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Utilitarian and nonutilitarian valuation of natural resources: A game-theoretical approach

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Abstract

Ecological services such as food, fresh water, fuel, minerals, and flood control – to name only a few – are essential conditions for human well-being. Many of the areas that provide such services – wetlands, coastal areas, and deserts – are common pool resources, which are characterized by non-excludability and subtractability. That makes them vulnerable to collective action problems such as the prisoner's dilemma, where individual and collective interests collide and ultimately result in overexploitation and degradation. Damaged areas that provide ecological services are increasingly recognized as targets for ecological restoration. However, restored areas run the risk of back-sliding to the previous state if their common pool characteristics are ignored. Collective action problems are often analyzed from a game-theoretical perspective that usually assumes rational, self-interested individuals, who do not take collective and nonutilitarian perspectives into account. However, people do not value natural resources just for utilitarian reasons but also because of ethical nonutilitarian ones. This paper develops a multiple-actor game-theoretical approach to one's "value achievement" by taking into account both utilitarian and nonutilitarian perspectives. It demonstrates that someone's value achievement is contingent on choices made by others and that considering nonutilitarian perspectives may avoid the prisoner's dilemma. Accordingly, this model is empirically confirmed by a survey among life-sciences and biology students by presenting them a hypothetical case of a restored natural area. Based on these results, it is argued that emphasizing nonutilitarian considerations may be an important additional strategy in conservation and restoration projects.

Keywords

Ecological restoration, Ecological services, Common pool resources, Prisoner's dilemma, Game theory, Value achievement

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Implications

- Restoration projects that aim to restore common pool resources should take into account the vulnerability of these areas and the related societal circumstances.
- An exclusive focus on ecosystem services and utilitarian gains in restoration ecology underestimates the role of nonutilitarian motives.
- A lower utilitarian profit may nevertheless lead to a higher value achievement if one recognizes the nonutilitarian value of nature.
- Involvement of local people in restoration and conservation projects should be accompanied by communicative, discursive, and reflective activities concerning the value of natural resources in order to mobilize nonutilitarian valuation motives.

Introduction

It is increasingly recognized that ecological services are a critical condition for future human well-being on a global scale. Well-functioning ecosystems provide mankind with essential goods and services such as food, fresh water, fuel, and minerals, for example. They are essential for climate and water system regulation, nutrient cycling, soil formation, flood control, primary production, carbon storage, etc. Moreover, ecosystems provide us with cultural services such as spiritual, religious and aesthetic values, along with opportunities for recreational and educational use (MEA 2005). In this context ecological restoration is increasingly recognized as a global priority due to the globally disruptive effects of desertification, land degradation, and climate warming on ecosystem services – to name just a few – which have such consequences for the well-being of humanity (e.g., Aronson et al. 2007; Aronson and Alexander 2013). Moreover, international policy bodies recognize the role of ecosystem services. Articles 14 and 15 of the Aichi targets, formulated at the 2010 Conference of the Parties (COP) and reaffirmed by later COP meetings of the Convention of Biological Diversity (CBD), for example, acknowledge the importance of ecological services and the role of ecological restoration (CBD 2010; 2012; 2014).

Recently, Alexander and colleagues (2016) stressed the relevance of ecosystem services for restoration: "The desirability of different ecosystem services dictates the form of restoration or rehabilitation to be undertaken." The concept of ecosystem services is related to the concept of natural capital: the stocks of natural resources that facilitate the continuous and sustainable flow of services to societies (Aronson et al. 2007). Many ecosystems, such as wetlands, forests, natural grasslands, and the oceans with their fish populations, are examples of natural capital, because they deliver important ecosystem services to humanity. Many of these examples of natural capital – although not all – are especially vulnerable, because they must be considered as common pool resources, characterized by non-excludability and subtractability (Ostrom 2010). Non-excludability implies that it is very difficult to exclude people from utilizing the resource. For example, it is very difficult to restrict herders from letting their flocks grazing on open access rangelands. Subtractability means that utilization reduces the availability of the resource for others; thus grazing by one decreases the grazing opportunities for other herders.

As a consequence, decisions that are profitable for individual users of a common pool resource may, all things being equal, be disastrous for the group of users as a whole because of the cumulative detrimental effects from all users of the resource. This so-called "Tragedy of the Commons" (Hardin 1968) is a collective action problem where individuals reap the benefits of the resource at the cost of the common good of all. This may result in overexploitation and degradation of natural resources, for instance, in terms of collapsed fish populations, fresh water pollution, desertification, erosion, and biodiversity loss (Feeny et al. 1990; Garrity 2012; Hardin 1998). Hardin (1968) believed that private ownership of natural resources and top-down, state-led measures were needed to prevent such disasters. However, Elinor Ostrom has demonstrated that community-based approaches, where local communities have the opportunity to set their own rules in order to prevent overexploitation, may also work (Ostrom 1990; 2010).

The recognition that overexploitation and degradation of natural resources may be causally related to common pool characteristics implies that ecological restoration should take into account the related societal issues. If a degraded natural area has been successfully restored, it is important that the causal human and social conditions be mitigated to avoid a backsliding of the area to the previous state, later on. Ecological restoration may thus imply social-ecological system approaches (Gosnell & Kelly 2010; Petursdottir et al. 2013). Collective action problems are often analyzed by means of game-theoretical analyses. In conservation biology and ecological restoration, we also find these approaches (Buckley & Holl 2013; Busby & Albers 2010; Colyvan et al. 2011; Frank & Sarkar 2010). However these approaches focus on costs and profits, and conflicts between stakeholders (environmental managers, land owners, governments, farmers, etc.), thus stressing the affected utilitarian, anthropocentric interests of stakeholders.

In this paper, we will be taking another approach, because people do not consider nature from such anthropocentric and utilitarian perspectives alone. Many people believe that nature and natural landscapes should also be preserved or restored for non-anthropocentric and nonutilitarian reasons, for example, because of their intrinsic value, as a civic duty, or because of the rights of future human and non-human generations (Dietz et al. 2003; Dobson 1998; Paavola 2003/2004; Gelissen 2007). In our "value game" approach, we use the terms utilitarian and nonutilitarian values to distinguish between these two main environmental-ethics positions. First, we will sketch a multi-actor game-theoretical model for the valuation of natural resources and illustrate the model by a numerical example. Next, we will report on a survey experiment among biology and life-sciences students to test the model. Finally, we will discuss our results and the implications for environmental communication and policymaking strategies in restoration and conservation projects.

Theory

Conflicting interests in environmental issues are often illustrated by the well-known prisoner's dilemma metaphor, a scenario in which two actors act according to their self-interests, which then prevents a better outcome for them both. For example, suppose that two fishermen are both free to choose between moderate fishing and maximizing fishing in a pond given the payoffs from the four combinations (see Case A in Figure 1). The best-shared solution is that both choose for moderate fishing. However, it is tempting for one actor to maximize his or her fishing efforts if the other actor chooses for moderate fishing, because he will then reap a much higher profit. Because this is also the case for the other fisherman, both may reap a payoff of only 5 units, in this example, whereas 10 units for both could have been possible (Figure 1, Case A). This suboptimal result is called a Nash equilibrium, meaning that an actor has nothing to gain by changing his or her strategy, given the maximizing strategy by the other.

Case A

		Actor II: Moderate use	Actor II: Maximized use
Actor I	Moderate use	(10, 10)	(2, 12)
	Maximized use	(12, 2)	(**5, 5**)

Case B: $\alpha = 0.4; \beta = 0.6$

		Moderate use	Maximized use
Actor I	Moderate use	(**10, 10**)	(5.9, 4.1)
	Maximized use	(4.1, 5.9)	(5, 5)

Case C: $\alpha = 0.8; \beta = 0.2$

		Moderate use	Maximized use
Actor I	Moderate use	(**10, 10**)	(2.9, 8.4)
	Maximized use	(8.4, 2.9)	(**5, 5**)

Figure 1. Game-theoretical representation of possible payoffs of two actors (e.g. fishermen), who can choose between moderate and maximized use (e.g., fishing) (Cases A and B are taken from Lejano & De Castro [2014]). The numbers between parentheses in Case A are hypothesized payoffs units for Actors I and II, respectively. In Cases B and C, the numbers between parentheses are derived utilities based on the payoffs in Case A, according to $U_i = p_i^{\alpha} p_j^{\beta}$. In all cases, the underscored and bold payoffs are stable configurations (Nash equilibria), implying that actors cannot turn individually to another strategy without losing payoffs, given the maximizing strategy by the other. In Case A, both actors only take their own payoffs into account, which leads to a prisoner's dilemma. In Cases B and C, both actors also take the payoff for the other into account (see text). This avoids the prisoner's dilemma. However, in Case C, there are two stable equilibriums, implying that, although moderate use is profitable for both, when both start with maximum utilization, they cannot turn individually to moderate use without losing payoffs.

However, people do not just behave out of selfish considerations. Acheson and Gardner (2011), for example, describe how lobster fishers in the state of Maine (USA) were able to avoid the prisoner's dilemma trap by establishing a socially shared rule not to take egg-bearing lobsters. Lejano and De Castro (2014) argue that compassion for others and social norms also determine one's actions and that altruistic considerations can be incorporated in a utility function: $U = f\,(p_1, p_2, \ldots p_n)$, where U is the utility, f is a functional expression, and $(p_1, p_2, \ldots p_n)$ is a vector of payoffs of the actors involved. These authors applied a Cobb-Douglas function to model an altruistic two-actor situation:

$$U_i = kp_i^{\alpha} p_j^{\beta} \quad \text{Eq. 1}$$

where U_i is the actor i's utility, k is a constant, p_i and p_j are the payoffs for actor i and j, respectively, and α and β are coefficients representing, respectively, the strength of selfish and altruistic attitudes of actor i. Lejano and De Castro (2014) demonstrate that Equation 1 with $k=1$, and $\alpha=0.4$, and $\beta=0.6$ results in an escape from the prisoner's dilemma (see Case B in Figure 1). In Case C in Figure 1, with $\alpha=0.8$ and $\beta=0.2$ we get a so-called assurance game outcome (Dixit et al. 2015), which is characterized by two equilibriums: one with the optimal result, the other with the suboptimal result as in Case A. Of course, whether or not the prisoner's dilemma will indeed be avoided also depends on the nature of the preference function U_i.

Valuation achievements of the use of common pool resources

In our approach, we will elaborate on the approach by Lejano and De Castro (2014) by applying a similar reasoning to the utilization of common pool resources, in which utilitarian and nonutilitarian motives are involved. Suppose that an actor takes p_u units (e.g., fish, timber, etc.) from a common pool resource. Because this common pool resource is a subtractable resource, $(p_{max}-p_u)$ units remain in the resource pool, where p_{max} is the total available size of the resource. We also assume that an actor may be willing to limit his profit for nonutilitarian reasons. Those reasons may be: for other people, for eco-centric reasons, for future generations, etc. In this context both p_u and $(p_{max}-p_u)$ contribute to one's utility, albeit for different reasons, i.e. because of utilitarian and a nonutilitarian considerations, respectively. Figure 2 shows the construction of this model. We prefer to use the term "value achievement" (V) instead of "utility" (U), because the latter term sounds inappropriate for the nonutilitarian value considerations used in our approach. Analogous to the approach by Lejano and De Castro (2014), we assume that the total value achievement can be described by a Cobb-Douglas function.

$$V=kp_u^{\alpha}(p_{max}-p_u)^{\beta} \quad \text{Eq. 2}$$

where k is a constant, and α and β are coefficients representing the strength of utilitarian and nonutilitarian motives, respectively. Lejano and De Castro (2014) sum up α and β to 1. However, in

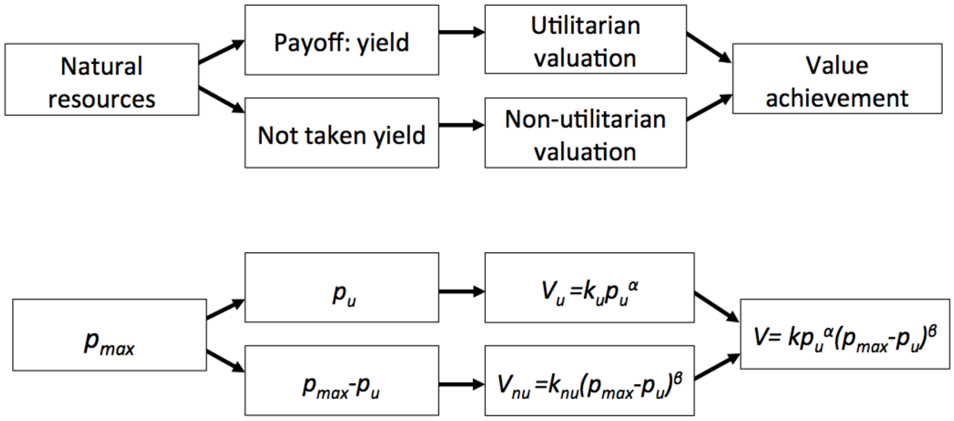

Figure 2. Schematic model of the value achievement approach. The lower scheme is a mathematical representation of the upper scheme (see text in the section Theory).

our model we consider nonutilitarian motives as being additional motives, since we see no reason why utilitarian motives would reduce the strength of competing nonutilitarian motives. In general, assuming a diminishing marginal utility for both α and β this implies that $0 \leq \alpha, \beta < 1$. Equation 2 results in a hill-shaped curve with a maximum value of V (by taking $dV/dp_u = 0$) at: $p_u = p_{max}\, \alpha/(\alpha+\beta)$, see Figure 3 with two arbitrary examples. Thus the maximum value achievement is gained by a moderate payoff, if nonutilitarian motives play a role.

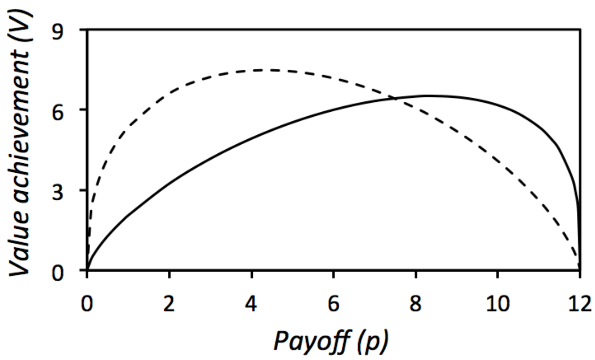

Figure 3. Two examples of value achievements based on a combination of utilitarian and nonutilitarian valuation of a payoff from a hypothetical resource according to Equation 2 (see text) in which $k = 1$; $p_{max} = 12$. Solid line: $\alpha = 0.7$, $\beta = 0.3$; Dashed line: $\alpha = 0.4$, $\beta = 0.7$. The value of p_u with the maximal value of V can be derived by calculating dV/dp_u=0 which results in $p_u = p_{max}\, \alpha/(\alpha+\beta)$. The maximal value of V of the solid line is at $p_u = 8.4$ and of the dashed line at $p_u = 4.36$.

Multiple users

Most environmental problems are not a two-actor prisoner's dilemma but involve many actors. A multiple-actor situation can be described by plotting an actor's payoff against the number of all the moderate actors involved (Dixit et al. 2015). A moderate user is someone who refrains from any possible maximal utilization for nonutilitarian reasons. As an example, in Figure 4A we see two payoff plots expressing the utilization of natural resources by maximizing users and moderate users, as a function of the number of moderate users (n). The function $p_{mod}(n)$ expresses moderate payoffs, the function $p_{max}(n)$ expresses payoffs of the remaining *(N-n),* maximizing users. For every payoff according to $p_{mod}(n)$, there is a corresponding higher payoff according to $p_{max}(n)$. Both functions show increasing payoffs (from left to right along the *x*-axis) with an increase in the number of moderate users because of the less negative effects on the resource through decreasing numbers of maximizing users. Thus p_{max} is not a constant anymore as in Equation 2 but a variable that depends on the number of moderate actors *(n)*.

Now, suppose that all actors are moderate users ($n=N$) and aim to reap payoffs from the resource at level *P*, because it is expected that it will guarantee a sustainable and durable yield for all. Similar to the case of the two actors, a single actor may decide to maximize his or her use because of the tempting higher payoff, according to $p_{max}(n)$. As a consequence, the payoffs for all the other actors are reduced somewhat. Furthermore, the number of moderate actors will decrease and the number of maximizing actors will increase, each with one actor (see inset in Figure 4A). As long as $p_{max}(n-1)>p_{mod}(n)$, it is attractive for everyone to make the change to maximizing use, thus to choose profits at the level of line *R-S*. If all actors behave according to this reasoning, they all will end up at position *S*, whereas the better position *P* would be possible. Thus, as in the two-actor prisoner's dilemma, the multiple-actor prisoner's dilemma leads to a non-optimal result.

However, let us assume that moderate users do not change to line *R-S* because of additional, nonutilitarian considerations, which also contribute to their value achievement (see Figure 2). The more moderate users there are, the less the negative effects will result through the remaining maximizing users. This may result in a higher value achievement for the moderate users because of the resulting higher ecological quality of the natural resource. In case of strong nonutilitarian attitudes it may be perhaps, even higher than the value achievement of maximizing users that only consists of their utilitarian payoff. This situation is illustrated by line *P'-Q* which crosses line *R-S* at a point $n=N_c$. The point $n=N_c$ functions as a tipping point for value achievement. Assuming that the actors aim for maximizing their value achievement will move moderate users above $n=Nc$ to point *P';* however, below $n=N_c$, it will move them to point *S*. The point $n=Nc$ functions as a tipping point for value achievement.

Thus the inclusion of nonutilitarian considerations with respect to natural resources may lead to achieving a higher value. However, one's value achievement and the accompanying rational choice will also be contingent on the behavior of other people. To test this hypothesis we performed a numerical simulation and an empirical test.

Simulation of a multiple-actor value game

Based on Equation 2, we define two value achievement functions in a multiple-user situation: V_{max} and V_{mod} as functions of maximizing and moderate payoffs, respectively, and the number of moderate users (n). To do so, we replaced the term p_u in Equation 2 by p_{max} in V_{max} and by p_{mod} in V_{mod}. Moreover, it is assumed for simplicity's sake that the constant *k* in Equation 2 is equal to 1 and that the nonutilitarian coefficient is $\beta=0$ in the case of the maximizing (purely utilitarian) actors. Finally, we must use $p_{max}(n-1)$ in the function V_{mod} instead of $p_{max}(n)$ because of the reduction of the number of complying actors (n), if an actor switches to maximizing use (see inset Figure 4A). This results in:

$V_{max}(n)=[p_{max}(n)]^{\alpha}$ Eq. 3

and

$V_{mod}(n)=[p_{mod}(n)]^{\alpha}\ [p_{max}(n\text{-}1)\text{-}\ p_{mod}(n)]^{\beta}$ Eq. 4

Now, suppose we have 100 actors using a common pool resource (e.g., an open-access grazing area), and that moderate users and maximizing users reap payoffs as given in Case A in Figure 1A. Thus, if all actors limit their use in order to maintain a moderate and therefore sustainable use of the resources, their payoff is 10 units at $n=N=100$. However, if users switch to maximizing use, moderate payoffs will decrease through degradation of the resources. At $n=0$ the payoff is only 2 units. Also, the payoffs of maximizing users will decrease, but they are higher over the whole range than those of moderate users: 12 units at $n=N=100$ and 5 units at $n=0$. For simplicity's sake, we assume a linear relationship (comparable to Figure 4A) for both payoffs functions and the number of moderate users:

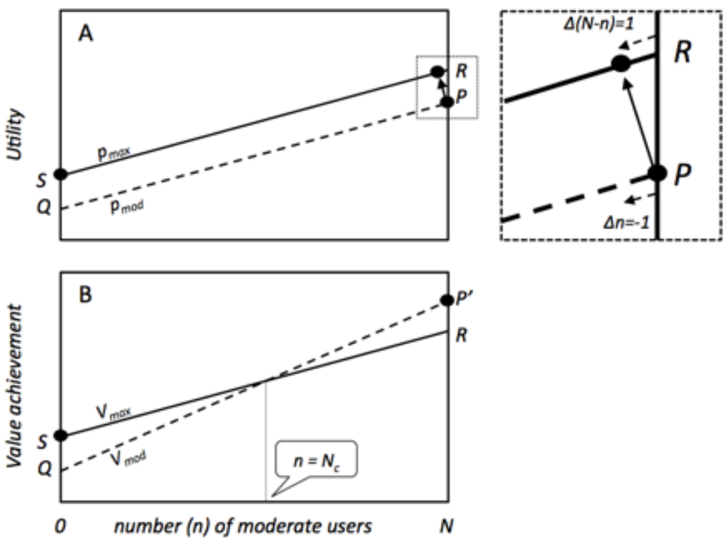

Figure 4. Box A: Multiple-actor prisoner's dilemma. Box B: Multi-actor value achievements model, in which nonutilitarian values are considered in the model. Legends are Solid line: maximizing users; Dashed lines: moderate users; n: number of moderate actors; N: total number of actors involved; N_c: critical number of moderate users above the value achievement for moderate use is higher than maximizing use (see text in the section Theory for further explanation).

$p_{max}(n)=0.07n+5$ Eq. 5

and

$p_{mod}(n)=0.08n+2$ Eq. 6

where p_{max} and p_{mod} are the payoffs of maximizing and moderate users, respectively, and n is the number of moderate actors. Substituting p_{max} and p_{mod} in Equations 3 and 4 for Equations 5 and 6, respectively, results in corresponding value achievement functions:

$V_{max}(n)=[0.07n+5]^{\alpha}$ Eq. 7

and

$V_{mod}(n)=[0.08n+2]^{\alpha}\ [2.93\text{-}0.01n]^{\beta}$ Eq. 8

In Figure 5, we have plotted some examples of Equations 7 and 8 with $\alpha=0.8$ in all cases. The solid line in Figure 5 represents the value achievement of maximizing users (Equation 7), and the Dashed lines the value achievements of moderate users (Equation 8) for different values of β. This figure demonstrates that, in contrast to Figure 4B, value achievements need not to be represented by straight lines, even if the payoff functions are given by simple linear functions. The plots of Equations 7 and 8 cross each other in case of β=0.4 somewhere at $n=32$. Thus in case of β=0.4 the value achievement of a moderate actor appears to be higher than that of a maximizing actor, if the number of moderate actors is higher than 32. Below that point, nonutilitarian valuation does not sufficiently compensate for the reduced utilitarian valuation. For $\beta=0.6$, nonutilitarian value compensation happens for nearly all values of the number of moderate users (n). However, if $\beta=0.2$, such compensation does not occur at all. Thus, the numerical simulation supports the idea that at higher values of the nonutilitarian coefficient β, one's value achievement through moderate use may in a sense compensate for utility loss, but that it is also contingent on the number of actors that follow a moderate strategy.

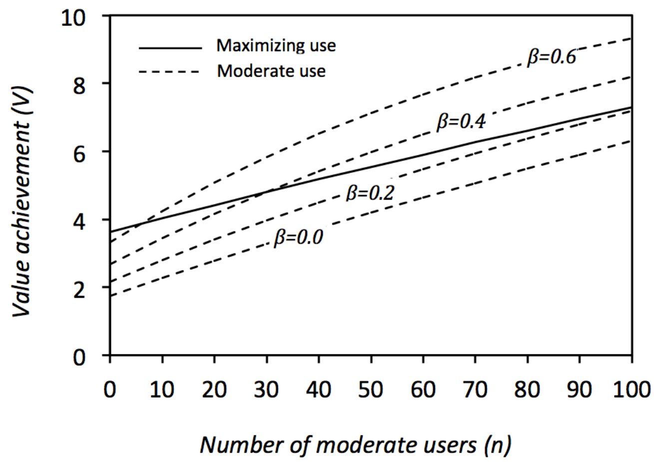

Figure 5. Examples of value achievement based on Equations 7 and 8 with α=0.8 for all cases. Legends are Solid line: Value achievement maximizing users (V_{max}) based on Equation 7; Dashed lines: Value achievements moderate users (V_{mod}) based on Equation 8; β : nonutilitarian coefficient in Equation 8 (see text for further explanation).

An empirical test

Suppose we have a successfully restored natural area, where rare bird species now breed. In order to protect the area, the nature conservation organization involved has asked the local population if they are willing to use a new and alternative footpath through the area during the breeding season (March 1 to June 30), instead of the already existing footpath that goes right through the most vulnerable part of the area. The new footpath is, however, less attractive than the old footpath.

From a purely utilitarian point of view, compliance to the request will lead to a lower utilitarian payoff (that is: less pleasure) because of the lower level of natural beauty of that area. However, we hypothesize that, in spite of a lower utilitarian payoff, compliance with the request by the natural protection organization may nevertheless result in a higher value achievement as compared to non-compliance because of nonutilitarian motives. To test this hypothesis, we assessed value achievements that resemble the points of *P', Q, R,* and *S* in Figure 5 by means of a questionnaire given to second-year biology and life sciences students at the University of Groningen, the Netherlands, during a course that was supervised by the authors of this paper.

Methods

In our questionnaire, based on an approach by Chua (2003), we asked the respondents to evaluate four situations with respect to the request by the nature conservation organization not to use the footpath through the vulnerable area during the breeding season, as described above (see also Appendix A1).

- A1: Assume that EVERYONE (including yourself) follows the request to use only the new footpath outside the vulnerable part of the natural area during the breeding season.
- A2: Assume that ONLY YOU will make use of the new footpath. Thus nearly everyone will still make use of the path through the vulnerable part of the natural area during the breeding season.
- A3: Assume that ONLY YOU will make use of the path through the vulnerable part of the natural area during the breeding season. Nearly everyone else uses the new footpath.
- A4: Assume that EVERYONE (including yourself) still makes use of the path through the vulnerable part of the natural area during the breeding season.

Thus A1 and A2 refer to compliance; A3 and A4 refer to non-compliance with the request by the nature conservation organization. The four situations, A1, A2, A3, and A4, respectively, represent the points *P'*, *Q*, *R*, and *S* in Figure 4B. The survey ended with a question about how great the chance was that the respondent would comply with such a request in reality. The reason for this last question was to distinguish between subgroups with possibly different distributions of utilitarian and nonutilitarian motives. In addition to these questions, we also asked for information on age, sex, study specialization or major, and year of arrival at our university to get an idea of the researched population.

For each situation (A1, A2, A3, and A4), the respondents were asked how much they agreed with the four items expressing the valuation statement of the described situation, using a 5-point Likert scale (see Appendix A1). For all four situations, the same set of value items was used. So the differences related to the situations described. The mean value scores of the items with regard to the A1, A2, A3, and A4 situations represent, respectively, the respondent's value achievement of complying when 1) all others also comply *($n=N$)*, 2) he or she is the only one who complies *($n=1$)*, 3) the respondent is the only one who does not comply *($n=N-1$)*, and 4) nobody complies *($n=0$)*.

Our first hypothesis is that the resulting value achievements are an increasing function of the number of complying respondents, thus that of A1>A2 and A3>A4. Our second hypothesis is that somebody's value achievement through compliance differs from non-compliance behavior, thus A1≠A3 and or A2≠A4 (ignoring the differences between *n=N* and *n=N-1*, and *n=1* and *n=0*, respectively).

Prior to the survey, the questionnaire was tested with smaller student groups from third- and fourth-year courses and the clarity of the described situations and value statements was accordingly discussed with them. The survey was taken on the first day of the second-year course in Science, Ethics, Technology, and Society in 2016. Participation in the survey was voluntary, and the survey was anonymous. Course assistants put the data from the survey into an Excel sheet and double-checked them for errors. Subsequently, the data were transported to an IBM SPPS statistics 23 data file for statistical analysis.

Based on the outcomes of the last question as to their behavior in a real case, we divided the students into a high scoring group (HS group) of people that scored 50% or higher and a low scoring group (LS group) of people that scored below 50%. We calculated Cronbach's alpha in order to determine the reliability of the respondent's answers on items related to the situations A1, A2, A3, and A4. Assuming an ordinal nature for the Likert-scale data, we applied a Related Samples Wilcoxon Signed Rank test to compare the values of A1, A2, A3, and A4, according to the hypothesized relationships described above for all respondents, male and female groups, and the HS and LS groups.

Results

In the analysis, we only included questionnaires in which the four situations (A1, A2, A3, and A4) and the last question on compliance in a real case were completed. This resulted in 164 (84%) useable surveys. The majority of the respondents were female (55.5%) The mean age was 20.2 years (range: 18-29 years; S.E.M.=0.14). About half of our respondents were majoring in biomedical sciences. Our sample represents a typical second-year student population in life sciences and biology studies in the Netherlands. Table 1 gives an overview of the respondents.

Table 1. Overview of the respondents in the survey.

Total students invited	196
Total respondents	170
Total valid questionnaires	164
Mean age (16 respondents missing)	20.2 years
Women	91
Men	73
Specializations or majors (1 respondent missing)	
General Biology	4
Molecular Life Sciences	17
Behavior- and Neurosciences	27
Ecology and Evolution	34
Biomedical Sciences and related majors	81

In general, the calculated Cronbach's alphas (see Table 2) indicate sufficient reliability of the responses to the four sets of statements for each situation. Only the reliability of A1 in the HS group and female responders were just below the level of 0.70 that is usually recommended. All other reliabilities were above that level. Accepting the reliability of the responses, it appears from our analysis that our first hypothesis, implying that value achievement is an increasing function of the number of complying respondents (Hypothesis I), was confirmed for both the compliance (A1>A2) and non-compliance strategy (A3>A4), although the difference in the latter case is rather small. It appears that A1>A3, meaning that, if everybody complies (thus $n=N$), the expected value achievement turns out to be maximum. If nobody complies ($n=0$), there is no significant difference between the mean A2 and A4 values in the all-respondents groups, the male and female groups, and the HS groups. However, the LS group shows a value for A2 that is a significantly lower value than A4 at $n=0$. Thus the value achievement of compliance for the number of complying respondents close to $n=0$ is lower than that of non-complying respondents (see Table 2 and Figure 6, in which we have plotted the value achievements by the LS and HS groups).

Table 2. Statistics of the survey on value scores by respondents in four situations (A1, A2, A3, and A4) (see Appendix A1). The HS and LS groups refer to respondents who indicated that they estimated the chance >50%, respectively < 50% that they would comply with the request by the nature protection organization in reality. The *p*-values were generated by the SPSS Related Samples Wilcoxon Signed Rank test.

		All	Male	Female	HS	LS
Subgroup size		164	73	91	131	33
Cronbach's α	A1	0.74	0.77	0.69	0.65	0.81
	A2	0.78	0.81	0.76	0.80	0.74
	A3	0.86	0.84	0.87	0.85	0.86
	A4	0.87	0.87	0.87	0.88	0.83
Mean (SE)	A1	4.33 (0.04)	4.25 (0.07)	4.04 (0.54)	4.43 (0.04)	3.95 (0.13)
	A2	1.99 (0.07)	2.02 (0.11)	1.98 (0.08)	2.01 (0.08)	1.90 (0.13)
	A3	2.47 (0.08)	2.56 (0.12)	2.40 (0.10)	2.36 (0.08)	2.95 (0.18)
	A4	2.12 (0.07)	2.21 (0.11)	2.04 (0.09)	2.02 (0.08)	2.51 (0.15)
p	*A1>A2*	0.000	0.000	0.000	0.000	0.000
	A3>A4	0.000	0.003	0.001	0.000	0.019
	$A1 \neq A3$	0.000	0.000	0.000	0.000	0.000
	$A2 \neq A4$	0.149*	0.138*	0.547*	0.785*	0.006

*: Not significant $p \geq 0.05$.

Although we have drawn straight lines between A1 and A2 and between A3 and A4 in Figure 6, we may not assume a linear relationship, since we do not know the actual functions of these lines. Thus we cannot determine where the lines of the LS group in Figure 6B cross each other. But we may conclude that if the numbers of complying respondents in the LS group is small, thus close to $n=0$, compliance will lead to a lower value achievement; in contrast, if the numbers of complying respondents is close to $n=N$, compliance results in a higher value achievement than non-compliance. The differences for A1, A3, and A4 between the LS and HS group are, respectively, 0.48, 0.59, 0.48 on the 5-point Likert scale, with significant levels $p<0.05$ (Mann-Whitney U test). The difference between the A2 values is -0.11 units and not significant. Thus, the crossing of the two lines in Figure 6B seems likely to be the result of an upward shift in the value achievement of the non-compliance strategy (A3-A4 line) by the LS group, as compared to the HS group over the full range of the number of complying respondents, indicating a stronger utilitarian attitude. We also analyzed the different major groups (see Table 1). However this did not result in sharp differences with the all-respondents group in Table 2 (data not shown).

In conclusion, considering compliance to be an expression of a nonutilitarian attitude, the analysis of the survey confirms the value achievement model and is in line with the simulation. Moreover, the survey question about compliance in a real situation demonstrates that respondents may differ with respect to their nonutilitarian attitudes.

We administered our survey to young biology students but cannot help wondering what the outcomes would have been with a broader group of people. We hypothesize a similar distribution of utilitarian and nonutilitarian attitudes with regard to ecological restoration across gender, age, and social variables (Gobster et al. 2016). Our survey assessed attitudes towards a hypothesized restoration project and indicated the willingness of people to adapt their behavior for utilitarian and nonutilitarian reasons. We believe that such an empirical approach might also be useful in advance of the implementation of real restoration projects, to collect information on people's attitudes regarding the proposed projects. This might give restoration managers a chance to adjust their projects so as to gain greater public support.

General discussion

The results of the survey confirm the idea that limitation of the use of resources may contribute to someone's total value achievements and that this behavior is contingent on behavior of others. Thus, value games, in which value is attributed to the act of not using natural resources, may lead to different outcomes compared to classic, purely utilitarian payoff games. This is in line with Lejano and De Castro (2014), who focused on altruistic behavior towards other users. We applied their approach in the context of the utilitarian and nonutilitarian valuation of natural resources and extended their analysis to a multiple-actor case where nonutilitarian valuation of natural resources implies a positive value towards non-use that may compensate for the reduced utilitarian-value achievement.

However, the fewer moderate users there are, the smaller the nonutilitarian value achieved because of the detrimental effect on the natural resource. This might even result in a sort of tipping point, below which nonutilitarian considerations would be overridden by utilitarian considerations, as demonstrated in Figure 4 and confirmed by the numerical simulations and the LS group in the survey experiment.

In general, nonutilitarian orientations all have one thing in common, which is that one refrains from full utilization of natural resources for the benefit of "the other," whoever or whatever "the other" is. Thus the coefficient β in Equation 2 may refer to different and/or multiple types of nonutilitarian considerations. People may restrict their use of the commons or of natural resources for different nonutilitarian reasons. In many Western societies this might primarily be due to ecocentric considerations (Swart et al. 2001) or to a recognition of the rights of wild animals (Swart & Keulartz 2011), but in more traditional societies it might instead be related to spiritual or religious considerations (Houde 2007).

It might be argued that all these nonutilitarian motives contribute to the satisfaction of one's own key values and that they should be considered as utilitarian motives after all. However, this reasoning ignores the debate on utilitarian and nonutilitarian environmental ethics. Because of our more ethical perspective, we introduced the term "value achievement" instead of the term "utility" to distinguish between these ethical orientations.

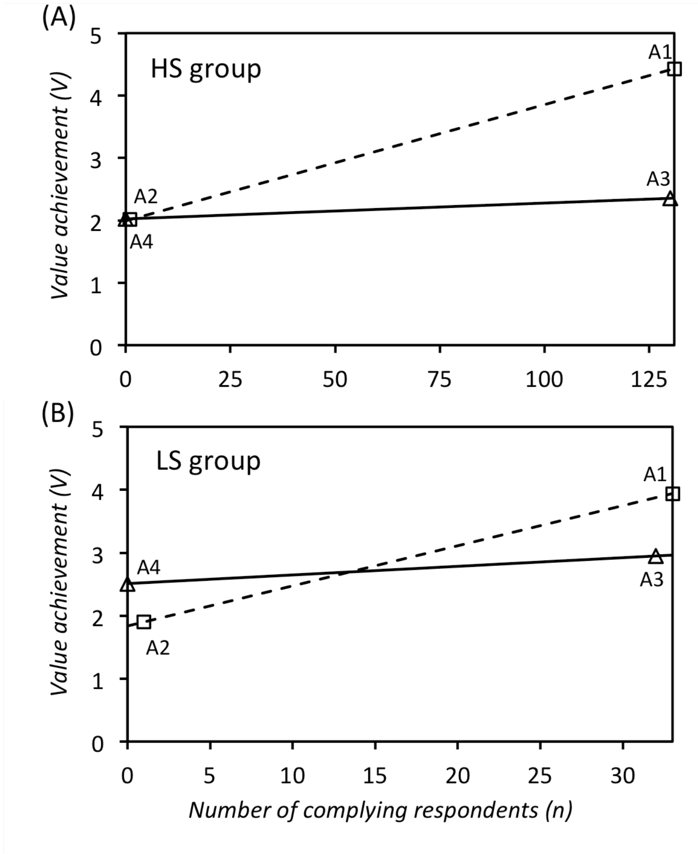

Figure 6. Box A. Graphic representation of the value achievements of the high-scoring responders (HS group) on the question if they would comply the request in a real case. Box B: low-scoring group (LS- group). Legends are Solid lines: Value achievement of compliance behavior; Dashed lines: Value achievement of non-compliance behavior; A1, A2, A3, A4: Likert-scale values of situations presented (see also Appendix S1).

Of course, the result of our analysis depends on the type of value achievement function chosen. In this analysis, we applied the Cobb-Douglas function. An alternative might be, for example, a max-min function (Lejano & De Castro 2014). However, the Cobb-Douglas function applied here is interesting, since it implies an environmental axiology, where the utilitarian and nonutilitarian values are intrinsically related, and where utilitarian values may even be considered as constitutive for nonutilitarian values (e.g., intrinsic value) (Korsegaard 1983; Kagan 1998). Our approach may therefore be seen as a response to the criticism that the concept of ecological services reduces restoration and conservation to a purely utilitarian enterprise (Swart et al. 2001; McCauley 2006; Turnhout et al. 2013; Schröter et al. 2014). It stresses a stewardship perspective that recognizes the multiple layers of meaning in our natural landscapes (Hourdequin & Havlick 2016). Welchman (2012, p. 303), for example, defines environmental stewardship as "responsible management of human activity affecting the natural environment to ensure the conservation and preservation of natural resources and values for the sake of future generations of human and other life on the planet." The value of linkages between social and ecological objectives is recognized in many restoration projects (Egan et al. 2013) and in nature conservation initiatives, such as Integrated Conservation and Development Programs (ICDP), Community Conservation Plans (CCP) (see, e.g., Brown 2002; Salafsky & Wollenberg 2000; Berkes 2007), and Payment for Environmental Services (Engel et al. 2008), to cite some examples.

Our analysis demonstrates that nonutilitarian attitudes may lead to higher value achievements as compared to purely utilitarian attitudes. This conclusion is, of course, only true for actors who indeed recognize nonutilitarian perspectives. A purely utilitarian actor is, so to speak, impervious to the additional value that restricted use may offer him or her. The difference between the HS and LS groups illustrates that people may differ in this respect. However, moving from maximizing towards moderate utilization is not simply an issue of value maximization but rather a matter of changing one's perspective vis-à-vis nature. Communication, discussion, and reflection are therefore important. Decision traditions and strategies, in which multiple visions of nature are respectfully discussed and shared, may contribute to a change in people's mindsets and thereby to a wider social acceptance of conservation and restoration projects in which local people participate or which depend on the support of lay people.

As explained in the introduction, many ecosystem services stem from common pool resources, which are vulnerable to over-exploitation because of their non-excludability and subtractability features. Restoration projects that aim to restore open accessible and subtractable resources, including many wetlands, rangeland, and marine and coastal areas, should take these features into account. Our analysis demonstrates the game-theoretical characteristics of public support for such projects not only with respect to utilitarian considerations but also to nonutilitarian considerations. In addition, our survey makes clear that these considerations can be measured and proactively used for presenting and adjusting restoration projects in accordance with the perceptions, preferences, and attitudes of local people (see also Van Marwijk et al. 2012; Buijs et al. 2011). In addition to measures to regulate access and utilization of such areas (e.g., zoning, fishing limits, income compensation, payment for environmental services, permit regulations, etc.), strategies that may enhance, mobilize, or respond to nonutilitarian valuation are important, especially when top-down organized access and restrictive utilization measures are not feasible, or feasible only to a limited extent. Pro-active communication, discussion, and reflection are therefore important: they may contribute to a change in people's mindsets, and ultimately result in more sustainable management and restoration of our commons and natural resources.

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Literature

Acheson J, & Gardner R 2011 The evolution of the Maine lobster V-notch practice: cooperation in a prisoner's dilemma game. Ecology and Society 16: 41

Alexander S, Aronson J, Whaley O, & Lamb D 2016 The relationship between ecological restoration and the ecosystem services concept. Ecology and Society 21(1):34

Aronson J, & Alexander S 2013 Ecosystem Restoration is Now a Global Priority: Time to Roll up our Sleeves. Restoration Ecology 21:293–296

Aronson J, Milton SJ, & Blignaut JN 2007 Definitions and rationale. Pages 3-8 In Aronson J, Milton SJ, Blignaut J (eds) Restoring natural capital: science, business, and practice. Island Press, Washington, D.C.

Berkes F (2007) Community-Based Conservation in a Globalized World. Proceedings of the National Academy of Sciences 104:15188-15193

Brown K (2002) Innovations for Conservation Development. The Geographical Journal 168:6–17

Buckley M, & Holl K 2013 Game theory Tools for Improving Ecological Restoration Outcomes. Pages 239- 253 In Egan D, Hjerpe EE, Abrams J (eds)Human Dimension of Ecological Restoration. Integrating Science, nature, Culture. Island Press, Washington, D.C.

Buijs AE, Arts BJM, Elands BHM, Lengkeek J (2011) Beyond environmental frames: The social representation and cultural resonance of nature in conflicts over a Dutch woodland. Geoforum 42: 329-341

Busby G, & Albers HJ 2010 Wildfire Risk Management on a Landscape with Public and Private Ownership: Who Pays for Protection? Environmental Management 45:296-310

CBD [Convention on Biological Diversity] 2012 XI/16. Ecosystem restoration https://www.cbd.int/decisions/cop/?m=cop-12 [accessed on 4 September 2016]

CBD [Convention on Biological Diversity] 2010 Strategic Plan for Biodiversity 2011–2020 and the Aichi Targets. https://www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-EN.pdf [accessed on 4 September 2016]

CBD [Convention on Biological Diversity] 2014 XII/19. Ecosystem conservation and restoration. https://www.cbd.int/decisions/cop/?m=cop-11 [accessed on 4 September 2016]

Chua A (2003) Knowledge sharing: a game people play. Aslib Proceedings 55:117-129.

Colyvan M, Justus J, & Regan HM 2011 The conservation game. Biological conservation 144:1246-1253

Dietz T, Ostrom E, Stern PC (2003) The Struggle to Govern the Commons. Science 302:1907–1912

Dixit A, Skeath S, Reiley D (2015) Games of Strategy. 4th Edition. Norton & Company, New York

Dobson A (1998) Justice and the environment. Conceptions of environmental sustainability and theories of distributive justice. Oxford University Press, Oxford, United Kingdom/New York

Egan D, Hjerpe EE, & Abrams J 2013 Why People Matter in Ecological Restoration. Pages 1-21 In Egan D, Hjerpe EE, Abrams J (eds) Human Dimension of Ecological Restoration. Integrating Science, nature, Culture. Island Press, Washington, D.C.

Engel S, Pagiola S, Wunder S (2008) Designing Payments for Environmental Services in Theory Practice: an Overview of the Issues. Ecological Economics 65:663–74

Feeny D, Berkes F, Mccay BJ, Acheson JM (1990) The Tragedy of the Commons: Twenty-Two Years Later. Human Ecology 18:1–19

Frank DM, & Sarkar S 2010 Group Decisions in Biodiversity Conservation: Implications from Game Theory. PloS One 5:e10688

Garrity EJ (2012) Tragedy of the Commons. Business Growth the Fundamental Sustainability Problem. Sustainability 4: 2443–71

Gelissen J (2007) Explaining Popular Support for Environmental Protection: a Multilevel Analysis of 50 Nations. Environment Behavior 39:392–415

Gobster PH, Flores K, Westphal LM, Watkins CA, Vining J, & Wali A (2016) Resident and user support for urban natural areas restoration practices. Biological Conservation 203:216-225

Gosnell H, & Kelly EC 2010 Peace on the river? Social-ecological restoration and large dam removal in the Klamath basin, USA. Water Alternatives 3:361-383

Hardin G (1968) The tragedy of the Commons Science 162:1243-48.

Hardin G (1998) Extensions of the Tragedy of the Commons. Science 280:682–83

Houde N (2007) The Six Faces of Traditional Ecological Knowledge: Challenges Opportunities for Canadian Co-Management Arrangements. Ecology Society 12:34

Hourdequin M & Havlick DG (2016) Restoring Layered Landscapes. History, Ecology, Culture. Oxford University Press

Kagan S (1998) Rethinking intrinsic value. The Journal of Ethics 2:277-297.

Korsgaard CM (1983) Two distinctions in goodness. The Philosophical Review 92:169-195.

Lejano RP, De Castro FF (2014) Norm, Network, Commons: the Invisible Hand of Community. Environmental Science Policy 36:73–85

McCauley DJ (2006) Selling out on nature. Nature 443:27-28

MEA 2005 [Millennium Ecosystem Assessment] 2005 *Ecosystems and human well-being: biodiversity synthesis*. Island Press, Washington D.C., USA

Ostrom E (1990) Governing the Commons. The Evolution of Institutions for Collective Action. Cambridge University Press, Cambridge, UK

Ostrom E (2010) Beyond Markets States: Polycentric Governance of Complex Economic Systems. American Economic Review 100:1-33.

Paavola J (2003/2004) Protected Areas Governance and Justice: Theory and the European Union's Directive. Environmental Sciences 1:59-77

Petursdottir T, Arnalds O, Baker S, Mongtanarella L, & Aradottir ÁL 2013 A Social–Ecological System Approach to Analyze Stakeholders' Interactions within a Large-Scale Rangeland Restoration Program. Ecology and Society 18: 29

Salafsky N, Wollenberg E (2000) Linking Livelihoods Conservation: a Conceptual Framework Scale for Assessing the Integration of Human Needs Biodiversity. World Development 28:1421–1438

Schröter M, Van der Zanden EH, Van Oudenhoven APE, Remme RP, Serna-Chavez HM, De Groot RS, & Opdam P (2014) Ecosystem Services as a Contested Concept: A Synthesis of Critique and Counter-Arguments. Conservation Letters 7:514–523

Swart JAA,Van der Windt, HJ & Keulartz J (2001) Valuation of nature in conservation restoration. Restoration Ecology 9:230-238

Swart JAA, & Keulartz J (2011) The wild animal in our society. A contextual approach to the intrinsic value of animals. Acta Biotheoretica 59:185-200

Turnhout E, Waterton C, Neves K, & Buizer M (2013) Rethinking biodiversity: from goods and services to "living with" Conservation Letters 6:154–161

Van Marwijk RBM, Elands BHM, Kampen JK, Terlouw S, Pitt DG, & Opdam P (2012) Public Perceptions of the Attractiveness of Restored Nature. Restoration Ecology 20:773-780

Welchman J (2012) A Defence of Environmental Stewardship. Environmental Values 21:297-316

APPENDIX S1: Casus and survey questions

Imagine, a natural area in the direct surroundings of your home. You use it regularly for walking, for example with your dog, or for running.

In this natural area rare and vulnerable communities of different animal and plant species can be found. The area is especially vulnerable for human disturbance during the breeding season. Already a single visitor can have a negative impact on the breeding success of some species.

According to some ecologists there is a need to minimalize the recreation pressure during the breeding season (from March 31 until July 1). It will contribute to the biodiversity and the protection of threatened species. The nature conservation organization decides after consultation with the municipality and the neighbor organization to construct new footpaths in order to avoid the use of the footpath through the vulnerable part of the natural area.

The users of the natural area are asked to make use of the new walking paths instead of the old footpath through the vulnerable part of the area especially during the breeding season. However, your favorite route with the dog or your running route goes through the vulnerable part of the area. The new footpaths are qua natural beauty less attractive.

Please, read thoroughly the case above and answer subsequently the list of questions. It will take in total about 10 minutes. The answering of the question list is completely anonymous. Many thanks in advance for your cooperation.

The question list below consists of two parts: (1) a short, general part, and (2) four hypothetical situations, which focus on the casus. At each situation we present the same set of statements.

Part 1. General questions

Sex:	□ Man	□ Women
Age:	……………………………	
Bachelor:	□ Biology □ LS&T (Life Science and Technology) □ Other: …………………………………………………	
Specialization or Major study:	□ General Biology □ Molecular Life Sciences □ Behavior and Neurosciences □ Ecology & Evolution □ Biomedical Sciences □ Biomedical Technology □ Other: …………………………………………………	
Year of arrival at the University of Groningen:		

Part 2: Four situations with regard to the casus

Please fill in your first intuitive answer in the second part of the list of questions

		Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
A1	**Assume that EVERYONE (including yourself) follows the request to use only the new footpath outside the vulnerable part of the natural area during the breeding season. In that case:**					
	I think it is fine	□	□	□	□	□
	Will this situation deliver me enough	□	□	□	□	□
	I think it is an acceptable situation	□	□	□	□	□
	The situation will contribute to my interests	□	□	□	□	□
A2	**Assume that ONLY YOU will make use of the new footpath. Thus nearly everyone still make use of the path through the vulnerable part of the natural area during the breeding season. In that case:**					
	I think it is fine	□	□	□	□	□
	Will this situation deliver me enough	□	□	□	□	□
	I think it is an acceptable situation	□	□	□	□	□
	The situation will contribute to my interests	□	□	□	□	□
A3	**Assume that ONLY YOU will make use of the path through the vulnerable part of the natural area during the breeding season. Nearly everyone else uses the new footpath. In that case:**					
	I think it is fine	□	□	□	□	□
	Will this situation deliver me enough	□	□	□	□	□
	I think it is an acceptable situation	□	□	□	□	□
	The situation will contribute to my interests	□	□	□	□	□
A4	**Assume that EVERYONE (including yourself) still makes use of the path through the vulnerable part of the natural area during the breeding season. In that case:**					
	I think it is fine	□	□	□	□	□
	Will this situation deliver me enough	□	□	□	□	□
	I think it is an acceptable situation	□	□	□	□	□
	The situation will contribute to my interests	□	□	□	□	□

	0-25%	25-50%	50-75%	75-100%
How big do you estimate the chance that in reality you will make use of the new paths outside the vulnerable part of the natural area during the breeding season?	□	□	□	□

Many thanks for filling in the survey