one of the key issues in forest BT as well as in BT in general. Nobody disputes that adjusting BT to site characteristics improves the transfer results, but which forest attributes have an important influence on welfare estimation still needs further investigation. Similarity not only between sites but spatial location should be considered in BT as well, since, for example, not only the aggregated area of forest sites but also their different dispersion can bias the BT outcomes. In this context, tools like GIS can be very helpful. At the same time, selection of the study sites from which the value is transferred can affect BT validity. However, adding more information to benefit transfer estimations will not always reduce transfer errors. The studies based on many environmental sites (other than just forests) do not highlight the role of forest site characteristics.

The time aspect is another important issue for BT in general as it is known that preferences and behavioral patterns vary over time. In the forest context, additional problems appear with the fact that values evolve with environmental changes, e.g. forest age. And a lot of forest planning is long term, so variations in benefit estimates have to be expected. So far, only two forest BT papers have been devoted to this matter (Zandersen et al. 2007a and 2007b). In other cases, time gaps were "cured" by an adjustment to the inflation index, without using the WTP/CS elasticity according to income changes.

Our review summarizes 12 years of research on BT application in the forest context and shows the challenges remaining in this area to increase the precision, accuracy and reliability of transferred estimates.

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7. References

Barbier, E B. and G. M. Heal (2006), Valuing ecosystem services, The Economists' Voice 3: http://www.bepress.com/ev/vol3/

Bartczak, A., H. Lindhjem, S. Navrud, M. Zandersen, and T. Zylicz (2008), Valuing forest recreation on the national level in a transition economy: The case of Poland, Forest Policy and Economics, in press

Bateman, I. J., R. T. Carson, B. Day, M. Hanemann, N. Hanley, T. Hett, M. Jones-Lee, G. Loosem, S. Mourato, E. Ozdemiroglu, D. W. Pearce, R. Sugden, and J. Swanson (2002), Economic Valuation with Stated Preferencje Techniques. A manual. Edward Elgar

Bateman, I. J., A. A. Lovett, and J. S. Brainard (1999), Developing a methodology for benefit transfers using geographical information systems: Modeling demand for woodland recreation, Regional studies 33(3): 191-205

Bergstrom, J. C. and L. O. Taylor (2006), Using meta-analysis for benefits transfer: Theory and practice, Ecological Economics 60: 351-360

Bishop, J.T. (1999), Valuing forests: A review of methods and applications in developing countries, London, Environmental Economics Program, International Institute for Environment and Development

Brouwer, R. (2000), Environmental value transfer: state of the art and future prospects, Ecological Economics 32: 137-152.

Brookshire, D. and J. Chermak (2007), Benefit and informational transfer, in: S. Navrud and R. Ready, ed., Environmental value transfer: issues and methods, Springer

Colombo, S. and N. Hanley (2008), How can we reduce the errors from benefits transfer? An investigation using the choice experiment method, Land Economics 84(1): 128-147

Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, S. Naeem, K. Limburg, J. Paruelo, R.V. O'Neill, R. Raskin, P. Sutton and M. Van den Belt (1997), The value of the world's ecosystem services and natural capital, Nature 387:253-260

Cubbage, F., Harou, P., Sills, E., (2007), Policy instruments to enhance multi-functional forest management, Forest Policy and Economics 9: 833-851.

Gundersen, V. S. and L. H. Frivold (2005) Integrating visual structures in urban siviculture: A review of Fennoscandian preference studies and a proposal for a zoning model. In V. S. Gundersen. Urban woodland management in Norway: Integrating aesthetic and ecological elements in siviculture. PhD Thesis 2005:34. Norwegian University of Life Sciences.

De Groot R. S., M. A. Wilson, and R.M.J. Boumans (2002), A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics 41: 393-408

Elsasser, P., J. Meyerhoff, J., C. Montagné, and A. Stenger, (2008), A bibliography and database on forest benefit valuation studies from Austria, France, Germany and Switzerland - a possible base for a concerted European approach, Journal of Forest Economics, forthcoming

Holmes, T. P., Boyle, and J. Kevin (2003), Stated Preference Methods for Valuation of Forest Attributes in: Sills, Erin O., Abt, Karen, Lee, eds. Forests in a market economy. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Johnston, R., J. (2007), Choice experiments, site similarities and benefit transfer, Environmental Resources Economics 38: 331-351

Kristofersson, D. and Navrud, S. (2005), Validity Tests of Benefit Transfer – Are We Performing the Wrong Tests? Environmental and Resource Economics 30: 279-286

Leon, J. C., F. J. Vazquez-Polo, and R. L. Gonzales (2003), Elicitation of Expert Opinion in Benefit Transfer of Environmental Goods, Environmental and Resource Economics 26: 199-210

Leon, C.J, F.J. Vazquez-Polo, N. Guerra, and P. Riera (2002), A Bayesian model for benefit transfer: application to national parks in Spain, Applied Economics 34: 749-757

Leon-Gonzalez, R. and R. Scarpa (2008), Improving multi-site benefit functions via Bayesian model averaging: A new approuch to benefit transfer, Journal of Environmental Economics and Management, in press

Lindhagen, A. and L. Hörnsten (2000), 'Forest recreation in 1977 and 1997 in Sweden: Changes in public preferences and behaviour', Forestry 73: 143-153

Lindhjem, H. (2007), 20 Years of stated preference valuation of non-timber benefits from Fennoscandian forests: A meta-analysis, Journal of Forest Economics 12: 251-277

Lindhjem, H. and S. Navrud (2008), How reliable are meta-analyses for international benefit transfers?, Ecological Economics 66 (2-3): 425-435.

Loomis, J. B. (2005), Updated outdoor recreation use values on national forests and other public lands, U.S. Department of Agriculture & Forest Service

Loomis J. B., H. T Le, A. Gonzales-Caban (2005), Testing transferability of willingness to pay for forest fire prevention among three states of California, Florida and Montana, Journal of Forest Economics 11: 125-140

Loomis, J. B. (1989), Test-retest reliability of the Contingent Valuation Method: A comparison of general population and visitor responses, American Journal of Agricultural Economics 71: 76-84

Lovett A. A., J. S. Brainard, and I. J. Bateman (1997), Improving benefit transfer demand functions: A GIS Approach Journal of Environmental Management 51: 373-389

Matthews, D. I., W. G. Hutchison, and R. Scarpa (2007), Testing the stability of the benefit transfer function for discrete choice contingent valuation data, Working Paper in Economics 8/07, University of Waikato

Moons E., B. Saveyen, S. Proost, and M. Hermy (2008), Optimal location of New forests in a suburban region, Journal of Forest Economics 14: 5-27

Navrud, S. and R. Ready, ed. (2007), Environmental value transfer: issues and methods, Springer

Navrud, S. and R. Brouwer (2007), Good practise guidlelines in benefis transfer of forest externalities, COST Action E45, European Forest Externalities, Euroforex

Nunes, P. , J. Van den Bergh, and P. Nijkamp (2003), The ecological economics of biodiversity: Methods and policy applications., Edward Elgar

Pearce D. and C. Pearce (2001), the value of forest ecosystems: a report to the secretariat convention on biological diversity. University College London, London

Pearce D. (2001) Valuing biological diversity: issues and overview. In: OECD, Valuation of Biodiversity Benefits: Selected Studies, OECD,Paris, Chapter 2.

Ready, R. and Navrud, S. (2006), International benefit transfer: Methods and validity tests, Ecological Economics 60: 429-434.

Ribe, R. G. (1989) The aesthetics of forestry: what have empirical preference research taught us? Environmental Management 13: 55-74.

Rittmaster R., W.L. Adamowicz, B. Amiro and R.T. Pelletier (2006), Economic analysis of health effects from forest fires, Canadian Journal of Forest Research 36: 868-877

Rosenberger, R. S. and Loomis, J. B. (2001), Benefit transfer of outdoor use values. A technical document supporting the Forest Strategic Plan (2000 revision), U.S. Department of Agriculture & Forest Service

Rosenberger, R. S. and J. B. Loomis (2000), Using meta-analysis for benefit transfer: In-sample convergent validity tests of an outdoor recreation database, Water Resources Research 36(4): 1097-1107

Rosenberger, R. S. and T. D. Stanley (2006), Measurement, generalization, and publication: Sources of error in benefit transfers and their management, Ecological Economics 60: 372-378

Santos, J. M. L. (2007), Transferring landscape values: How and how accurately?, in: S. Navrud and R. Ready, ed., Environmental value transfer: issues and methods, Springer

Scarpa R., W. G. Hutchinson, S. M. Chilton, J. Buongiorno (2007), Benefit value transfers conditional on site attributes: some evidence of reliability from forest recreation, in: S. Navrud and R. Ready, ed., Environmental value transfer: issues and methods, Springer

Shrestha, R. K. and J. B. Loomis (2003), Meta-analytic benefit transfer of outdoor recreation economic values: testing out-of-sample convergent validity, Environmental & Resource Economics 25: 79-100

Shrestha, R. K. and J. B. Loomis (2001), Testing a meta-analysis model for benefit transfer in international outdoor recreation, Ecological Economics 39: 67-83

Smith, V. K., Pattanayak, S. K. and G., L., Van Houtven (2006), Structural benefit transfer: An example using VSL estimates, Ecological economics 60: 361-371

Troy, A. and M., Wilson (2006), Mapping ecosystem services: Practical challenges and opportunities in linking GIS and value transfer, Ecological economics 60: 435-449

UNECE/FAO European Forest Sector Outlook Study (2005), 1960 – 2000 – 2020. Main report, Geneva

Van Houtven, G., J. Powers and S. K. Pattanayak (2007), Valuing water quality improvements using meta-analysis: Is the glass half-full or half-empty for national policy analysis?, Resource and Energy Economics 29 (3): 206-228

Willis, K., G. Garrod, R. Scarpa, N. Powe, A. Lovett, J. I. Bateman, N. Hanley, and D. C. Macmillan (2003), The social and environmental benefits of forests in Great Britain, Report to Forestry Commission, Edinburgh

Wilson, M. and J. Hoehn (2006), Valuing environmental goods and services using benefit transfer: The state-of-the art and science, Ecological economics 60: 335-342

Young, R. A. (2004), Determining the economic value of water. Concepts and methods, Resources for Future, Washington, DC, USA

Zandersen, M., M., Termansen, and F.S. Jansen (2007a), Testing benefits transfer of forest recreation values over a 20-year time horizon, Land Economics 83(3): 412-440

Zandersen, M., M. Termansen, and F.S. Jensen (2007b), Evaluating approaches to predict recreation values of new forest sites, Journal of Forest Economics 13: 103-128