ELSEVIER

Ecological Economics 42 (2002) 459–467

ECOLOGICAL ECONOMICS

This article is also available online at:
www.elsevier.com/locate/ecolecon

ANALYSIS

Knowledge and recognition of ecosystem services among the general public in a drainage basin in Scania, Southern Sweden

Lillemor Lewan [a,*], Tore Söderqvist [b]

[a] *Centre for Environmental Studies, Lund University, Svenska vägen 19, SE-22639 Lund, Sweden*
[b] *Beijer International Institute of Ecological Economics, The Royal Swedish Academy of Sciences, Box 50005, SE-10405 Stockholm, Sweden*

Received 30 June 2000; received in revised form 21 May 2002; accepted 22 May 2002

Abstract

Human preferences are likely to depend on such things as knowledge and information, propaganda and advertising, and formal (laws) and informal (norms) institutions. We focus on knowledge about how nature works and how this may be manifested in recognition of ecosystem services among the general public. Participants and non-participants in a plant nutrient abatement programme with detention ponds in a river drainage area in Scania, Southern Sweden, were asked to rank some selected ecosystem services, classified as visible services, invisible services and services involving human activities in nature. Three studied groups of local actors were originally not familiar with the concept of ecosystem services, but the concept was easily grasped. The results of the study include the following findings: (1) The groups of local actors were consistent in ranking the groups of visible and invisible services higher than the group of services involving human activities, but there were considerable differences in their ranking of individual services. (2) The generally high priority given to invisible services can partly, but not fully, be explained by the existence of the abatement programme. (3) There was uncertainty regarding relationships among and the relative importance of different ecosystem services. (4) Some informants had multiple preferences. In fact the role people chose to play may have larger impact on preferences than the level of information. (5) Several interviewees objected to the idea of ranking services, and preferred to view nature as a whole. The results are discussed from a knowledge perspective, and we conclude that a widespread recognition of ecosystem services in policy and economics cannot be expected until the general public has gained some critical level of basic knowledge about functions in nature.

Keywords: Knowledge; Ecosystem services; Preferences; Ranking; Plant nutrient

1. Introduction

The concept of ecosystem services has become firmly established in the vocabulary of ecological economics. It also seems to have gained attention

* Corresponding author. Tel.: +46-46-123222
E-mail address: lillemor.lewan@miclu.lu.se (L. Lewan).

0921-8009/02/$ - see front matter
PII: S0921-8009(02)00127-1

in wider scientific circles and among some policy-makers. This is at least partly likely to be due to publications such as Baskin (1997), Costanza et al. (1997) and Daily (1997). But what about the general public? It might be the case that the often abstract nature of ecosystem services implies an obstacle to widespread public understanding and recognition. Broadly speaking, people are not scientists and thus might not be able to grasp what ecosystem services such as 'translocation of nutrients' and 'decomposition of wastes' (Daily, 1997, p. 3–4) are about, and what benefits they give society. It might also be the case that people, at least to some extent, recognise what are here called 'ecosystem services', but in a different way than scientists would expect because of a non-scientific worldview (cf. Burgess et al., 2000).

One point of departure to study nature's support to humans is to find out how people actually use nature by enjoying, e.g. silence, fishing or other human activities. Another point of departure would be scientifically based definitions of particular ecosystem services. We believe that some of these services are more difficult to comprehend than other ones. Some services can be perceived with the senses. For simplicity, we call them 'visible services' here. In contrast, 'invisible services' require instruments for detection and observation. Both these types of services require knowledge in order to be understood. But while the knowledge required to understand visible services could be based on experience, the understanding of invisible services depends on theoretical learning.

In order to make these ideas more concrete, consider the example of an apple tree, and the goods and services it provides. We would guess that the easiest goods and services to grasp are food (the apples), but also the shade the tree offers on a hot summer's day and the beauty it proffers, not least when it is decked with flowers. A greater degree of knowledge is necessary for interpreting other visible phenomena as services. For example, if equipped with enough knowledge, an observation of a bee's visit to the apple blossoms is interpreted as pollination and a step in the production not only of apples, but also of honey in the neighbour's hive. Considerably more abstract and totally dependent on theoretical learning is an interpretation of the apple tree as a provider of life-support services by producing oxygen along with photosynthesis, or as being part of an ecosystem with intricate links to other organisms.

Is there any correlation between the degree of abstraction and the recognition of ecosystem services? It may be hypothesised that this correlation is negative for individuals who have little theoretical learning about how nature works. If so, they would tend to recognise highly abstract ecosystem services to a relatively low degree. However, while it is indeed a possibility, this does not necessarily imply a positive correlation in the case of individuals who have good theoretical learning. For example, their learning might imply that they tend to see the relationships between different functions in nature to a greater extent and thus experience difficulties in viewing individual services (whether visible or invisible) in isolation from other ones.

In order to illustrate these issues and stimulate further discussions and research, we have made a small-scale empirical study of the degree of people's recognition of various ecosystem services in a river drainage area in Southern Sweden. Section 2 describes how we collected data by organising meetings and distributing a questionnaire about ecosystem services. The results are presented in Section 3. A discussion and conclusions are found in Section 4.

2. Data collection

The purpose of the data collection was to find out to what degree people recognise various ecosystem services provided by nature in the Kävlinge River drainage basin in SW Scania, southernmost Sweden. We conducted the empirical study in 1997–1998 in relation to a local plant nutrient abatement programme focusing on detention ponds and buffer zones along watercourses. Data were collected from the following groups of informants:

(I) A mixed group of 62 farmers and other local stakeholders (officials, politicians, researchers)

was recruited to a meeting by letters of invitation. They were all more or less involved in the local nutrient abatement programme. A discussion took place at the meeting, and a questionnaire was distributed to all group members. Responses came from 19 farmers and 20 other stakeholders.

(IIa, IIb, IIc) Three focus groups with a total of 22 representatives of the general public in the Kävlinge River drainage basin were recruited by advertisements in local newspapers inviting people interested in local nature. None of them were farmers, and they were not involved in the local nutrient abatement programme. One meeting per focus group was held and all group members also received a questionnaire. All gave complete answers.

(III) A group of 119 randomly selected farmers was recruited through the farmers' local organisation. No meeting with these farmers was held, but they all received a mail questionnaire. They were familiar with the introduction of ponds for plant nutrient abatement in the area. Fifty-eight farmers gave complete answers.

The data collection made use of a set of 11 selected ecosystem services for studying the degree to which they were recognised by the informants; see Table 1. The selection of services is, to a large extent, explained by the local setting. Four of the services are 'invisible' in the sense discussed in Section 1, and theoretical learning is thus needed for comprehending them: (d) carbon dioxide uptake by growing trees/plants, (e) wetlands' plant nutrient reduction, (f) contribution of weathering to soil fertility, and (k) nitrogen uptake by alders and leguminous plants. Three services are visible phenomena in nature and can be spontaneously understood as services: (a) rainfall, (c) wild plants and animals, and (j) predation by birds of vermin insects. The four remaining services are very concrete; they reflect how people enjoy nature: (b) silence, (g) opportunities for hunting, (h) opportunities for fishing, and (i) other opportunities for enjoying nature. These three subsets of services will be referred to as 'invisible services', 'visible services' and 'human activities in nature' in the following.

A set of 11 social services was also selected, see Table 1. They served mainly as a background and explanation to discussions about ecosystem services and they will only very briefly be subject to empirical analysis in this paper. Comparing the two sets of services also illustrated the difference between them. The social ones are organised by individual or cooperative human activity along with social development. Prices are set by the market or by political decisions. Prices for social services can be negotiated, and the actual costs can be calculated. In contrast, ecosystem services are the result of long-term geo-chemical and biological evolution and now under increasing human impact. Harvested products and similar goods from nature are typically marketed and prices negotiated, but many ecosystem services are not marketed and thus unpriced.

Table 1
Ecosystem services and social services listed

A	Ecosystem services	B	Social services
a	Rainfall	1	Jobs in farming and forestry
b	Opportunities for enjoying silence	2	Jobs, other private enterprises
c	Wild plants and animals	3	Jobs, state and municipal
d	Carbon dioxide uptake by growing trees/plants	4	Care of children and elderly
e	Wetlands' Plant nutrient reduction	5	School education
f	Contribution of weathering to soil fertility	6	Medical care, dentistry
g	Opportunities for hunting	7	Public transport
h	Opportunities for fishing	8	Private transportation (car)
i	Other opportunities for enjoying nature	9	Non-governmental organisations
j	Predation by birds of vermin insects	10	Cure of souls
k	Nitrogen uptake by leguminous plants and alders	11	Telephone/electronic information

The degree of recognition of the services was measured by a simple ranking exercise. In the questionnaire, informants were asked to rank the 11 ecosystem services and the 11 social services respectively from first (the most important service) to eleventh (the least important service). They were also invited to add their own examples to the two lists of services. The concept of ecosystem services was briefly explained to the participants in groups I and IIa–IIc before the ranking exercise, but the relative importance of the services was not discussed at this stage. Group III was only approached by the questionnaire together with written material giving information on the plant nutrient abatement programme, but not on ecosystem services in general. They were just asked to rank the phenomena in Table 1 according to personal appreciation.

On the whole, the brief oral (groups I and IIa–IIc) or written (group III) introduction to the issues given to the informants is not likely to have caused any major change in their initial recognition of ecosystem services. However, at the focus group meetings of IIa–IIc, the ecosystem services were subject to a more in-depth discussion and comparison to the social services after an initial ranking made by the participants. A short presentation of the functions of nature from a natural science point of view was also given. The ranking exercise was repeated after this presentation and the discussions, which meant that the participants were given an opportunity to revise their earlier rankings. These possibly revised rankings might have been influenced by the presentation and the discussions.

3. Results

In general, the concept of ecosystem services seemed to be new to the informants. This was true also for many informants with a background in natural science, such as local environmental officers. However, the general concept—but not necessarily individual services—seemed to be grasped after a brief introduction and the comparison to social services. Several informants opposed the idea of ranking pieces of nature and rather wanted nature to be seen as a whole; see also below. The list of social services and their possible ranking were discussed in the groups. A major difficulty here was to identify the chicken and the egg. However, there was a general agreement that school education is most important and basic to the functioning of other activities in society.

3.1. The stakeholder group (I)

Some informants in group I ranked all listed ecosystem services from first to eleventh. Table 2 is based on their answers, showing the proportion of informants who ranked a service first, second and third. Other informants included just some of the services in their ranking or gave the same number to two or several services. There were also some protests against the whole idea of ranking ecosystem services ('*[nature] is* one *object only!*').

Table 2 shows that 44% of the informants ranked wetlands' reduction of plant nutrients first. This focus on the ecosystem service provided by wetlands is readily explained by the informants' involvement in the nutrient abatement programme. Twenty-eight percent ranked wild plants and animals first, 8% ranked rainfall first and 8% ranked silence first. General enjoyment of nature, CO_2 uptake by growing trees/plants, predation by birds of vermin insects and hunting opportunities were also viewed as relatively important services. Farmers differed by giving rainfall and CO_2 uptake a higher priority than the other informants in group I. In general, the three services related to human activities in nature tended to be viewed as being of relatively low importance.

Table 3 is based on the three subsets of ecosystem services identified in Section 2, i.e. invisible services, visible services and human activities in nature. For each informant, we ranked these subsets first, second or third according to the mean value of the ranking given by the informant to the individual services included in each subset. We then computed the total number of subsets ranked first, second and third. These totals are reported in Table 3. The table shows that visible and invisible services were generally ranked above human activities in nature. For example, human

Table 2
Group I's ranking of ecosystem services

	Highest rank (percentage of answers given)			2nd highest rank (percentage of answers given)			3rd highest rank (percentage of answers given)		
	Farmers $n = 19$	Other respondents $n = 20$	All respondents $n = 39$	Farmers $n = 19$	Other respondents $n = 19$	All respondents $n = 38$	Farmers $n = 18$	Other respondents $n = 19$	All respondents $n = 37$
Invisible services									
CO_2 uptake by growing trees/plants	11	0	5	10	5	8	22	0	11
Wetlands' plant nutrient reduction	42	45	44	16	21	18	17	5	11
Contribution of weathering to soil fertility	0	0	0	0	5	3	6	5	5
Nitrogen uptake by alders and leguminous plants	0	0	0	0	5	3	6	5	5
Visible services									
Rainfall	11	5	8	16	0	8	0	0	0
Wild plants and animals	21	35	28	26	32	29	11	10	11
Predation by birds of vermin insects	0	0	0	0	0	0	11	10	11
Human activities in nature									
Opportunities for enjoying silence	5	10	8	21	5	13	11	5	8
Opportunities for hunting	5	0	3	0	5	3	11	10	11
Opportunities for fishing	0	0	0	0	5	3	0	16	8
Other opportunities for enjoying nature	0	5	3	10	16	13	6	32	19
Other: 'Fertile soils'	5	0	3	0	0	0	0	0	0
Total[a]	100	100	102	99	99	101	101	98	100

Source: Answers from 39 informants. Their answers were consistent with the instruction in the question (63%), though one respondent ranked only one service and one respondent ranked only two services. Answers from 12 informants were not consistent with the instruction (19%) and 11 informants did not deliver any answer (18%).

[a] Totals not equal to 100 are due to rounding errors.

Table 3
Group I's ranking of three subsets of ecosystem services

	Invisible services	Visible services	Human activities in nature
No. of rank 1	10 (31%)	16 (50%)	6 (19%)
No. of rank 2	15 (47%)	11 (34%)	6 (19%)
No. of rank 3	7 (22%)	5 (16%)	20 (62%)
Total	32 (100%)	32 (100%)	32 (100%)

Source: Answers from 32 informants out of 62 allowed the computation of mean values of their ranking for each subset of services.

activities in nature were only ranked first in 19% of the cases.

3.2. The focus groups (IIa–IIc)

In conformity with group I, more than half of the participants in the focus groups ranked visible services first, slightly less than 50% ranked invisible services first, and just a few ranked human activities first see Table 4. Especially the participants with tertiary natural science education tended to rank the ecosystem services from an evolutionary perspective, acknowledging that rainfall contributing water is the first prerequisite for life, uptake of CO_2 for photosynthesis is basic in nature, the contribution of weathering is essential to soil fertility, and uptake of nitrogen by leguminous plants and alders improves soil fertility.

When the answers to the ranking question had been collected, a discussion arose about the difficulty of providing a full ranking. The arguments typically concerned the relationship among ecosystem services, and to what extent some services are more fundamental than other ones. A few participants commented that their ranking depends on what preferences they choose to have in focus. They said: "*there is a difference [for the valuation] if I have myself or society as the point of departure for the valuation*", "*[when valuing,] I try to think as an environmentalist, but I don't fully succeed*" and "*[when valuing,] am I supposed to think as a mother, as an employee, as an environmentalist or as who?*"

A further discussion was stimulated by providing the participants a brief presentation of services and their relationships from a natural science point of view. After the discussion, the participants received a new copy of the questionnaire and were asked to rank the services again. In the new ranking, the subset of services related to human activities in nature was not ranked first at all, and this is likely to be due to the presentation and the discussion.

3.3. The farmer group (III)

Fifty-eight informants in group III gave a complete answer to the ranking question. Table 5 shows their mean ranking of the 11 ecosystem services. Like the farmers in group I, they tended

Table 4
Group II's ranking of three subsets of ecosystem services

	Invisible services		Visible services		Human activities in nature	
	Before discussion	After discussion	Before discussion	After discussion	Before discussion	After discussion
No. of rank 1	9 (41%)	10 (48%)	13 (59%)	13 (62%)	3 (14%)	0 (0%)
No. of rank 2	8 (36%)	5 (24%)	7 (32%)	8 (38%)	3 (14%)	5 (24%)
No. of rank 3	5 (23%)	6 (28%)	2 (9%)	0 (0%)	16 (72%)	16 (76%)
Total	22 (100%)	21 (100%)	22 (100%)	21 (100%)	22 (100%)	21 (100%)

Source: Answers from 22 (before discussion) and 21 (after discussion) informants out of 22 allowed the computation of mean values of their ranking for each subset of services.

Table 5
Group III's ranking (mean values) of listed ecosystem services 58 farmers

Invisible services	
CO_2 uptake by growing trees/plants	4.1
Wetlands' Plant nutrient reduction	3.7
Contribution of weathering to soil fertility	6.6
Nitrogen uptake by leguminous plants and alders	7.3
Visible services	
Rainfall	4.3
Wild plants and animals	3.9
Predation by birds of vermin insects	7.0
Human activities in nature	
Opportunities for enjoying silence	7.6
Opportunities for hunting	6.8
Opportunities for fishing	8.0
Other opportunities for enjoying nature	6.6

Other alternatives mentioned: to be part of the eco-cycling system, quality of life, good environment for children, freedom, horses, riding, income.

to rank elimination of plant nutrients in wetlands first. On average, wild plants and animals, CO_2 uptake and rainfall were ranked second, third and fourth, respectively. Lower priority was given to opportunities for fishing and silence, nitrogen uptake by alders and leguminous plants, and birds' predation of vermin insects. Note that the participants considered elimination of excess plant nutrients to be more important than nitrogen uptake by alders and leguminous plants. The perceived importance of wetlands' nutrient reduction is likely to be due to the existence of the local nutrient abatement programme and the information that the informants have received on this programme. Interestingly, contribution of weathering to soil fertility was considered as being of relatively little importance, possibly because of the availability of cheap commercial fertilisers.

Table 6 reports how group III ranked the three subsets of ecosystem services. Despite the fact that group III was not provided any introduction to ecosystem services, the results are similar to those of groups I and IIa–IIc: a clear dominance of the visible and invisible services over human activities. This is thus a result valid for all groups included in this empirical study.

4. Discussion

The informants in the empirical study were in general not acquainted with the concept of ecosystem services. When asked to rank the selected services, many informants were not able to provide a full ranking. Instead, they emphasised nature as a whole rather than specific ecosystem services. It was therefore not surprising that the discussions with the informants in groups I and IIa–IIc typically concerned the relationship among different ecosystem services, and to what extent some services are more fundamental than other ones. However, a general result from the ranking exercise was that visible and invisible services were ranked above services involving human activities such as enjoying silence or hunting and fishing. The fact that priority was often given to invisible services is likely to be partly explained by the current attention to detention ponds and buffer zones in the local plant nutrient abatement programme. However, the degree of involvement in the programme did not provide any explanation for the degree of recognition of invisible services; the results were similar for groups I, IIa–IIc and III, despite the fact that only group I mainly consisted of informants involved in the programme. We therefore interpret the high priority given to invisible services as not only being dependent on the ongoing nutrient abatement programme. Moreover, the subset of ecosystem services labelled as 'human activities in nature' was ranked below visible and invisible services by all groups. This suggests that there was a basic natural scientific knowledge among the informants of the functioning of nature. Moreover, there were many comments from informants indicating knowledge about functions in nature, and this is also likely to explain an emphasis on the visible and invisible services. In fact, some discussions indicated that an evolutionary perspective on ecosystem services could be one ground for ranking them, making rainfall into a basic life-support service.

Some participants in the focus groups were uncertain about what preferences they should choose to use in the ranking exercise. Their private opinions were not always in agreement with those

Table 6
Group III's ranking of three subsets of ecosystem services

	Invisible services	Visible services	Human activities in nature
No. of rank 1	33 (43%)	36 (47%)	13 (17%)
No. of rank 2	31 (40%)	33 (43%)	17 (22%)
No. of rank 3	13 (17%)	8 (10%)	47 (61%)
Total	77 (100%)	77 (100%)	77 (100%)

Source: Answers from 77 informants out of 119 allowed the computation of mean values of their ranking for each subset of services.

felt to be expected from the family, employers or society. This finding gives support to the hypothesis that people do not necessarily have a fixed set of preferences when they participate in a complex exercise aiming at value judgements (Gregory et al., 1993). On the contrary, their choice of preferences seems to depend on whom they choose to represent in the exercise. For example, Sagoff (1988) suggested that every individual might either play the role of consumer or the role of citizen; while a person's preferences in his or her role as a consumer is largely determined by self-interest, the good of society is in focus for his or her preferences as a citizen. Even results from very simple ranking exercises such as the one in our empirical study may thus be difficult to interpret if the issue of multiple preferences within one individual are not approached by including, for example, instructions or questions to respondents related to this issue. This difficulty is likely to be present also in more advanced valuation exercises, such as contingent valuation surveys and choice experiments; see e.g. Carson et al. (2001) and Adamowicz et al. (1998) for reviews of these methods. While it is analytically convenient to assume the existence of well-defined and given human preferences, an improved understanding of economic and other human behaviour would require increased attention to the endogenous nature of preferences, i.e. the dependence of human preferences on such things as knowledge and information, worldviews and ethics, propaganda and advertising, and formal and informal institutions; see also e.g. Costanza and Folke (1997) and Norton et al. (1998).

Are there reasons to be concerned about the uncertainty some informants showed when ranking the ecosystem services? We believe so, and this has to do with the difficulties of economising on these services. Ecosystem goods and services are the result of long-term geo-chemical and biological evolution. Thanks to this evolution, the planet was successively transformed from empty desert to green habitats sufficiently stabilised for human life. Ecosystem services have always been used by consumers, i.e. animals and humans, for feeding, extra-somatic constructions and commodities. The stabilising effect of the ecosystems on the climate and their roles in the cycles of water, carbon, oxygen, nitrogen and other elements will always be of the utmost importance to human beings. There are thus good reasons to take into account natural scientists' warnings that some natural resources, biologically productive areas and environmental space for pollution are limited. Still, ecosystem services have generally been neglected in policies and management because of global redundancy and the great promise that new technology seems to offer. The typically non-market nature of ecosystem services make them invisible in the present economic system. A widespread recognition of such services cannot be expected until the general public has gained some critical level of basic knowledge regarding the functions in nature. Still, democracy requires political decision-making to be based on the preferences of individuals. This is also the standard premise in economics. This position nourishes considerations about whose preferences should count. For example, it has been suggested that only the preferences of well-informed individuals should be taken into account, introducing problems of how to measure knowledge and screen individuals; see Hausman and McPherson (1996) for a review. In this context, we

note that the number of individuals who are well informed about a broad set of issues is likely to diminish in many modern societies because of these societies' reliance on a system of specialisation for solving problems. We conclude that there is an increasing need for developing political decision-making mechanisms that cope with the difficult combination of both economising on ecosystem services and having sufficient respect for individual preferences. This suggests efforts for building consensus on natural resources use, one of the many suggested interpretations of sustainable development (de Graaf et al., 1996).

We would finally allow ourselves to remind readers that humans are also a part of the ongoing evolution on the planet. While being consumers of ecosystem services, humans have also developed a capacity for understanding and recognising their reliance on nature. In that sense, we feel that we are being realists, not optimists, when we agree with Markl (1999, p. 359):

> 'Through the evolution of the conscious mind in the human species, nature became aware of itself and can thus for the first time in more than three billion years of natural evolution, influence and even to some degree, take control of its own future development according to intentional goals'.

Acknowledgements

We are grateful to three anonymous referees for helpful comments. This paper describes work that was partly carried out in the research project 'Ecological-Economic Analysis of Wetlands: Functions, Values and Dynamics' (ECOWET). Funding from the EU/DGXII Environment and Climate Programme (Contract No. ENV4-CT96-0273) and the Swedish Council for Planning and Coordination of Research (FRN) is gratefully acknowledged.

References

Adamowicz, W., Boxall, P., Williams, M., Louviere, J., 1998. Stated preferences approaches to measuring passive use values. American Journal of Agricultural Economics 80, 64–75.

Baskin, Y., 1997. The Work of Nature: How the Diversity of Life Sustains Us. Island Press, Washington, DC.

Burgess, J., Clark, J., Harrison, C.M., 2000. Knowledges in action: an actor network analysis of a wetland agri-environment scheme. Ecological Economics 35, 119–132.

Carson, R.T., Flores, N.E., Meade, N.F., 2001. Contingent valuation: controversies and evidence. Environmental and Resource Economics 19, 173–210.

Costanza, R., Folke, C., 1997. Valuing ecosystem services with efficiency, fairness, and sustainability as goals. In: Daily, G.C. (Ed.), Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington, DC, pp. 49–68.

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

Daily, G.C. (Ed.), Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington, DC 1997.

de Graaf, H.J., Musters, C.J.M., ter Keurs, W.J., 1996. Sustainable development: looking for new strategies. Ecological Economics 16, 205–216.

Gregory, R., Lichtenstein, S., Slovic, P., 1993. Valuing environmental resources: a constructive approach. Journal of Risk and Uncertainty 7, 177–197.

Hausman, D.M., McPherson, M.S., 1996. Economic Analysis and Moral Philosophy. Cambridge University Press, Cambridge, UK.

Markl, H.S., 1999. The future of nature. In: European Review, vol. 7/3. Academia Europea, UK, pp. 359–369.

Norton, B., Costanza, R., Bishop, R.C., 1998. The evolution of preferences: why 'sovereign' preferences may not lead to sustainable policies and what to do about it. Ecological Economics 24, 193–211.

Sagoff, M., 1988. The Economy of the Earth: Philosophy, Law, and the Environment. Cambridge University Press, Cambridge.