Economic methodologies for valuing forest genetic resources

P. Elsasser

Introduction: Resource allocation as a decision problem

Conservation of forest genetic resources is itself resource consuming. Specific conservation measures require thought, labour, land, and money; *in situ*-conservation may restrict harvests or other forest uses. A society wishing to preserve its genetic resources is thus faced with several decision problems concerning resource allocation: How much conservation is desirable if the claims for protection and for consumption are competing for the same resources? How many and which genetic resources deserve special protection, given the opportunity costs associated with such efforts? Which endeavour to protect diversity is appropriate in the presence of limited budgets?

Questions like these have both economical and political aspects. Answering them requires social choices in a democratic society which are based on the preferences of its individual members. A central problem is thus how to coordinate individual preferences by a suitable method of decision-making, *i.e.* how to find rules for an adequate aggregation of individual preference orderings. Several decision rules exist within democratic market economies which are sometimes competing with each other; examples are decisions by majority votes, by market allocation, or by experts and bureaucracies. None of these rules is free from distributive norms (*i.e.* value judgements implied by the fact that aggregating individual preferences inevitably means weighting

Th. Geburek & J. Turok (eds.)
Conservation and Management of Forest Genetic Resources in Europe
Arbora Publishers, Zvolen, 2003, XX–XX, ISBN 80-967088-1-3

these preferences in relation to each other)[1]. Such normative elements may severely influence the decision result (for a discussion see DOEL & VELTHOVEN 1993).

Moreover, it has been shown that it is not even possible to construct a collective decision method which excludes logical contradictions and is at the same time non-dictatorial ('General Impossibility Theorem' by ARROW 1963).

In the absence of an 'ideal'decision method, neither voting procedures nor market allocations can claim general superiority. Both methods are mutual supplements. Bureaucracies need both as inputs – otherwise they are in danger of disregarding the individual citizens' preferences on which the legitimacy of decisions in a democracy is ultimately based. Accordingly the analysis of economic values associated with genetic resources can be seen as a *support tool* for guiding decisions about resource allocation. Its function is to support better informed and more rational social choices, and to make such choices more accessible for critical discussions.

While most private and public expenditures associated with conservation can rather easily be compiled (*e.g.* from the respective accounting systems), benefits may be less clear at first sight, specifically those benefits which do not accrue to a few identifiable persons or firms only, but to many or all members of society. Indeed, comprehensive valuation results addressing private as well as public benefits of forest genetic resources in Europe are generally still lacking today, although methods for valuing such benefits (as well as applications in other areas) do exist. This chapter therefore cannot present specific valuation results. It describes methods which might be used to analyse the economic benefits of forest genetic resources (FGR in the following), and some problems associated with this analysis. To simplify matters, it will mainly focus on demand side valuation.

The objective of the chapter – addressing geneticists rather than economists – is not to compile a 'valuation cookbook for FGR'. Instead, it is meant to provide the reader with an idea of how economic value analysis works, and of the caveats which must be understood when the results of specific valuation exercises are presented. Generally, the exposition will not be specifically restricted to the *genetic* level alone (as opposed to the species or habitat level, respectively). This would too often make no sense in economic terms, because forest genetic resources often do not affect the relevant beneficia-

---

[1] Consider for example a municipal administration having to decide whether one of its forest lodges should be let to a local nature protection group, or to an association running a nursery school. Majority voting (implying the norm 'one person, one vote') would warrant every voter the same influence on the decision, but it would ignore that one of the competing groups might have a vital interest in using the lodge, whereas the other might be only moderately interested. On the other hand, a market allocation based at each group's willingness-to-pay would probably reflect different intensities of interest, but would also be influenced by their respective ability to pay (implying a weight by interest as well as by wealth).

ries on their own. On the one hand, many elements of genetic diversity are elementally linked to diversity at other levels. On the other hand, economic value analyses often focus at *bundles* of environmental goods (of which genetic resources may be elements), or they try to elicit values associated with certain protection measures (which may affect FGR and other environmental goods at the same time).

Starting with some theoretical background on which the economic valuation of environmental commodities is based, the chapter subsequently mentions what type of objects may be valued when addressing genetic resources, and which motives may be responsible for individuals to hold values for these resources. Then, an overview of methods suitable for analysing economic values of FGR is given. Since it turns out that many values of FGR are only tangible by using stated preference valuation techniques (subsumed under the term 'contingent valuation'), a separate section is devoted to possible biases of these methods, and another one to extensions which originate from attitude-behaviour research and from the deliberation/participation policy approach, respectively.

Some theoretical background of environmental valuation[2]

Approaches for analysing economic values of environmental goods emanate large ly from the theory of welfare economics (allocation theory; *e.g.*, HAMPICKE 1991, SOHMEN 1992, JOHANSSON 1993). It is based on two normative propositions, 'methodological individualism' and 'self-determination'. The 'individualism' postulate implies that only values held by human individuals are taken into account. A consequence of this proposition is that other values are being disregarded (*e.g.*, *independent* intrinsic values of nature are not seizable within this theory, although intrinsic values may be included if they motivate people to be willing to pay for nature). The 'self-determination' postulate says that only the individuals themselves may decide what is beneficial for them. This excludes paternalism, *e.g.* by governmental bureaucracy or by scientists: Although such experts may assist, *e.g.* by clarifying the impacts of certain measures, any assessment of these measures ultimately remains in the citizens' domain. The methodological consequence is that the analysis in the frame of this theory has to draw on the valuations of the individual citizens only.

Welfare economics makes the assumption that people have well-defined preferences among alternative bundles of goods (commodities and services). The bundles may consist of various quantities of these goods (which need not necessarily be sold through markets, *i.e.* the bundles may also include non-market goods, like environ-

[2] Since PREGERNIG (in this volume) has already explained much of the economic rationale which forms the basis for economic valuation, these explanations will not be repeated here.

mental quality or health). Welfare economics also assumes that the respective preferences about the goods making up the bundles have the property of substitutability. Substitutability means that if the quantity of one element in one individual bundle is reduced, it is possible to increase the quantity of some other element in the bundle so as to leave the individual no worse off than before because of the change, *i.e.* the increase in the quantity of the second element substitutes for the decrease in the first. This is the core of the value concept because substitutability establishes the trade-off ratios between pairs of goods that matter to people, and hence reveals something about the values (monetary or otherwise) people place in these goods. Values based on substitutability can be expressed either in 'willingness to pay' (WTP, associated with demand for a good) or 'willingness to accept compensation' (WTA, associated with supply). Both WTP and WTA can be defined in terms of any other good that the individual is willing to substitute for the good being valued.

Individual valuations of a good are directly observable if this good is traded in a market: At the demand side, the *maximum* price somebody is willing to pay for a good reveals her valuation of this good. Actual prices often are below this maximum willingness-to-pay – if the good is supplied at a lower price, it will be bought at this price. The difference between actual price and maximum willingness-to-pay constitutes a surplus for the buyer, the 'consumer surplus' (for the supply side, a 'producer surplus' can be defined the opposite way round). Aggregate consumer (and producer) surpluses can be derived econometrically from market prices.

Markets thus have two functions. They inform about society's valuations of the traded goods, and they govern the utilisation of scarce goods: If competing uses for a resource exist, an ideal market will direct the resource into the most beneficial use and will exclude less beneficial ones, thus preventing waste. However, many of the goods provided by ecosystems (including FGR) exhibit characteristics of public goods[3]. As a consequence, markets are not fully evolved for these goods, and market prices for them are either distorted or missing at all. Even if there is no market price, such goods may be positively valued by the members of society. In this case, the full willingness-to-pay for a good can be interpreted as consumer surplus, and the economic analysis would aim at quantifying this consumer surplus, or the respective willingness-to-pay (the methodology used for doing so will be described below).

Very basically, human existence is dependent on a multitude of other forms of life. An economic valuation of resources indispensable to life would be meaningless, for money values of indispensable resources are irrelevant for the basic decision of whether we want to maintain our existence. The development of safe minimum standards (PERRINGS & PEARCE 1994) seems more appropriate in this context. Value analyses us-

[3] For a definition of 'public goods', see PREGERNIG (this volume).

able for decision support purposes are only helpful for (reasonably small) changes in the supply of (environmental) goods which can be substituted in some way or the other. But even in these cases, there are some obvious problems when the market model is applied to assessing genetic resources, since these resources often differ from perfectly marketable commodities in some aspects (HAMPICKE 1991). In addition to the public good problem, many genetic resources cannot easily be substituted by other products. Even if they are substitutable, it is often very difficult to assess their potential future value, and this value may accrue only to later generations which are not represented in today's markets. Finally, allocation decisions taken today might prove irreversible if they lead to the extinction of a genetic resource, and extinction probabilities may be nearly impossible to estimate due to unknown ecological threshold effects (WISSEL & SCHMITT 1987, PERRINGS & PEARCE 1994). All these are indeed real problems. However, their basic cause is not the application of the market model for guiding allocations, but lack of knowledge. Therefore, a rejection of the market model would not contribute to a solution; the ignorance problem challenges *all* possible decision methods.

What type of object might a valuation address?

The term 'forest genetic resources' may embrace several different phenomena. First, it may be defined in a narrower sense (*i.e.* below species level only), or in a broader sense (including *e.g.* species as genetic resources). Unless otherwise noted, the term will be used in its broader sense here. Second, economic analyses may focus on various aspects of FGR, and accordingly they may draw on several different measurement concepts. Depending on the potential beneficiaries and on the value components relevant for them (cf. VIRCHOW 1999a), a valuation may address either the benefits provided by

(1) certain taxonomic units (*e.g.* crop variants, species, habitats), or

(2) the information coded in the genes of a taxonomic unit (*e.g.* the genetic structure of a species or a certain variant, or the enzymes coded by these genes), or

(3) the diversity between units (including possible interdependencies between the units which may be necessary for sustaining ecosystem services),

or a combination of these.

Many economic analyses have so far concentrated on the first mentioned possibility. Aside from common financial return analyses (*e.g.* yield analyses of tree species in conventional silviculture, or of poplar clones in short rotation plantations), several studies have investigated protection values for single species (for review see LOOMIS & WHITE 1996), or for certain habitats or areas (see ELSASSER & MEYERHOFF 2001, and contributions therein). Potential values of genetically coded information have been discussed especially with regard to protection incentives induced by commercialisation of genetic resources, mainly for use by the pharmaceutical industry and plant breeders (*e.g.*, SIMPSON *et al.* 1996, VIRCHOW 1999a, 1999b, DEKE 2001). In most of these cases, a quantification of the units relevant for valuation does not raise severe theoretical problems (although it may be practically complicated in some cases).

This is different with the quantification of diversity, because a unique definition and measurement concept is lacking here. Commonly, diversity quantification is not based on absolute numbers, but on index numbers instead. At species level, various diversity indices are used by ecologists (like *e.g.* Simpson's D or Shannon's H; see BEGON *et al.* 1990). These indices measure species richness in a community, and/or evenness of species distribution, rather than addressing the *differences* between species[4] (thus two rather similar biological units – *e.g.* elm and oak– would be attributed the same diversity metric like two dissimilar ones – *e.g.* elm and elk–). Other diversity indices used by geneticists (*e.g.*, NEI 1977) come closer to measuring differences between biological units, but they are less known outside genetics, and may be too specific for many economic purposes.

The diversity discussion within environmental economics has been seminally influenced by WEITZMAN (1992), who proposed a recursive distance measure for defining genetic diversity. This diversity measure is based at the propinquity of two species, using DNA-hybridisation for a comparison of their genetic codes. A diversity function is then derived by a recursive pairwise comparison of all species in a community, thus constituting an operational measure of diversity, or genetic dissimilarity, within the community.[5] Intuitively, this diversity function may be interpreted as a measure which captures scarcity and substitutability of genetic resources (but not their utility: the diversity function alone would ignore that people usually value diversity among gnus higher than among gnats, for instance)[6]. WEITZMAN (1993) as well as SOLOW *et al.* (1993) combined such diversity measures with estimated survival probabilities for the 15 crane species existing on earth, thus illustrating how the described approach may help in setting priorities for the protection of endangered species. The approach was further extended by WEIKARD (1998) in order to allow not only for instrumental values of diversity, but also for the value associated with the freedom of choice implied by a greater degree of diversity.

---

[4] BROCK & XEPAPADEAS (2001) have linked such diversity metrics to an economic optimisation model.

[5] Instead of genetic distances, phylogenetic distances may be used alternatively, e.g. the distances among species within the taxonomic tree.

[6] Later papers demonstrated how the diversity function can be combined WITH EXOGENOUSLY DETERMINED UTILITY MEASURES (WEITZMAN 1998, METRICK & WEITZMAN 1998).

However, some problems remain with the diversity function. A practical problem is that if larger genetic systems had to be considered (*e.g.* all species of a habitat), the information requirements for establishing the diversity function would be exorbitant (MAINWARING 2001). Beyond that, open problems exist with regard to handling evolutionary convergence (*i.e.* the development of structural similarity under equal selection pressure, *e.g.* between fishes and dolphins). More generally, for many economic questions it may be more relevant to ask for the behavioural or functional differences between species than for their genetic or phylogenetic differences. Additionally, the diversity measure does not capture the integrity of a genetic system (*e.g.* whether species are autochtonous or not, or whether the size of a population is close to a threshold), hence introducing some vulnerability into the measurement concept in cases where 'diversity' has to be linked to some notion of 'nativeness' of species or variants. In spite of these problems, the diversity function has the important merit of having directed economic research to addressing 'diversity' as a separate phenomenon, beyond counting species and varieties.

Motivations for protecting FGR as a base for valuation

The mere fact that diversity is endangered has no normative implication, and it would therefore neither logically nor politically suffice as a substantiation for taking counter measures. The claim for protection needs to be justified in the public dialogue if there are opportunity costs of protection, *i.e.* when alternative beneficial utilisations of money and other resources have to be abandoned because of a protection measure. Hence it is necessary to understand how genetic resources affect individuals' well-being before estimating values for FGR. This may include identifying the reasons why individuals have preferences for protecting FGR.

Many possible reasons exist which may be motivated either ethically or instrumentally, *inter alia* (cf. RANDALL 1991, GOWDY 1997). Ethical reasons emphasise the moral duty to protect life. This idea may be founded in an anthropocentric perspective (as an example, stewardship for future human generations is one of the reasons to claim sustainable resource management), but it may also be founded in biocentric, religious or other norms which assign other creatures an independent right to live (cf. HAMPICKE 1987). Ethical questions are relevant for economic valuation due to two reasons:

(1) First, an economic valuation of living resources does only make sense if it regards the basic ethical convictions within a society (whatever these convictions may look like); in other words, decisions based on economic valuations can be limited by ethical considerations.

(2) Second, a valuation requires that individuals are willing to trade off FGR against other goods. If individuals (or groups) do not accept this trade-off due to cer-

tain moral convictions, their preference orderings will not match the respective economic axiom system. In certain cases this problem can be empirically relevant for the analysis of valuation results (the problem is related to the one of 'lexicographic preferences', which will be discussed below).

Instrumental (or utilitarian) reasons for protection ask for the utility which FGR offer to human individuals. Following the concept of 'Total Economic Value' (TEV), these reasons may be further subdivided according to the possible motives for appreciating FGR:

(1) So-called 'use values' (or rather, utilisation motives) are based at (direct or indirect) use or consumption of a resource (as an example, a common motive for the protection of forest genetic resources is their usability for wood supply, or for nutrition and health care in other cases. Examples for use values rather oriented at some notion of resource diversity are the values people hold for early morning bird concerts in a forest, for flowering herb layers at different seasons, or even for a well spiced dinner). Such 'use values' are contrasted with different 'non use values':

(2) 'Option values' (cf. PLUMMER & HARTMANN 1987) are motivated by the wish to perpetuate decision options in the presence of incomplete information[7] (*e.g.*, one of the reasons for protecting Forest Genetic Resources is that these can sustain management options under changing climatic conditions. A well-known reason for protecting genetic diversity in tropical forests is their largely unknown pool of genetically coded information (WEIKARD 1998) which is predominantly of pharmaceutical interest; for a valuation attempt, see *e.g.* MENDELSOHN and BALICK (1995).

(3) 'Existence values' are based on the sheer awareness of the existence of a good; this may be motivated in favour of the use options of other coevals or of later generations, or it might even lack any reference to a possible utilisation (*e.g.* it seems plausible that donations for the protection of whales or for the conservation of tropical forests are largely due to existence values, for most donors will hardly ever have any direct use opportunity).

Unfortunately, the TEV concept is not used uniquely throughout the literature, and several different value classifications are used under this term.[8] It must be noted that the various elements of TEV discussed by different authors may show logical overlappings (HAMPICKE 1991). To avoid double counting, RANDALL (1992) as well as PEARCE *et al.* (1990) argue in favour of not further subdividing 'non use values' when using the TEV concept in practical applications (*i.e.* not valuing each kind of 'non use value' sep-

[7] FISHER & HANEMANN (1990) distinguish these option values from 'quasi-option values' which are motivated by the wish to sustain the possibility of individual resource use in the future (in the absence of uncertainty).
[8] The classification given above is different from PREGERNIG's (tis volume) mainly due to didactic reasons.

arately). It should be further noted that the commonly used term 'value' might be misleading in this context. Individuals may not hold separable 'use' and 'non use values' for a good; these categories should rather be interpreted as different motives determining the willingness-to-pay for a good.

Whichever classification of TEV is used, the examples given above show that the esteem for biodiversity in general, and specifically for FGR, may be strongly influenced by 'non use values'. Existence values might often be more important here than in the case of commonly marketable goods (although these goods may also be determined by existence values, *e.g.* many cultural treasures). Option values are of special importance in this context too, due to the pronounced uncertainty about the consequences of diversity losses for living systems.

Methods for analysing economic values of FGR

There are three main types of analysing marginal economic values. First, conventional market techniques are suitable in cases where markets for the resource in question already exist. Second, revealed preference techniques can be applied where markets only exist for complementary goods, but not for the interesting resource itself. And third, stated preference techniques are suited for valuation even in the absence of any market related to the resource (since this may often be the case for FGR, the presentation below will emphasise these methods and their problems).

Market prices for genetic resources

In cases where markets for genetic resources already exist, valuation analysis is relatively straightforward; it basically consists of a multiplication of market prices and resource quantity (which results in a lower bound estimate of consumer surplus)[9]. However, the result might be biased if there is market failure (*e.g.* due to incompletely assigned property rights). In this case, markets do not capture every function the resource might have for humans. Therefore one of the challenges for valuation analyses based on market prices is to identify possible market failures. If these failures exist, eliminating their causes appears a natural remedy, at least in the long run (*e.g.* by as-

[9] For a measurement of consumer plus itself, the reaction of quantity changes to price changes would have to be known in order to estimate demand curves, the area under which can be interpreted as (Marshallian) consumer surplus. Strictly speaking, this measure is still influenced by an income effect which would have to be isolated in order to derive a (Hicksian) compensated measure.

signing missing property rights, where possible). As long as such a possibility is absent, one would have to proceed with one of the 'non-market' valuation techniques described below.

The Convention on Biological Diversity (UNEP-CBD 1992) has founded an important base for defining such property rights, recognising the national sovereign rights of each country over plant genetic resources originating within its jurisdiction. Much interest has since been focussed on the possible commercial value of genetic resources, mainly for pharmaceutical or agricultural uses. For example, naturally occurring compounds from individual plant species have provided the basis for developing new pharmaceuticals, the sales of which generated annual returns of several millions of dollars to their developers (for some examples see KOO & WRIGHT 1999). Commercial values associated with some notion of 'diversity' could be generated by 'biodiversity prospecting', *i.e.* the search for chemicals still unknown today (for valuation examples and a discussion, see SIMPSON *et al*. 1996, RAUSSER & SMALL 2000, DEKE 2001).

Although such commercial values can be important – especially as an incentive to protect tropical 'biodiversity hot spots' –, they likely are of minor relevance for less diverse European forests. Moreover, they only capture a limited part of the functions genetic resources may have for humans, *i.e.* that part for which exchange markets have been established. Many (functions of) genetic resources are not marketable, they are 'natural' public goods at least to some degree. Several 'non-market' methods are available for the analysis of consumer surplus in this situation. Basically there are two options for such an analysis. If the value of a resource is reflected in prices of other (complementary) goods, it may be possible to indirectly deduce its value from these related market prices. On the other hand, consumers can be directly asked for their willingness-to-pay for a resource.

Indirect methods to analyse revealed preferences

The two customary indirect methods are the Hedonic Price Method (HPM, ROSEN 1974) and the Travel Cost Method (TCM, CLAWSON & KNETSCH 1969, BROWN & NAWAS 1973). Both methods rely on revealed preferences: They tie in with the expenses people incur in order to enjoy the benefits of an environmental resource, and analyse these expenses econometrically. The HPM utilises the resource's influence on prices of other goods. An example is the influence of a public park on the prices of adjacent houses: If housing prices are rising *ceteris paribus* with increasing proximity to the park, the economic value of the services provided by the park can be derived using this relationship. The TCM is mainly used to analyse values of recreation areas; it examines the reduction of visit rates with increasing costs of visits due to increasing distances to the recreation area. The resulting relationship is applied to derive a demand function for visits to the area, which again allows to deduce consumer surplus, or willingness-to-pay, respectively. Furthermore, TCM can be extended to estimate values for individual features of different recreation sites using Random Utility Models (see SANDEFUR *et al.* 1996, PARSONS 1999).

Although there have been several practical applications of these methods in other areas, their usefulness for a value analysis of FGR may be restricted to special cases only. The first and foremost problem is that both methods are primarily capable of analysing values motivated by direct or indirect use. Protection values determined by non use motives may be too poorly reflected by complementary markets (in case such markets exist at all). Additionally, both methods suffer from specific data problems. In the case of the HPM, trying to isolate the influence of a single natural resource on housing (or other) prices is often virtually futile, given the multitude of explanatory variables potentially relevant at the one hand, and the often limited quality of available housing price data at the other hand. In the case of the TCM, not all of the input data necessary for establishing cost-distance functions can be observed empirically; some other data are inherently unobservable and must be replaced by assumptions which cannot be fully verified for the time being (*e.g.* assumptions about time costs of travelling; cf. RANDALL [1994]).

Direct methods to analyse stated preferences in simulated markets

As already mentioned above, a valuation of FGR may often require the use of direct valuation approaches for determining the respective willingness-to-pay. These approaches use carefully structured questionnaires to collect stated preferences from a representative sample of the population; they can be subsumed under the term Contingent Valuation Method[10] (CVM, DAVIS 1963, MITCHELL & CARSON 1990). The CVM is the most flexible and powerful of the described methods in its capability to fully address also non use value motives. The basic principle of this method is to confront respondents with a hypothetical market situation in which they would have to pay for the good in question, or otherwise go without it. Essential elements of the hypothetical market have to be carefully outlined in such a survey, including an adequate description of the good in question and its attributes, the measures taken and the mechanisms used to secure the supply of this good, the institution responsible for its supply, and

[10] Alongside with CVM there exists another set of stated preference techniques called Choice Modelling. Both approaches use questionnaires of comparable design, but differ in the way they address the environmental resource of concern: CVM addresses the resource as a whole (i.e. bundling its relevant attributes), whereas Choice Modelling rather addresses the individual attributes of the resource.

other details of the institutional framing. Afterwards respondents are asked for their maximum willingness-to-pay for that good under the described circumstances. The willingness-to-pay gathered by this procedure can be interpreted as consumer surplus.[11] The valuation question itself can be formulated using different elicitation formats, including open and closed ended questions (What are you willing to pay? – Would you pay €x?), bidding games (*i.e.* auction-like questions), and payment card formats (*i.e.* asking the respondents to choose their willingness-to-pay from a list of proposed amounts). Although theoretically all customary methods for conducting surveys might be applied (by mail, by telephone, by internet, or by face-to-face interviewing), a Contingent Valuation addressing FGR should strike for statistical representativeness (which excludes internet surveys for the time being), and it might require that respondents are given extensive explanations, possibly including visual aids for a description of the good to be valued (and/or other necessary elements). In such cases, face-to-face interviewing often remains the only suitable option, unfortunately making CVM exercises rather expensive[12].

Since a state-of-the-art CVM survey addressing FGR in Europe has not been conducted yet (and would indeed require a lot of preparation), it could be misleading to present a fictive snapshot example here. Instead it may be illustrative to outline the steps necessary for conducting such a study; this is given in textbox 1.

Bias sources and reliability of stated preferences

In contrast to indirect valuation methods which interpret actual behaviour as preference revelation, CVM reflects behavioural *intentions* rather than behaviour itself, and deduces preferences from intentions. Hence models are required which link preferences, intentions, and actual behaviour. The most simplistic of these models just contend that there is no sufficient relation between these phenomena in the frame of a CVM study. If this really was the case, no inference from stated to actual preferences would be possible. Although such oversimplifications have long since been disproved, they are still sometimes mentioned in reliability discussions. A further popular pre-

---

[11] More precisely, it can be interpreted as a Hicksian compensation or variation measure (depending on the specific question).

[12] Different researchers recently reported costs between 4.50 and 160 € per interview for their CVM studies (including project management, data analysis and documentation of results), depending on survey method, sample size, and country of origin (MUTHKE 2001). According to the same source, costs for face-to-face CVM interviews in the USA and Germany were in the range of 25-150 € per interview. A single, sound FRG valuation might therefore cost some 50,000-100,000 € or even more.

sumption is that respondents generally try to manipulate valuation results by purposefully giving untruthful answers (hypothesis of strategic behaviour). Meanwhile these (and several other) bias sources have been empirically scrutinised (for an over view see MITCHELL & CARSON 1990; for a comparative empirical test of several bias sources, see ELSASSER 1999). The two general findings are first, that such biases are possible, but can be clearly limited by a careful study design; and second, that it is easier to value resources familiar to the respondents (this implies that these resources are being used, and accordingly, that they have comparatively high use values – which unfortunately is quite unlikely when valuing FGR). What is still a challenge for research is the quantification of non use values; generally 'the validity of the CV results is assumed to decrease when the good is more abstract or when the valuation motive is more related to non-use value' (WIERSTRA 1996, *loc. cit.* p. 120). Mainly three issues deserve attention especially when non use values are involved:

(1) the unequal knowledge of interview partners concerning the good in question,
(2) the problem of lexicographic preferences,
(3) and the problem of possible embedding effects.

Information problems

The first of these issues concerns an informational problem: A (simplifying) neoclassical assumption holds that rational actors have (complete and transitive) preference orderings which are stable at least over some time; respondents would thus only have to 'read off' their preferences from this ordering when asked for their valuation of a certain good. This idea may be disputable if no necessity existed to bother about the given problem prior to the survey. Especially when such public goods are concerned for which non use values are particularly relevant, it is quite probable that at least some of the respondents are only poorly informed about the good in question. This induces a dilemma: Preferences based at scanty information might neither be stable enough nor suited at all for forecasting actual behaviour in real decision situations (for if these decisions are considered important, rational individuals will at first remedy their information deficit and then correct their original preference ordering, if necessary). The obvious alternative is to provide ample information about the subject during the survey, but this option bears the danger of manipulation and leads to sampling problems: An 'artificially well informed' sample is no longer representative for the population to be surveyed (PRICE 1999).

Box 1: Steps necessary for conducting a CVM-study addressing the value of FGR

1. **Preparation**
   a. Define exactly which resource (or which measure to protect FGR) shall be valued
   b. Translate the resource (measure) into a potentially marketable commodity; identify possible beneficiaries and losers
   c. Clarify the direct and indirect side effects possibly associated with the resource (measure)
   d. Construct a plausible hypothetical market situation where the institutional frame allows the resource (measure) to be traded between individuals like a private good
2. **Questionnaire design**
   a. Draft a questionnaire based at the results of step 1 which is detailed enough for reliable results, and at the same time understandable for a lot of very different people
   b. Discuss draft questionnaire with genetics experts as well as economics/survey design experts to secure factual adequacy; discuss with several lay people to secure perspicuity; modify questionnaire accordingly
   c. Conduct some focus group discussions to learn how people understand (or misunderstand) the questionnaire, and what they really associate with the good in question; modify questionnaire accordingly
   d. Do a field pretest to learn about possible problems under field conditions, and preliminarily analyse the test data collected to avoid later data problems; modify questionnaire accordingly
3. **Data collection**
   a. Define relevant population, and conduct interviews with a representative population sample, using the questionnaire developed in step 2 (a typical CVM survey would require around 15-45 minutes for each interview; a typical sample size would be in
   b. the order of 500-1500)
   c.
   d. (Optionally) conduct parallel tests for potential bias sources
4. **Analysis**
   a. Estimate descriptive statistics for mean/median willingness-to-pay (and other relevant parameters)
   b. (Optionally) test for reliability and plausibility using regression analyses, conduct sensitivity analyses to allow for different assumptions on central parameters, compare results to other methods' results, compare to other studies
5. **Documentation**
   a. Report and explain results, include documentation of all relevant elements described above

The first measure for handling the mentioned dilemma is to limit the problem behind it. WHITEHEAD and BLOMQUIST (1991) suggest investigating the information initially available to respondents before asking any valuation questions (cf. MEYERHOFF 2001). For this purpose, they categorise respondents according to their previous experience with using the good in question (*e.g.* past on-site-user/past off-site-user/non-user), interpreting this as an indicator for the respondents' initial information level. For the following valuation questions, a sequential design seems appropriate. If it is unlikely at all that respondents are aware of the existence of a good (*e.g.* a disease resistant elm variety), it may be convenient to initially ask whether respondents ever have heard of this good. A first valuation question should be asked *before* offering any information which goes beyond the mere description of the good and the respective hypothetical market. Afterwards background information may be supplied, and respondents may be given the opportunity to revise their initial valuation (background information well suited for this purpose is every detail which respondents would collect independently; this should be determined by focus group interviews. Information which only 'experts' deem relevant might yield unrealistic results). For the sake of transparency in such a procedure, it would have to be documented how many respondents took the opportunity to revise their initial valuations, and how far initial and revised willingness-to-pay fell apart.

Lexicographic preferences

A second problem may exist with regard to the assumption that the individual preference orderings are complete and transitive. If a major number of respondents refuses to trade off biodiversity protection against money (or against any other good), this assumption may not hold. In this case, respondents will either explicitly refuse answering any WTP-question, or they will answer inconsistently (*i.e.* by giving 'protest votes' which do not reflect their willingness to pay for the good in question, but their refusal to trade it off against money. Such protest votes are usually identified by follow-up questions which scrutinise the consistency of the WTP answers). For example, HANLEY *et al.* (1995) found some 25 % 'protest votes' in several studies and interpreted this as an indication for the existence of non-transitive (or 'lexicographic'[13]) preferences. This share was indeed markedly lower in studies of other authors; in a control study for example, VEISTEN and VALEN (1997) found only about 2 % answers which might *possi-*

[13] The term 'lexicographic' derives from the alphabetical order of words in a dictionary, or lexicon; an economic definition of lexicographic preferences is 'the preferences of an individual who strictly prefers one bundle of goods to another, so long as it contains more of a particular good and regardless of the amounts of other goods in the bundle' (PEARCE & SHAW 1992, cf. FISHBURN 1974).

bly be ascribed to lexicographic preferences. Whatever the percentage may be in a specific case, it seems that environmental goods generally elicit more potentially lexicographic responses than many other public goods (ROSENBERGER *et al.* 2001).

Again, the primary option for handling this problem is to record its dimension, and to limit its consequences as far as possible (*i.e.* to avoid other causes for protest votes). A CVM study with an exceptionally large amount of answer refusals and/or protest votes (or without attempts to identify and distinguish protest votes from truthful WTP answers) would give some cause for distrust. However, if a major part of the population really had lexicographic preferences with regard to the protection of genetic resources, this would not be a problem for economic valuation analysis alone, but a general problem for *every* decision method which relies on a (utilitarian) comparison of benefits. In this case, the only problem specifically remaining for valuation analysis would again be a sampling problem: The percentage of persons showing lexicographic preferences in the sample would have to be recorded and to be taken into account when extrapolating to the total population. A promising approach for tackling this problem could emerge from the mathematical theory of Partially Ordered Sets (which include utilitarian rank orders as a special case), and from a visualisation of this theory, the Hasse Diagram Technique. This approach has already been applied to decision problems in environmental sciences (*e.g.*, BRÜGGEMANN *et al.* 1997, SIMON *et al.* 2000, VOIGT *et al.* 2000), but it has not yet entered the economic mainstream.

Embedding effects

A third problem in the current discussion is the problem of embedding effects, or part-whole biases (KAHNEMAN & KNETSCH 1992). This bias hypothesis says that respondents in a CVM survey do not sufficiently consider the aggregation level at which a good is to be valued. As an example, KAHNEMAN (1986) held embedding effects liable for his finding that respondents valued water quality improvements in *one* sea nearly at the same level like they valued water quality improvements in *all* seas of a specific region. It is controversial if this effect is really a 'bias', because it can be plausibly attributed to substitution effects which are fully compatible with economic standard theory (for a couple of alternative hypotheses see *e.g.* DEGENHARDT & GRONEMANN 1998). However, handling such effects is specially awkward when valuing biodiversity goods because of the influence of non use values: First, non use values often restrict the opportunities to experimentally control valuation results; and second, it is rather likely that non use values boost substitutive relations between different goods.

Altogether the embedding discussion accentuates that individual willingness-to-pay amounts may not generally be summable across different public goods. Valuation results are therefore only valid for the aggregation level at which the original valuation study was targeted. Comparisons between studies targeted at different aggregation levels have to be interpreted very cautiously; they are mainly useful for deducing substitution curves between different goods.

Some extensions of the CVM approach

The problems listed above have stimulated researchers to look for extensions of the CVM which could help in enhancing its acceptability specifically in cases where the valuation is affected by noticeable non use motivations. Two proposed extensions, employing a social psychology and a political science approach, shall be shortly outlined.

Integrating attitude – behaviour research

A frequent observation in regression analyses of CVM results is an unsatisfactory low correlation between willingness-to-pay and standard economical explanatory variables. This has caused an increased interest in integrating social psychological theories into the CVM approach, in order to explicitly account for the relationship between attitudes and behaviour (cf. ARROW *et al.* 1993, ENNEKING 1999). The Theory of Reasoned Action by Fishbein and Ajzen (see AJZEN 1985) has proven especially fruitful for this purpose, interpreting behavioural intentions (like stated willingness-to-pay) as a function of individual attitudes and social norms. In the CVM context, investigating attitudes aims at appraising and advancing the probability that stated behavioural intentions (willingness-to-pay) would in fact be followed by the respective behaviour (actual payment) if a market was created.

Empirical studies have showed that indeed this approach can lead to deeper insights into the motives particularly of non-users of a resource, thus improving the explanatory power of regression results at the same time (cf. WIERSTRA 1996, MOISSEINEN 1999, KOTCHEN & REILING 2000). This demonstrates that the approach is capable of reducing possible discrepancies between stated intention and actual behaviour, hence leading to a greater plausibility of elicited CVM values.

A danger however is that practical applications may easily resort to circular reasoning, given the close association between 'attitudes' and 'preferences': if preferences for a good are being explained by attitudes towards the *same* good, both approaches might simply measure the same phenomenon by different concepts, and an enhanced explanatory power would be only a consequence of this redundancy. If on the other hand preferences for a good are being explained by *general* attitudes (*e.g.* towards the environment), the concept may remain merely descriptive as long as the underlying causality is not fully understood.

Deliberative and participatory approaches

A different extension originates from political science, complementing CVM by deliberative and participatory elements (for some thoughtful arguments in favour of this approach, see SAGOFF 1998). The basic idea is to evolve preferences for a resource (or a policy linked to that resource) from a structured group discussion process, rather than to elicit them by a few one-shot answers to preformulated interview questions. The practical aim is to overcome problems associated with the high cognitive demands a standard CVM procedure might put on respondents (like the problems noted above). An additional normative aim can be to initiate public debate over resource use, accentuating the need for discursive reason (as opposed to instrumental reason; cf. HABERMAS 1981).

Following SÖDERHOLM (2001), a deliberative CVM study would in practice involve the use of moderated focus groups (or 'citizen juries') which meet several times. In a first step, group members would typically discuss the given resource use problem rather spontaneously, in order to gain a basic understanding of the problem, to identify the possible conflicts behind it, and to develop a common frame of reference. A second step might involve a discussion with expert witnesses. The last step might be devoted to a synthesis of the different views put forward (by formulating policy recommendations which imply a valuation, by expressing an explicit valuation, or by other forms). In a recent careful study, MACMILLAN *et al*. (2002) have applied this rather new extension to wild goose conservation benefits in Scotland, and have compared the results with those of a standard CVM procedure. This study shows that the participatory approach indeed offers important advantages, especially in situations where the restricted time available during a standard CVM interview would have to be considered a major obstacle. This would typically be the case with the valuation of FGR, insofar as these resources are often unfamiliar to the respondents, and therefore need much time for explanation and consideration.

The main disadvantage of such an approach lies in its possible tendency towards exclusivity. Focus groups may lack democratic control, and in most cases they will not even be statistically representative of the relevant population, involving only a (very) limited number of members due to cost reasons. Apart from several other practical problems, the approach could tempt initiators and executors of a 'deliberative CVM' to manipulate results by selecting 'convenient' focus group members, and it could tempt group members to further particular interests at the expense of third parties (cf. ELSASSER 2002, WBWi 2000). These problems must be kept in mind when further developing this promising approach.

Conclusions

Valuing forest genetic resources is no simple task, neither for researchers who want to observe other people's values, nor for the people themselves whose values shall be observed. Already many basic ecological interrelations are still poorly understood, and their economic valuation additionally imposes significant cognitive demands on researchers as well as on market or survey participants. Although methods have been developed to address even non-market values which often are of major importance for genetic resources, these methods have weaknesses which are not completely cleared today.

When assessing these methods, it is necessary to be aware of the role of economic valuation in social decision processes. Demand for monetary valuation originates from several subject areas. Examples are the design of environmental liability (*e.g.* damage compensation), the design and assessment of governmental regulations or single projects concerning the environment (*e.g.* in cost-benefit-analyses), or informational purposes (*e.g.* the extension of national accounting by satellite accounts to include environmental commodities, or the general information of politicians and the public). Precision demands are quite different in these areas (cf. ELSASSER & MEYERHOFF 2001a). While a court deciding about financial compensation for an environmental damage would need a highly reliable methodology,[14] accuracy requirements are typically much lower in the other areas mentioned above: Even with many formal cost-benefit analyses alluding to nature protection, a comparison of cost-benefit *orders of magnitude* would suffice to achieve unambiguous decisions. Even if results may be distrusted in their decimal places, using the valuation methods available seems more sensible than entirely ignoring the value of environmental commodities with reference to unresolved methodological problems, or leaving decisions solely to alleged experts and their particular interests (*loc. cit. p.* 318). Here is the part of the citation missing, ask author!

Finally, a main danger for the usefulness of valuation results does not originate from valuation technology, but from addressing inadequate questions, especially when genetic resources are concerned. If people are asked to value goods which they consider irrelevant (or which they do not well understand), valuation results will likely be unreliable. What is ultimately interesting for an end user is not the genetics of a creature or an ecosystem itself, but the consumables and services these entities yield. Therefore it might be cognitively overstraining for many people to state the value they hold for a specific genetic resource, as they would be more interested in the functions offered by this resource or by several resources together – like the buyer of a car might

[14] The European Commission has recently presented a 'white book' outlining a possible framework for future environmental liability rules which would also include damages to natural commodities, stressing the need for guidance concerning juridical damage valuation (EC 2000). Additional to this discussion, a study was published which explicitly concentrated on the possibilities to value biodiversity damages economically (EC 2001).

refuse to value the singe screws and other components of this car, not being interested in the mechanical details of an automobile, but in driving it.

References

AJZEN, I. 1985: From Intentions to Actions: A Theory of Planned Behavior. Pg. 11–39 *in*: Kuhl, J. & Beckmann, J. (eds.). Action Control: From Cognition to Behavior. Berlin, Springer, Germany.

ARROW, K.J. 1963: Social Choice and Individual Values. New Haven/London: Yale Univ. Press. (2nd edn.), United Kingdom.

ARROW, K., SOLOW, R, PORTNEY, P., LEAMER, E., RADNER, R. & SCHUMAN, H. 1993: Report of the National Oceanographic and Atmospheric Administration Panel on Contingent Valuation. *Fed. Reg.* **58**: 4601–4614.

BEGON, M., HARPER, J.L. & TOWNSEND, C.R. 1990: Ecology: Individuals, Populations, and Communities. Blackwell Scientific Publications, Boston (2nd edn.), U.S.A.

BROCK, W. & XEPAPADEAS, A. 2001: Valuing Biodiversity from an Economic Perspective: A Unified Economic, Ecological and Genetic Approach. Univ. Wisconsin – Madison, Dept. Economics: SSRI Working paper 2001–17: 32.

BROWN, W.G. & NAWAS, F.W. 1973: Impact of aggregation on the estimation of outdoor recreation demand functions. *Am. J. Agri. Econom.* **55**: 246–249.

BRÜGGEMANN, R., GINZEL, G. & STEINBERG, C. 1997: Ein mathematisches Hilfsmittel zur Harmonisierung von Interessenkonflikten bei der Ausweisung von Trinkwasserschutzgebieten. *Zeitschr. f. Umweltchemie u. Ökotoxikologie* **9**: 339–343.

CLAWSON, M. & KNETSCH, J.L. 1969: Economics of Outdoor Recreation. Johns Hopkins (Res. for the Future). (2nd edn.), Baltimore, U.S.A.

DAVIS, R.K. 1963: The Value of Outdoor Recreation: An Economic Study of the Maine Woods. Harvard Univ.: Ph.D. dissertation (quoted from MITCHELL & CARSON 1990).

DEGENHARDT, S. & GRONEMANN, S. 1998: Die Zahlungsbereitschaft von Urlaubsgästen für den Naturschutz: Theorie und Empirie des Embedding-Effektes. Peter Lang, Frankfurt a.M., Germany.

DEKE, O. 2001: Conserving biodiversity by commercialization? A model framework for a market for genetic resources. Kiel Institute of World Economics: Working Paper 1054: 31.

DOEL, H. VAN DEN & VELTHOVEN, B. VAN 1993: Democracy and Welfare Economics. Cambridge Univ. Press. (2nd edn.), Cambridge, United Kingdom.

EC (European Commission) 2000: Weißbuch zur Umwelthaftung. Luxemburg: Amt für amtl Veröffentlichungen d. Europäischen Gemeinschaften.

EC (European Commission) 2001: Study on the Valuation and Restoration of Damage to Natural Res. for the Purpose of Environm. Liability. No. B4 – 3040/2000/265781/MAR/B3.

ELSASSER, P. 1999: Recreational benefits of forests in Germany. Pg. 175–183 *in*: Roper, C.S. & Park, A. (eds.). The Living Forest. Non-Market Benefits of Forestry. The Stationery Office, London. United Kingdom.

ELSASSER, P. 2002: Rules for participation and negotiation and their possible influence on the content of a national forest program. *For. Pol. Econom.* **4**: 291–300.

ELSASSER, P. & MEYERHOFF, J. (eds.) 2001: Ökonomische Bewertung von Umweltgütern. Methodenfragen zur Kontingenten Bewertung und praktische Erfahrungen im deutschsprachigen Raum. Metropolis, Marburg, Germany.

ELSASSER, P. & MEYERHOFF, J. 2001a: Die mögliche Rolle Kontingenter Bewertungen für die Umweltpolitik. Pg. 309–322 *in*: Elsasser, P. & Meyerhoff, J. (eds.) 2001: Ökonomische Bewertung von Umweltgütern. Methodenfragen zur Kontingenten Bewertung und praktische Erfahrungen im deutschsprachigen Raum. Metropolis, Marburg, Germany.

ENNEKING, U. 1999: Ökonomische Verfahren im Naturschutz. Der Einsatz der Kontingenten Bewertung im Entscheidungsprozeß. Peter Lang, Frankfurt a.M., Germany.

FISHBURN, P.C. 1974: Lexicographic orders, utilities and decision rules: a survey. *Manage. Sci.* **20**: 1442 –1470.

FISHER, A.C. & HANEMANN, W.M. 1990: Option value: theory and measurement. *Eu. Rev. Agri. Econom.* **17**: 167–180.

GOWDY, J.M. 1997: The value of biodiversity: Markets, society, and ecosystems. *Land Econom.* **73**: 25 –41.

HABERMAS, J. 1981: Theorie des kommunikativen Handelns. Suhrkamp, Frankfurt a.M., Germany.

HAMPICKE, U. 1987: Naturschutz als ökonomisches Problem. *Zeitschr. f. Umweltpolitik u. Umweltrecht* (volume is missing, ask authors): 157–195.

HAMPICKE, U. 1991: Naturschutz-Ökonomie. Ulmer (UTB), Stuttgart, Germany.

HANLEY, N., SPASH, C. & WALKER, L. 1995: Problems in valuing the benefits of biodiversity protection. *Environm. Res. Econ*. **5**: 249–272.

JOHANSSON, P.O. 1993: Cost-Benefit Analysis of Environmental Change. Cambridge Univ. Press. Cambridge, United Kingdom.

KAHNEMAN, D. 1986: Comments on the contingent valuation method. Pg.185–194 *in*: Cummings, R.G., Brookshire, D.S. & Schulze, W.D. (eds.). Valuing Environmental Goods. An Assessment of the Contingent Valuation Method. Rowman & Allanheld, Totowa, U.S.A.

KAHNEMAN, D. & KNETSCH, J.L. 1992: Valuing public goods: The purchase of moral satisfaction. *J. Environm.. Econom. Manage.* **22**: 57–70.

KOO, B. & WRIGHT, B.D. 1999: The role of biodiversity products as incentives for conserving biological diversity: some instructive examples. *Sci. Total Environ.* **240**: 21–31.

KOTCHEN, M.J. & REILING, S.D. 2000: Environmental Attitudes, motivations, and contingent valuation of nonuse values: a case study involving endangered species. *Ecol. Econom.* **32**: 93–107.

LOOMIS, J.B. & WHITE, D.S. 1996: Economic benefits of rare and endangered species: summary and meta-analysis. *Ecol. Econom.* **18**: 197–206.

MACMILLAN, D.C., PHILIP, L., HANLEY, N. & ALVAREZ-FARIZO, B. 2002: Valuing the non-market benefits of wild goose conservation: a comparison of interview and group-based approaches. *Ecol. Econom.* **43**: 49–59:

MAINWARING, L. 2001: Biodiversity, Biocomplexity, and the Economics of Genetic Dissimilarity. *Land Econ.* **77**: 79–83:

MENDELSOHN, R. & BALICK, M.J. 1995: The value of undiscovered pharmaceuticals in tropical forests. *Econom. Bot.* **49**: 223–228.

METRICK, A. & WEITZMAN, M.L. 1998: Conflicts and choices in biodiversity preservation. *J. Econom. Perspect.* **12**: 21–34.

MEYERHOFF, J. 2001: Nicht-Nutzungsabhängige Wertschätzungen und ihre Aufnahme in die Kosten-Nutzen-Analyse. *Zeitschr. f. Umweltpolitik u. Umweltrecht* **24**: 393–416.

MOISSEINEN, E. 1999: On behavioural intentions in the case of the Saimaa Seal. Comparing the contingent valuation approach and attitude-behaviour research. Pg. 183–204 *in*: O'Connor, M. & Spash C.L. (eds.). Valuation and the Environment. Theory, Method and Practice. Edward Elgar Publishing. town, country ask author

MITCHELL, R.C. & CARSON, R.T. 1990: Using Surveys to Value Public Goods: The Contingent Valuation Method. Resources for the Future, 2nd. edn., Washington D.C., U.S.A.

MUTHKE, T. 2001: Benefit Transfer: Eine Alternative zur primären Bewertung von Umweltgütern? Pg. 269–290 *in*: Elsasser, P. & Meyerhoff, J. (eds.).Ökonomische Bewertung von Umweltgütern. Methodenfragen zur Kontingenten Bewertung und praktische Erfahrungen im deutschsprachigen Raum. Metropolis, Marburg, Germany.

NEI, M. 1977: F-statistics and analysis of gene diversity in subdivided populations. *Ann. Human Genet.* **41**: 225–233.

PARSONS, G. 1999: A Bibliography of Revealed Preference Random Utility Models in Recreation Demand. http://www.csba.uncwil.edu/people/whiteheadj/aere/links/parsons.

PEARCE, D.W., MARKANDYA, A. & BARBIER, E.B. 1990: Blueprint for a Green Economy. Earthscan. 4th edn., London, United Kingdom.

PEARCE, D.W. & SHAW, R. (eds.) 1992: The MIT dictionary of modern economics. MIT Press, 4th edition, Cambridge, United Kingdom.

PERRINGS, L. & PEARCE, D. 1994: Threshold effects and incentives for the conservation of biodiversity. *Environ. Res. Econom.* **4**: 13–28.

PLUMMER, M.L. & HARTMAN, R.C. 1987: Option value: A general approach. *Econom. Inquiry* **24**: 455 –471.

PRICE, C. 1999: Contingent valuation and retrograde information bias. Pg. 37–44 *in*: Roper, C.S. & Park, A. (eds.). The Living Forest. Non-Market Benefits of Forestry. The Stationery Office , London, United Kingdom.

RANDALL, A. 1991: The value of biodiversity. *Ambio* **20**: 64–68.

RANDALL, A. 1992: A total value framework for benefit estimation. Pg. 87–111 *n*: Peterson, G.L., Swanson, C.S., Mccollum, D.W. & Thomas, M.H. (eds.). Valuing Wildlife Resources in Alaska. Westview Press, Boulder, U.S.A.

RANDALL A. 1994: A difficulity with the travel cost method. *Land Econom.* **70**: 88–96.

RAUSSER, G. & SMALL, A.A. 2000: Valuing research leads: Bioprospecting and the value of genetic resources. *J. Pol. Econom.* **108**: 173–206.

ROSEN, S. 1974: Hedonic prices and implicit markets: Product differentiation in pure competition. *J. Pol. Econom.* **82**: 34–55.

ROSENBERGER, R.S., PETERSON, G.L., CLARKE, A. & BROWN, T.C. 2001: Dispositions for Lexicographic Preferences of Environmental Goods: Integrating Economics, Psychology, and Ethics. RRI Res. Paper 2001–12. Morgantown, WV: Regional Res.Inst., West Virginia University, U.S.A.

SAGOFF, M. 1998: Aggregation and deliberation in valuing environmental public goods: A look beyond contingent pricing. *Ecol. Econom.* **24**: 213–230.

SANDEFUR, R.A., JOHNSON, F.R. & FOWLER, R.B. 1996: An Introduction to the Random Utility Model. Durham (NC): Triangle Economic Res.Working Paper G–9602: 13.

SIMON, U., PUDENZ, S. & BRÜGGEMANN, R. 2000: Ansätze zur integrativen Bewertung wasserwirtschaftlicher Maßnahmen am Beispiel Berlins. Pg. 149–163 *in:* WEIGERT, B., STEINBERG, C., & BRÜGGEMANN, R. (eds.). Chemische Stressfaktoren in aquatischen Systemen. Schriftenr. Interdisziplinären Forschungsverbundes Wasserforschung in Berlin.

SIMPSON, R.D., SEDJO, R.A. & REID, J.W. 1996: Valuing biodiversity for use in pharmaceutical Research. *J. Pol. Econom.* **104**: 163–185.

SÖDERHOLM, P. 2001: The deliberative approach in environmental valuation. *J. Econom.* **35**: 487–495.

SOHMEN, E. 1992: Allokationstheorie und Wirtschaftspolitik. Mohr (Paul Siebeck),(2nd edition), Tübingen, Germany.

SOLOW, A., POLASKY, S. & BROADUS, J. 1993: On the Measurement of biological diversity. J. *Environm. Econom. Manage*. **24**: 60–68.

UNEP-CBD (United Nations Conference Environment Programme – Convention on Biological Diversity.) 1992: Convention on Biological Diversity. UNEP/BIO.Div./CONF/L.2. http://www.biodiv.org/chm/conv/cbd_text_e.pdf.

VEISTEN, K. & VALEN, J.S.Y. 1997: Lexicographic Preferences in contingent valuation of biodiversity. Pg. 160–169 *in*: BUTTOUD, G., JÖBSTL, H. & MERLO, M. (eds.). Proceedings of the International Symposium 'Recent Developments in Accounting and Managerial Economics for an Environmentally-Friendly Forestry'. Nancy/France. 20–23 April 1997. Publisher missing, ask author

VIRCHOW, D. 1999a: Economic value of genetic resources: an agenda for res. *AgBiotechNet* **1**: 1–6.

VIRCHOW, D. 1999b: Conservation of Genetic Resources: Costs and Implications for a Sustainable Utilization of Plant Genetic Resources for Food and Agriculture. Springer, Berlin, Germany.

VOIGT, K., GASTEIGER, R, J. & BRÜGGEMANN, R. 2000: Comparative evaluation of chemical and environmental online and CD-ROM databases. *J. Chem. Inform. Computer Sci.* **40**: 44–49.

WBWi (Wissenschaftlicher Beirat beim Bundesministerium für Wirtschaft und Technologie) (2000): Aktuelle Formen des Korporatismus. Gutachten vom 20. 6. 2000. http://www.bmwi.de/download/korporatismus.doc.

WEIKARD, H.-P. 1998: Der Wert der Artenvielfalt: Eine methodische Herausforderung an die Ökonomik. *Zeitschr. f. Umweltpolitik u. Umweltrecht* **2**: 263–273.

WEITZMAN, M.L. 1992: On diversity. *Quart. J. Econom.* **106**: 363–405.

WEITZMAN, M.L. 1993: What to preserve? An application of diversity theory to crane conservation. *Quart. J. Econom.* **108**: 157–183.

WEITZMAN, M.L. 1998: The Noah's Ark problem. *Econometrica* **66**: 1279–1298.

WHITEHEAD, J.C. & BLOMQUIST, A. 1991: A link between behaviour, information, and existence value. *Leisure Sci.* **13**: 97–109.

WIERSTRA, E. 1996: On the domain of contingent valuation. Twente Univ. Press, Enschede, The Netherlands.

WISSEL, C. & SCHMITT, T. 1987: How to avoid extinction of populations optimally exploited. *Math. Biosci.* **84**: 127–138.