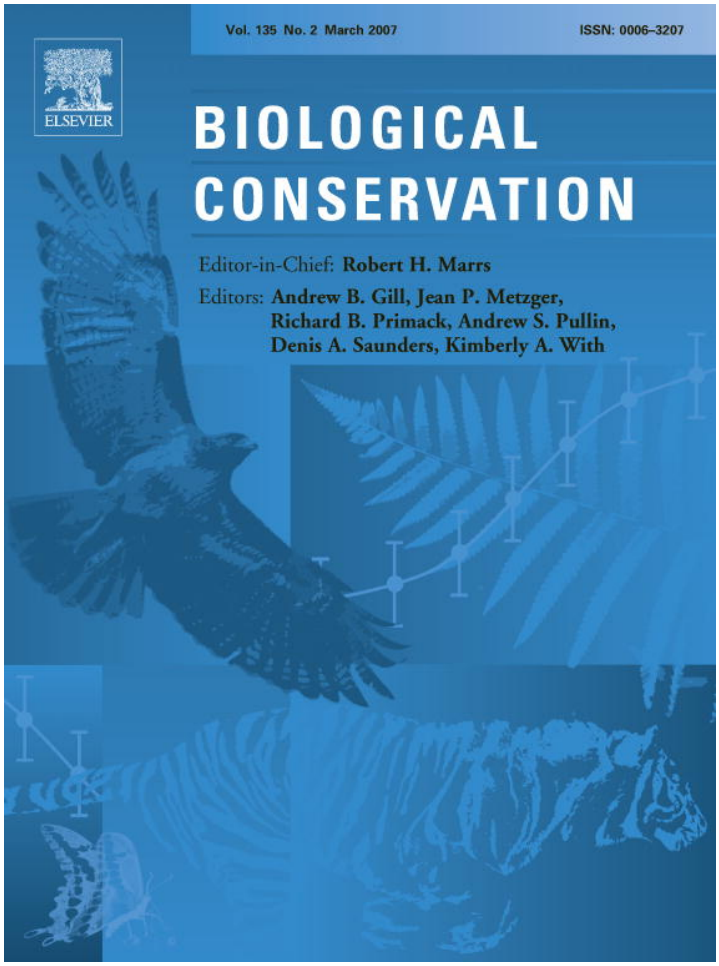

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Invasive plant suppresses charismatic seabird – the construction of attitudes towards biodiversity management options

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ABSTRACT

Public attitudes towards biodiversity issues and the value judgments underlying biodiversity management and conservation are still poorly understood. This has raised serious concerns regarding the effective use of public participation in biodiversity policy making. We conducted quantitative face-to-face interviews with members of the general public in southeast Scotland to assess attitudes towards biodiversity management and examine attitude formation. For this, we applied social psychological attitude–behaviour theories to a case study investigating biodiversity management options for an island ecosystem in which the abundance of a charismatic seabird, the Atlantic puffin (*Fratercula arctica*) is compromised by the expansion of a tall invasive plant, tree mallow (*Lavatera arborea*). We found that attitudes as expressed by members of the public are informed by both value- and knowledge-based elements. Our research provides clear support for the notion that, in a conservation context, value-based principles matter to the public. Out of a set of seven conservation-related values, 'balance' and 'naturalness' were important factors that related strongly to the respondents' attitudes. These relationships were even stronger for individuals emotionally involved with the topic. Other value-based principles such as uniqueness, autochthony and endangeredness of the species involved appeared to be of lesser relevance. The findings provide evidence that attitudes can be considered as distinct constructs that offer valuable and meaningful information to biodiversity policymakers and managers, and allow empirical insights into the way value judgments influence biodiversity management and conservation.

1. Introduction

Participatory approaches are increasingly called for in nature conservation and biodiversity policymaking, as public involvement is seen to foster successful solutions through enhanced public acceptance (Birner and Wittmer, 2004; Fischer, 2005; Ericson, 2006). However, two common criticisms are that members of the general public might have insufficient knowledge and motivation to contribute to environment-related decision making in a valid and meaningful way, and that their attitudes might be too unstable as a basis for reliable choices (Caplan, 2003; Freese and Rüffer, 2005; Ariely et al., 2006). There is a growing body of literature that links social psychological and sociological approaches with questions of wildlife

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and habitat management, which sheds light on the cultural and psychological contexts of public attitudes (Beedell and Rehman, 2000; Skogen, 2001; Ericsson and Heberlein, 2003; Kaczensky et al., 2004). Moreover, environmental economic approaches suggest ways to assess public preferences for biodiversity-related environmental goods and services building on categories such as use and non-use values (Pearce and Turner, 1990; Callicott, 1997; Millennium Ecosystem Assessment, 2003). Nevertheless, the factors that inform these preferences, i.e., the construction of attitudes with regard to biodiversity management, as well as their stability over time, remain poorly understood, as social scientific approaches are still not tightly linked to conservation-related topics (Mascia et al., 2003; Clayton and Brook, 2005). We suggest that the concept of values, which can be taken as guiding principles that provide general orientation for living (Rokeach, 1973; Dreezens et al., 2005), might improve our understanding of the ways individuals make choices between different biodiversity management options. This can be of high relevance for conservationists to help reflect upon the implicit values of conservation and biodiversity management. In addition to the work conducted earlier in the development of conservation biology (Ratcliffe, 1977), a number of more recent publications point out the need to examine the values underlying conservation policies in a critical manner (Harrison, 1993; Barry and Oelschlaeger, 1996; Matsuda, 1997). A greater awareness of public attitudes and their genesis would also allow better prediction of the acceptance of future biodiversity management measures, and facilitate the development of suitable ways of communicating these, hence increasing the likelihood of biodiversity management success.

Our study is based on three interrelated theoretical notions. First, we assume that the mental concepts that individuals hold, the evaluations these concepts might imply, and the attitudes they result in have been and are constantly being formed in interaction with the individuals' social and natural environment (Larochelle et al., 1998; Schwarz and Bohner, 2001). How people view biodiversity-related issues is thus based on the concepts they have developed which can be considered as neither "wrong" nor "right". Second, our thinking is based on attitude–behaviour theories and their extensions that include value orientations and basic beliefs (Ajzen, 1988; Schwartz and Bilsky, 1987; Frey and Irle, 1993). In this context, values are understood as standards that serve as guiding principles in a person's life. In comparison to attitudes, values are assumed to be much more stable over time whilst also much more general and independent from concrete situations (Rokeach, 1973). Attitude–behaviour and related theories describe values as factors that inform attitudes, which in turn are considered one of the precursors of behavioural intentions and eventually, actual behaviour. These complex models have been successfully applied in the biodiversity arena to explain the relationship between general value orientations and attitudes towards wildlife and the natural environment (Fulton et al., 1996; Kaltenborn et al., 1998; Schultz and Zelezny, 1999; Thøgersen and Ölander, 2002), as well as towards environmental health topics (Harreveld and Van der Pligt, 2004; Dreezens et al., 2005). Third, we highlight the fact that conservation – like other types of individual and institutional activities – is influenced by value judgments (Harrison, 1993; Barry and Oelschlaeger, 1996; Matsuda, 1997), and that the criteria that underlie management decisions and policy making in nature conservation can be considered crystallisations of values. Ratcliffe's (1977) conservation criteria are examples of such crystallised values, and a number of authors expand on selected criteria such as balance (Wallington et al., 2005), autochthony (Peretti, 1998), endangeredness (Rolston, 1997), naturalness (Götmark, 1992; Hunter, 1996; Machado, 2004), similarity to humans (Tisdell et al., 2006) and uniqueness (Vane-Wright et al., 1991; Montgomery, 2002), whilst others address the relationship between several of these criteria and individuals' aesthetic and visual preferences for landscapes (Purcell and Lamb, 1998; Van den Berg and Koole, 2006). We found these values also in cross-European qualitative studies on attitudes towards biodiversity management that involved members of the general public from a wide range of backgrounds (Buijs et al., 2006a).

Our study addresses the role that value-based criteria play in the formation of attitudes towards concrete biodiversity management measures. We apply the value concept and related social psychological constructs to an empirical study on management options for an island ecosystem where the expansion of a tall and easily identifiable invasive plant, tree mallow (*Lavatera arborea*) restricts breeding of a charismatic seabird species, the Atlantic puffin (*Fratercula arctica*). We present results from 236 quantitative face-to-face interviews on (i) the perception of both tree mallow and puffins among members of the general public, (ii) public attitudes towards concrete options regarding the local management of tree mallow, (iii) value-based principles with regard to conservation in general and (iv) the relationship between perceptions, values and attitudes towards concrete management options. Our study thus provides specific insights in the contentious issue of management decisions regarding invasive species (Peretti, 1998; Simberloff, 2003), whilst furthering our generic understanding of the decision processes of individuals – whether laypersons or experts in the field – with respect to biodiversity management options.

2. Methods

2.1. Study site

The study focused on an eye-catching conservation problem: the invasion of seabird islands by a plant, tree mallow, which leads to loss of coastal habitat used for breeding by seabirds. Tree mallow grows to 3 m tall and is a biannual Mediterranean–Atlantic herb. Within the UK, its native distribution is limited to the SW coastal fringe (Cox, 2002). However, the species has been kept in coastal gardens well outside its natural range from where it has spread into natural and semi-natural habitat along the coast and has now reached islands holding some of the UK's largest colonies of Atlantic puffins. Puffins on the east coast of Scotland have increased over the last 40 years at a rate of 7–12% per annum, indicating that conditions for puffins in this part of Scotland are favourable. Yet, for one of the largest UK colonies, Craigleith, East Lothian (56°N, 2°W), 35 km of Edinburgh, this trend has recently diverged with numbers dropping from 28 000 burrows in 1999 to only

12 100 in 2003 (Harris et al., 2003). Here, tree mallow has increased dramatically forming dense stands which appear responsible for the sharp reduction in puffin numbers whilst on nearby islands puffin populations continued to expand. Recent evidence has demonstrated that puffins are unable to breed successfully and abandon their burrows in areas where tree mallow has invaded (Van der Wal, 2004). There is growing concern among some conservationists and other stakeholders that the current expansion of tree mallow on a range of other seabird islands may have strong population implications on puffins, an iconic species of high conservation and recreational importance. The chance to see puffins brings many tourists to coastal areas, and local economies therefore benefit from these seabirds in many ways. Whereas tree mallow has been on nearby Bass Rock for at least 350 years (M'Crie et al., 1847), the species has rapidly expanded during the last decades in the region, perhaps facilitated by a series of milder winters.

2.2. *Proposed management options*

Several solutions have been proposed to restore the breeding habitat of puffins on Craigleith of which three are currently considered as viable management options: (a) cutting tree mallow, (b) spraying with herbicides, and (c) introducing neutered rabbits to prevent regeneration of tree mallow. As a fourth option (d), no direct human intervention is being considered.

Tree mallow can be cut down relatively easily and effectively with standard manual tools used in domestic gardening, thereby allowing puffins access to their burrows. However, large-scaled removal of tree mallow may lead to soil erosion, especially during winter. Field trials have revealed that regrowth after cutting rarely occurs, although seedlings will come up from the extensive seedbank, thus requiring repeated cutting within a single growing season for several years in a row (RvdW and AF, unpublished data). Alternatively, tree mallow can be controlled through the application of a contact herbicide that aims to kill off the plants whilst minimizing impacts on soil and water quality as well as non-target plant species. Again, seedlings will come up after the treated plants have died and thus herbicide applications are required for several years. Still, spraying is likely to be a less labour-intensive means of controlling tree mallow than cutting. The introduction of neutered rabbits forms a third management option, as tree mallow is susceptible to grazing (Gilham, 1953; Van der Wal, 2004). Rabbits have populated Craigleith in the past (Dickson, 1899) but are said to have disappeared after the UK-wide outbreak of the *Myxomatosis* virus in the late 1950s. Development of a sizeable rabbit population might cause soil erosion due to their burrowing activities, therefore neutered rabbits are proposed to be placed on Craigleith. A fourth management option would be to have no direct human intervention. This likely leads to a further expansion of tree mallow and a greater reduction in the number of breeding pairs of puffins.

2.3. *Data collection*

Data was collected through face-to-face interviews ($n = 248$) in autumn 2005 distributed among eight different villages across the East Lothian district within a radius of 17 km from the island of Craigleith. The majority of interviews (74%) were conducted in respondents' homes with about a third sampled among the residents of North Berwick, the village closest to the island, whilst 26% of the interviews were with visitors to the Seabird Centre, a visitor centre situated in North Berwick harbour that focuses on interpreting seabird life at the East Lothian coast for members of the public. In principle, every household in the villages sampled had an equal chance to be included in the sample as the interviewers tried to contact every household in the randomly selected streets. However, with 60% in the final sample as opposed to 53% in the population, women were overrepresented, whilst the group of 35–44 year old was similarly under- and the group of 45–65 year old slightly overrepresented (East Lothian Council, 2001). As age and gender did not correlate with any other relevant variables and the survey was not designed as a representative opinion poll, this is unlikely to affect the results. Individuals with higher education were also overrepresented, a phenomenon common in questionnaire- and interview-based research (Kaczensky et al., 2004; Mayer and Frantz, 2004). Data analysis took effects of education explicitly into account (Section 3.4). Most importantly, our sample captured sufficient variation in all relevant background variables to address our research questions. After exclusion of incomplete questionnaires, the sample comprised 236 interviews suitable for analysis.

The questionnaires included an introductory part that provided visual and verbal information on the situation on the island and presented the four potential management options as described above. The wording of the information section was based on previous ecological research conducted on the island, and was pre-tested with both experts and members of the population to avoid strong positive or negative connotations and to ensure comprehensibility. The information as well as all the questions were read out to the respondents who were given the opportunity to follow the text in the questionnaire.

2.4. *Measurements*

The design of the questionnaire built on own previous qualitative research on public attitudes and values with regard to biodiversity management (Buijs et al., 2006a). All items were pre- and pilot-tested and consequently improved upon. The questionnaire included qualitative elements such as open-ended questions that were audio-recorded to allow the respondents to talk naturally, and a number of quantitative elements, including:

(1) a semantic differential on a scale from −3 to +3 that elicited respondents' perceptions of the two species with regard to six opposing pairs of attributes, for example: "Would you say that tree mallow is rather vulnerable or rather strong?";
(2a) an attitude scale that included 20 Likert-type items to measure beliefs and the personal importance of these beliefs with regard to the four proposed management options according to the expectancy-value construct (Ajzen, 1988);

(2b) a ranking of the four management options to allow for triangulation: "Which one of these management options do you favour most? Which one least?" etc.;

(3a) a Likert-type value scale consisting of two items for each of the seven general value-based principles assessed, for example "I feel that environmental policies should specifically address *rare* animals, plants and habitats, because these are most important". The value scale addressed naturalness, balance, rarity, endangeredness, autochthony, uniqueness and closeness as principles potentially related to individual attitudes. In the questionnaire, 'naturalness' was defined as "untouched by humans" (Hunter, 1996; Machado, 2004), while 'endangered' was paraphrased as "under threat", 'unique' as "distinct from others" and 'native' as "has been here for a long time". 'Closeness' was used to capture emotional ties of the respondents with the species (see Ratcliffe's "intrinsic appeal", 1977; Tisdell et al.'s "similarity", 2006). To obtain a specific assessment of their perceptions with regard to the situation at hand, respondents were asked to which degree each of the principles, in their view, applied to the case of tree mallow management on Craigleith;

(3b) a ranking of the same seven values to allow for triangulation: "How important do you feel the following attributes are when making decisions about nature (...)? Please use 1 to indicate the attribute that you find most important, (...)" etc.;

(4) background variables such as age, gender, education, place of residence and numbers of visits to North Berwick, membership in conservation organisations, and the enjoyment of relevant outdoor activities such as birdwatching, gardening and voluntary work for nature conservation. These variables, in particular urban/rural place of residence, education and enjoyment of outdoor activities, have frequently been found to influence individuals' attitudes towards wildlife management and nature conservation (Fulton et al., 1996; Buijs, 2000; Skogen, 2001; Ericsson and Heberlein, 2003). In addition, interviewers rated the emotional involvement that respondents showed with regard to the topic on a −3 (very reserved) to +3 (highly involved) scale. This instrument has been successfully used in earlier studies (Fischer and Hanley, 2007). Interviewers were trained to ensure comparable ratings.

2.5. Scale performance and construction of indices

The performance of the attitude scale (2a) was analysed by means of a principal component analysis. As intended, factor loadings of the belief items reflected four components that represented the four management options, and were relatively high, ranging between 0.676 and 0.912 after orthogonal rotation. Attitude indices for each of the four options were calculated as the sum of the products of the belief ratings and the corresponding importance ratings (Ajzen, 1988, p. 120):

$$A_{MO} \propto \sum_{i=1}^{n} b_i e_i \quad (1)$$

A_{MO} = attitude towards a management option; b_i = belief (subjective probability) that the management option will lead to outcome i; e_i = personal importance (evaluation) of the outcome i; n = number of belief items.

A comparison of the pilot- and main study results of the attitude scale (2a) and the management option ranking (2b) revealed that both measurements did indeed lead to the same overall results.

From the value scale (3a), value indices were computed as the average rating of the two items that described the same value. The resulting means, however, differed slightly from the results of the value ranking exercise (3b), though a high degree of association ($r_p = -0.85$) was observed between the two measures. Differences were mainly due to an inversely phrased item in the value scale that most respondents tended to rate less decisively as they did with the remaining, positively phrased items.

The application of a generic value to a particular situation depends on the perceptions of the individual respondent. While some respondents might strongly support rarity of species as a guiding principle for conservation and consider puffins as rare, others might support this principle but perceive puffins as abundant. The applications of the value of rarity by these two individuals will consequently differ. Similarly, the perception of the applicability of the principle of naturalness will vary among individuals (as will be shown below). Hence, the questionnaire included items that asked for the applicability of each of these values to the situation on Craigleith (3a). For each respondent, value indices were thus multiplied with these factors to obtain weighted value indices that take the respondents' evaluation of the situation into account.

2.6. Data analysis

To test for the influence of values and perceptions on attitudes towards concrete management options, we applied multinomial logit regression, a specific form of logistic regression, in SPSS (version 14.0). The response variable 'preferred management option' represented the option individuals had ranked first and hence has a multinomial probability distribution.

Attitude–behaviour theory postulates that attitudes towards concrete objects are related to relevant values (Fulton et al., 1996). However, further social psychological theories (Petty and Cacioppo, 1986; Chaiken et al., 1989) and related empirical work (Fischer and Hanley, 2007) suggest that the relationship of stated values and attitudes might be moderated by the respondent's motivation to participate in the interview and to make a decision. The more personally relevant the topic is perceived, the more likely are elaborate decision processes (Petty and Cacioppo, 1986). As emotional involvement towards the issue of tree mallow management was scored by the interviewers (see above (4)), we were able to test whether the model performance changes as a function of this factor. For this purpose, the total sample was split into two groups of individuals according to the ratings of emotional involvement they had received. The sub-samples did not differ significantly from each other with regard to the management options they ranked first.

3. Results

3.1. *Public perception of tree mallow and puffins*

Respondents were asked to indicate their perceptions of both species with regard to six contrasting pairs of attributes. Whilst perceptions of tree mallow (Fig. 1a) tended to range over the entire breadth of the scales, respondents were much more unanimous with regard to the attributes of puffins (Fig. 1b). Puffins were on average perceived as extremely beautiful, slightly vulnerable, quite precious, neutral in terms of abundance, quite ancient and quite unique. Tree mallow was on average seen as slightly beautiful, quite strong, neutral to slightly worthless, slightly abundant, neutral to slightly ancient and neutral to slightly ordinary. No negative correlations were found between the two ratings, indicating that individuals did not see the two species as a pair of opponents (the beautiful vs. the ugly, the strong vs. the vulnerable) but each in its own right. Interestingly, the majority of respondents (75%) did not perceive tree mallow as a "new" species, and despite its obvious abundance on the island of Craigleith, 38% perceived the plant species as overall only slightly abundant, neutral or even rare.

3.2. *Preferred management options*

The management options that scored on average highest and lowest, 'cutting' and 'no intervention', showed relatively low variation, indicating a relatively high degree of agreement between the respondents with regard to these options, while reactions to the options 'introduction of rabbits' and 'use of herbicides' were much more varied (Fig. 2).

In an open-ended question, respondents were asked for the reasons for their rankings of the proposed management options. Sixty-one percent of the sample referred to a single reason, while the remaining 39% gave multiple motives. The reasons stated were classified according to the categories shown in Table 1. Risk- and control-related arguments were most frequently stated, while only 3.6% of the sample explicitly mentioned costs. A closer look at these data reveals relationships between individuals' perceptions and their choices, and illustrates the constructed nature of attitudes to biodiversity management. Respondents used particular arguments in a number of combinations to support different choices (Table 1, columns 3–6). While 57% of the participants who ranked 'cutting' first stated lesser perceived risk to be the main reason for their choice, 75% of those who opted for the use of herbicides expressed that their choice was due to considerations of (cost-) effectiveness. The perceived naturalness of the intervention seemed to be decisive for the majority of those who chose 'no intervention', but also for those who opted for the introduction of rabbits.

In their function as rationales that guide decision-making, some of these arguments can be considered an indirect expression of values. The following section summarises results of a direct assessment of values with regard to biodiversity management.

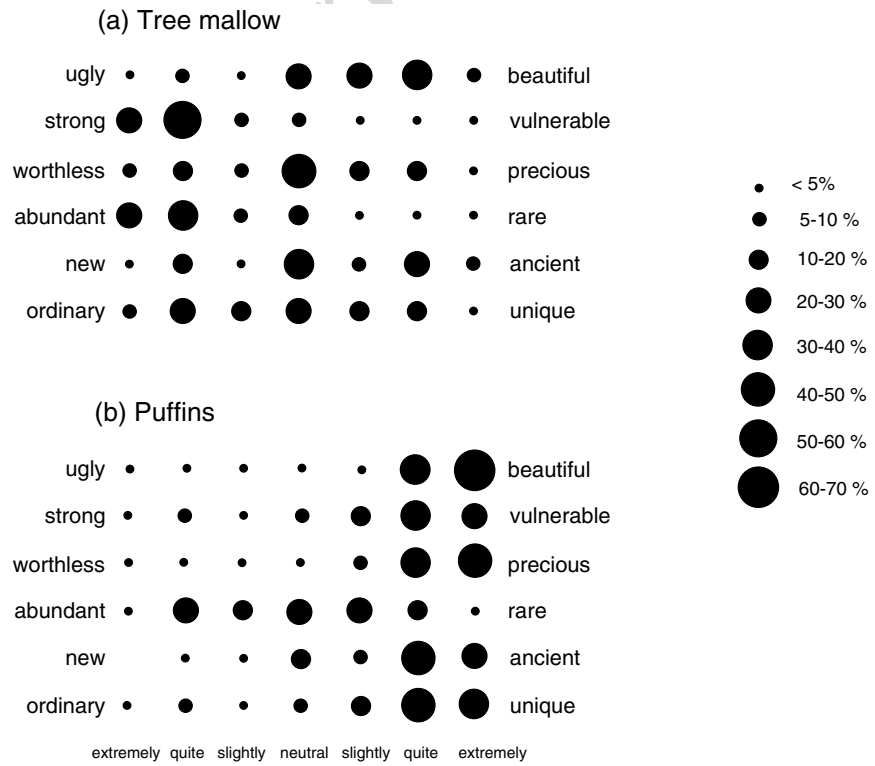

Fig. 1 – Public perception of (a) tree mallow and (b) puffins with regard to six opposing pairs of attributes. The size of the circles is proportional to the number of respondents selecting the respective response option (n = 236).

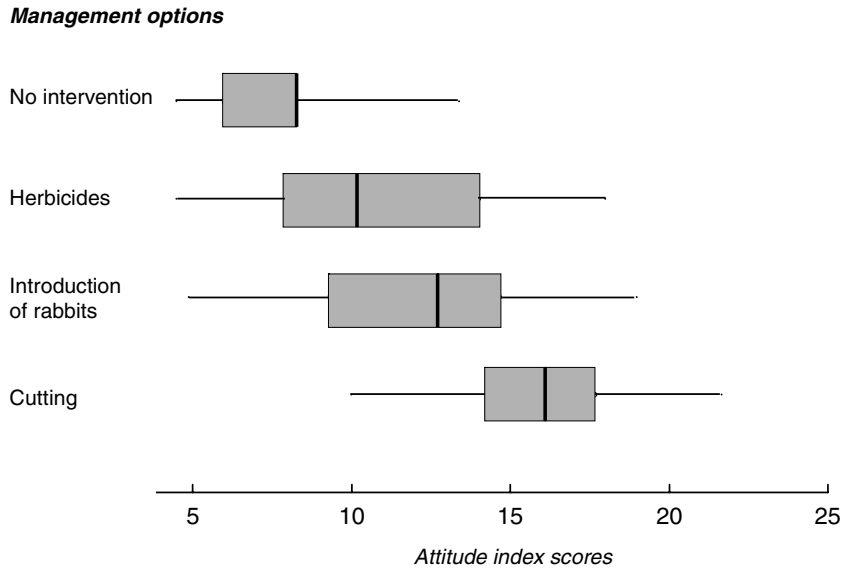

Fig. 2 – Support for tree mallow management options, measured through attitude indices. Higher scores indicate a more favourable attitude. Grey boxes indicate quartiles, thick vertical lines show the median, and whiskers depict percentiles 5 and 95 (n = 231). Scores could potentially range between 1 and 25; the actual range was 2.7–25.

Table 1 – Reasons for choosing the preferred management option in ranking exercise as stated by participants (n = 215) in response to the open-ended question "Why do you think the option you ranked first should be chosen?" Data are expressed as the percentage of respondents that mentioned a certain reason for the whole sample (total answers) and for each of the management options (tree mallow cutting, introduction of neutered rabbits, spraying tree mallow with herbicides, no intervention) separately

Reasons mentioned	Total answers (%) (n = 215)	'Cutting' ranked first (%) (n = 119)	'Rabbits' ranked first (%) (n = 55)	'Herbicides' ranked first (%) (n = 24)	'No intervention' ranked first (%) (n = 17)
Least risk, fewer side-effects, most control	**38**	57	27	17	17
Most natural	**18**	13	46	0	53
Most effective	**18**	15	9	58	18
Least intrusive	**14**	20	13	8	12
Allows local involvement, raises awareness	**8**	17	0	0	0
Leads to state of balance	**6**	3	7	8	18
Fair to rabbits and/or puffins (animal welfare)	**4**	8	0	4	0
Restores former state	**4**	1	15	4	0
Cost-effective	**4**	2	5	17	0
Most responsible, ethical	**4**	3	0	4	12

3.3. *Values in biodiversity management*

Values can be defined as relatively generic guiding principles that inform the selection and evaluation of behaviour and events, and are ordered by relative importance (Rokeach, 1973; Schwartz and Bilsky, 1987). Out of the seven values that we asked the respondents to rank, 'balance' and 'naturalness' were considered the most important principles overall (Fig. 3). 'Balance' was ranked first by 31% and last by 0.4%, whereas 'naturalness' was considered most important by 36% and least relevant by 9% of the sample. These percentages together with the distributions depicted in Fig. 3 suggest that while 'balance' seems to be an important principle for decisions on biodiversity management in a relatively unanimous way, 'naturalness' appears more controversial. Interestingly, respondents seemed to differentiate between 'rarity' and 'endangeredness' as criteria for biodiversity management, as distributions of the respective ranks differed quite considerably, with 'endangeredness' being on average considered as more important than 'rarity'. Supporting native species was seen as relatively important although variability was considerable, whereas the support for 'closeness' as a value in biodiversity conservation was almost invariably low.

For some of these value-based principles, support changed considerably when the respondents were asked how, in their view, these principles should relate to the situation on Craigleith. The distribution of support for the principle of 'balance' as measured by the value index was similar to the one for the

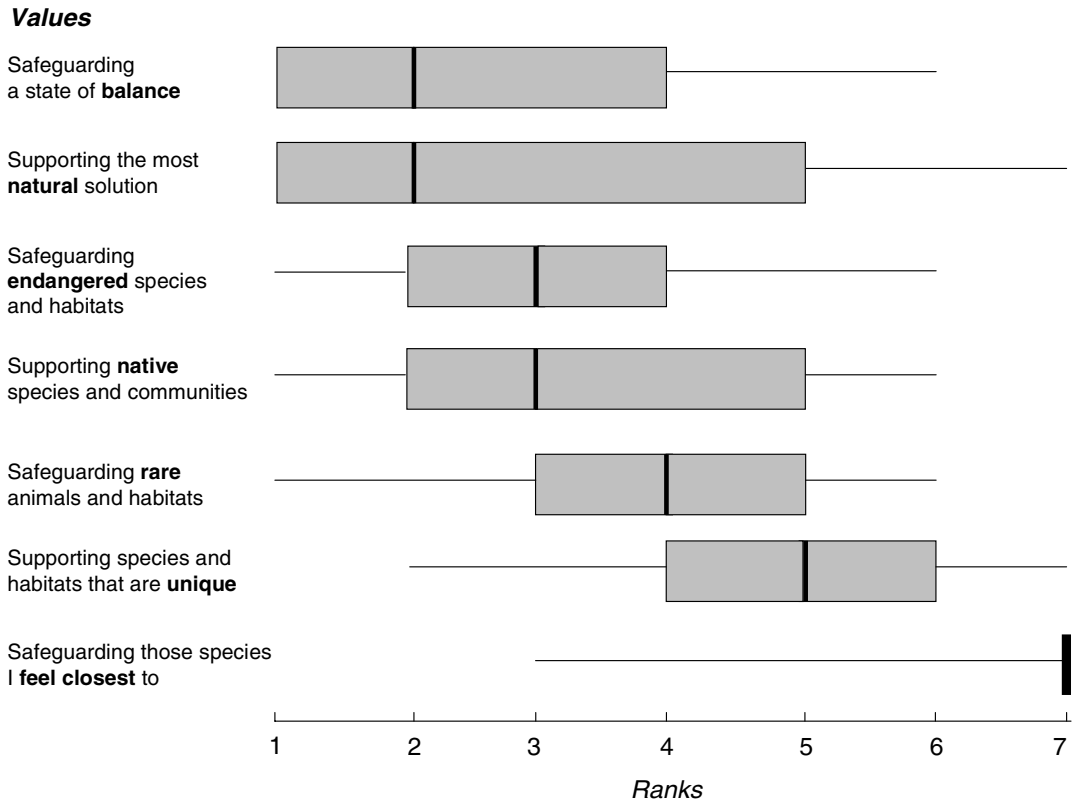

Fig. 3 – Support for seven value-based principles, measured through value ranking with '1' representing 'ranked first' and '7' meaning 'ranked last' as a response to the question "How important do you feel the following attributes are when making decisions about nature (. . .)?" Grey boxes indicate quartiles and thick vertical lines the medians; whiskers show percentiles 5 and 95 (n = 230).

restoration of an equilibrium on Craigleith (Fig. 4a and b). However, this was different for 'naturalness' as a guiding principle. While 71% of the respondents agreed or strongly agreed with abstract value statements regarding naturalness such as "That certain parts of the environment are as untouched by humans as possible is very important for me", and an additional 17% considered themselves neutral, the sample was clearly divided into two groups when it came to the applied question if Craigleith should indeed be as untouched by humans as possible (Fig. 4c and d). Forty-eight percent disagreed with this statement, whereas 46% agreed, and only 6% of the sample scored neutral. While the respondents thus were relatively unanimous in their support for the principle of naturalness on an abstract level, the application to the concrete case led to a bimodal distribution of support with relatively few undecided individuals in between. This suggests that the perceived applicability of abstract principles to concrete situations has to be taken into account in order to understand public views on biodiversity management issues.

3.4. *Do values and perceptions inform attitudes?*

Multinomial regression revealed that values and the attitudes towards concrete biodiversity management options were interrelated in a meaningful way (Table 2). The values 'naturalness' and 'balance' in particular, and 'rarity' to a lesser degree, were found to be significant predictors of preferred biodiversity management options (Table 2a). Level of education and residence within East Lothian county were contributing factors that further improved model fit. Other variables, such as age, gender, the enjoyment of voluntary conservation work, membership in conservation organisations and other variables that captured individuals' previous experiences and interests with regard to biodiversity-related subjects, were tested for but did not prove significant.

We also checked whether the degree to which individuals perceived a particular principle to be applicable or not (Fig. 4) had an influence on the relationship between value indices and attitudes. Whereas the above model was based on weighted value indices, thus included individuals' perceptions of the situation, and produced a Cox & Snell pseudo R^2 of 0.345, similar results were obtained when using unweighted value indices, but with a substantially smaller proportion of the variance explained (pseudo $R^2 = 0.228$). This suggests that taking account of the perceived applicability of values indeed tightens the conceptual link between attitudes and underlying values, and ignoring these perceptions might potentially lead to false-negative conclusions about the consistency of individual decisions concerning biodiversity management.

Model outputs concerning pairs of management alternatives provide a more detailed means of gaining insight in factors that play a role in individual choices of preferred options. As to be expected from the model summary (Table 3), 'natu-

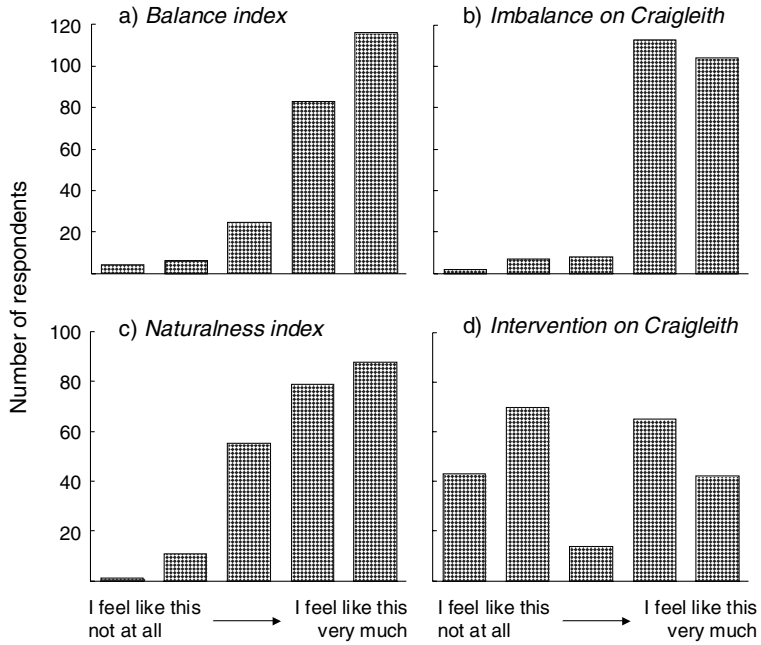

Fig. 4 – Distribution of ratings for (a) support for balance as a guiding principle, (b) item: "There is an imbalance on Craigleith and it should be addressed", (c) support for naturalness as a guiding principle, (d) item: "Craigleith should be as untouched as possible by humans" (n = 234). Charts (a) and (c) address abstract values, (b) and (d) their respective applications to the Craigleith case.

Table 2 – Summary statistics of multinomial logit regression models predicting preference among proposed biodiversity management options for (a) the overall model involving all applicable interviews, (b) the sub-sample of respondents with low involvement to the topic, and (c) the sub-sample of respondents with high involvement

Effect	(a) Total sample (n = 230)				(b) Low emotional involvement (n = 83)			(c) High emotional involvement (n = 137)		
	−2 Log Likelih.	χ^2	df	$p\leqslant$	−2 Log Likelih.	χ^2	$p\leqslant$	−2 Log Likelih.	χ^2	$p\leqslant$
Intercept	579.16	155.54	3	0.001	210.98	67.20	0.001	313.15	83.62	0.001
Naturalness	443.37	19.75	3	0.001	150.09	6.31	0.098	243.71	14.18	0.003
Balance	460.19	36.57	3	0.001	160.21	16.42	0.001	252.42	22.89	0.001
Rarity	431.98	8.37	3	0.039	144.50	0.72	0.869	241.02	11.50	0.009
Education	439.35	15.73	3	0.001	157.60	13.82	0.003	240.88	11.35	0.010
Residence in local county	434.72	11.10	3	0.011	145.35	1.57	0.667	244.68	15.12	0.002

Analyses were conducted on weighted value indices.

ralness' and 'balance' featured frequently and strongly (expressed through high β values) as significant variables. The higher the weighted naturalness index, the more likely an individual ranked 'no intervention' first. The opposite was found for the weighted balance index: the lower this value, the more likely an individual chose 'no intervention' as the preferred alternative. Indeed, individuals who ranked 'no intervention' first had on average relatively high value scores for naturalness, but low ones for balance, and vice versa (Fig. 5). This suggests that the respondents considered these two principles applied to the case of Craigleith, i.e., as captured in the weighted value indices, as opposites. However, such a contrast between the principles 'balance' and 'naturalness' was not observed at the abstract level.

In addition, and consistent with our a-priori expectations and the findings displayed in Table 1, individuals who scored higher in terms of 'naturalness' tended to prefer cutting and the introduction of rabbits over the use of herbicides (Table 3). Preference for the introduction of rabbits over cutting was influenced by support for the 'rarity' principle. Individuals with a higher level of formal education tended to opt for no intervention or cutting as opposed to the introduction of rabbits or the use of herbicides. Those respondents that lived outwith the local county were more likely to rank cutting first as opposed to the use of herbicides or rabbits.

Since we expected that relationships between attitudes and underlying values would vary depending on factors such

Table 3 – Summary statistics of multinomial logit regression sub-models concerning pairs of biodiversity management options

Contrast	Variable	β	$p\leqslant$
Herbicides vs. cutting	Naturalness	−0.559	0.021
	Education	−0.688	0.002
	Residence	−0.567	0.057
Rabbits vs. cutting	Rarity	0.443	0.012
	Education	−0.329	0.058
	Residence	−0.542	0.009
No intervention vs. cutting	Naturalness	1.381	0.003
	Balance	−1.814	0.001
Rabbits vs. no intervention	Naturalness	−1.342	0.005
	Balance	1.771	0.001
	Rarity	0.742	0.058
	Education	−1.045	0.023
Herbicides vs. no intervention	Naturalness	−1.939	0.001
	Balance	1.751	0.001
	Education	−1.404	0.004
Herbicides vs. rabbits	Naturalness	−0.597	0.020

All relevant factors in each sub-model are given along with their standardised regression coefficient β and level of significance p. Negative values of β indicate a decreased likelihood of a preference for the management option mentioned first in the sub-model heading whereas positive values indicate the reverse.

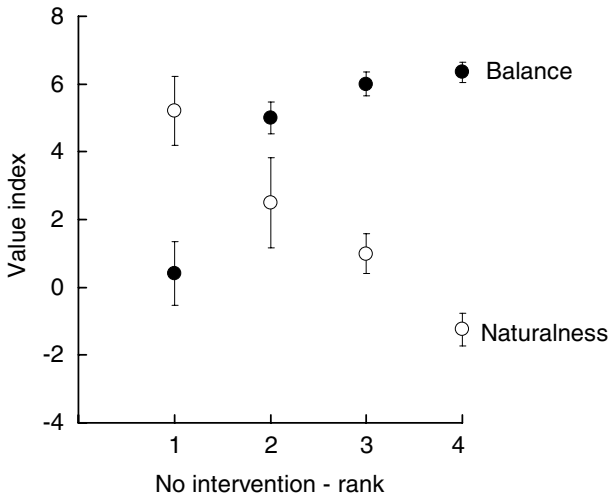

Fig. 5 – Support for the guiding principles 'balance' and 'naturalness' applied to the Craigleith case as measured through weighted value indices (mean ± standard error), in relation to the ranks assigned to the management option 'no intervention'.

as personal relevance and emotional importance of the issue being discussed, we split the total sample of interviews according to their emotional involvement scores and ran multinomial regression models of identical structure on both subsamples. Indeed, emotional involvement proved relevant as model performance was affected (Table 2b and c). Whilst the proportion of the variance explained by the model of the less-involved group (pseudo $R^2 = 0.367$) remained similar to that of the overall model (pseudo $R^2 = 0.345$), it increased to 0.433 in the high involvement group. The factors in the model thus seem to be stronger predictors for individuals that appear more interested in the topic of the survey. Moreover, whilst 'balance' proved to be a highly significant factor in both models, 'naturalness' and 'rarity' were only highly significant for the group of highly involved individuals. Education appeared to have a particularly strong role in the group with lower involvement, whereas place of residence was not a significant contributing factor in this group at all.

4. Discussion

This study demonstrates that attitudes as expressed by members of the public are indeed a distinct construct which can provide very valuable and meaningful information to policymakers in biodiversity management. Our analysis that combined qualitative and quantitative approaches revealed that individual perceptions, values and attitudes are indeed very closely linked, as perceptions and values combined were found to determine respondents' choices with regard to the four management options to a large extent. Our research provides clear support for the notion that value-based principles in a conservation context matter to the public (Buijs et al., 2006a), and that they, in contrast to the assumptions that underlie some consultation processes (Stewart, 2006), refer to similar concepts and criteria as conservation experts might do (Ratcliffe, 1977).

In this case, 'naturalness' and 'balance' were on average seen as the most important among the seven values suggested and at the same time, turned out to be the best descriptors of individuals' attitudes. The values expressed by the respondents reflect current public discussions on paradigms such as natural equilibrium, indicating a time lag as ecological sciences have been addressing non-equilibrium aspects of ecosystems for more than twenty years now (Levin, 1999; Wallington et al., 2005). To what extent members of the public perceive equilibria as necessarily static (Wallington et al., 2005) or as some sort of dynamic equilibrium when talking about balance, as qualitative studies suggest (Buijs et al., 2006a), needs further exploration, particularly in relation to the formal and informal environmental education curricula of the last decades. Tracing the history of 'naturalness' as a guiding principle could be equally instructive. Naturalness as wilderness, or as nature untouched by humans, has been a central, yet contested, principle in the conservation debate (Leopold, 1948; Primack, 2002; Van der Windt et al., 2006) and discussed as a concept that shapes individuals' behaviour in relation to their natural environment (Fulton et al., 1996; Buijs et al., 2006b; Van der Windt et al., 2006). Interestingly, although 80% of the respondents stated that they felt closer to puffins than to tree mallow, 'closeness' of a plant or animal to humans as a conservation principle was almost unanimously considered of least importance. This was often underscored verbally by remarks such as "I am tempted to say 'closeness' is important, but this cannot be a valid argument in situations where decisions for society's best have to be made". In contrast, Tisdell et al. (2006) found that respondents do indeed use this principle when informa-

tion on other criteria is systematically excluded, so that explicit consideration and prioritisation of criteria is neither encouraged nor feasible. When information on threats to species was subsequently disclosed, respondents' judgments changed accordingly, thereby underscoring our finding.

Our results demonstrate that invasive behaviour of a species is perceived as separate from the issue of allochthony. We focused on an invasive a plant species that occurred outside its natural range, and hence would be labelled non-native. Despite research on the socio-economic and political aspects of invasions (Perrings et al., 2002; Perrings et al., 2005; Lodge and Shrader-Frechette, 2003; Born et al., 2005), the values implied in management decisions on invasive species are a contentious issue and so far poorly understood (Peretti, 1998; Simberloff, 2003). In the Craigleith case, it appears that nativeness is not a major issue for the respondents, but the invasive behaviour of the species seems to create the perception that the situation on Craigleith is out of balance as tree mallow is overly dominant. This suggests that the respondents' attitudes are not based on a "good-versus-evil" thinking that unambiguously puts puffins in the role of the victim, but that their perceptions and evaluations are much more differentiated.

In addition to the value-based principles described above, we also found two demographic variables to play a significant role in influencing individuals' attitudes. Level of education had previously been found to correlate positively with support for the principle of naturalness and similar notions such as wildness and independence of nature (Buijs, 2000; Van den Berg and Koole, 2006). Often coinciding, individuals that lived in an urban place were also more likely to favour "wild", "unmanaged" nature (Buijs et al., 2006b). Skogen (2001) suggests this to be due to the hegemony of a "critical environmental paradigm", communicated through the media and other formal and informal channels of education which influence the views of more highly educated, often urban individuals who in their daily lives are not dependent on their natural environment. In line with this, level of formal education was a significant variable in all three variations of our multinomial regression model. More highly educated individuals tended to favour 'cutting' and 'no intervention', i.e., options that are consistent with an environmentalist stance. However, a correlation between education and the weighted value indices for naturalness and balance could not be found. This indicates that higher education might be related to support for principles such as 'naturalness' in their abstract form only, whilst in a concrete case individuals may critically reconsider the applicability of this principle. When given the choice between different options for intervention, more highly educated individuals then again choose the ones that are most compatible with the prevalent environmental views, for example cutting which was seen as relatively low in risk for the natural environment (Table 1).

Non-residents of East Lothian tended to favour cutting over the introduction of rabbits or the use of herbicides, an effect that might be explained by the fact that East Lothian is a relatively rural county, and that 40% of the non-residents were living in urban Edinburgh. The impact of non-residence might thus be analogous to the one described for higher education. An alternative explanation might be that non-locals did not want to impose potentially risky and/or controversial management options upon the local population, as spontaneous comments of non-residents suggest. Indeed, 64% of this group referred to arguments such as "least risk, fewer side-effects, most control" or "least intrusive" when asked for the reasons for their rankings.

Effects of age or preferences for particular outdoor activities on respondents' attitudes as shown in previous studies of related questions (Fulton et al., 1996; Buijs, 2000; Skogen, 2001) could not be found. This suggests that the Craigleith case was well suited to examine the relation between value-based principles, perceptions and attitudes, as individuals' private activities appeared to be unaffected by whatever management option would be chosen and did thus not interfere with their expression of values applied to tree mallow management.

An important aspect of our study was that we found a moderating effect of respondents' emotional involvement on the relationship between their values and attitudes. While the regression model showed that individuals' attitudes towards tree mallow management were generally informed by their values, this relationship was even stronger where the respondent's emotional involvement with the topic was high. In addition, choices appeared to be informed by different factors depending on the degree of emotional involvement. The fact that both highly and less involved participants seemed to base their choices on their assessments of the 'balance' principle suggests that 'balance' is indeed the most salient value for many of the respondents. This might be due to external factors such as trends in environmental education (Wallington et al., 2005), but could also be triggered by the framing of the survey or the characteristics of the case. For highly involved people, however, also other value-based principles, namely 'naturalness' and 'rarity', appeared to be important factors that informed their attitudes. These differences between individuals with higher and lesser involvement can be interpreted in the context of dual process models. While high emotional involvement correlates with a higher likelihood of systematic decision-making, low emotional involvement tends to correlate with the use of heuristic decision-making strategies that generally require less effort (Petty and Cacioppo, 1986; Fischer and Hanley, 2007). Indeed, the choices of highly involved participants were related to more complex decision processes that involved multiple value-based criteria, whereas the responses of less involved individuals related to only one value criterion, namely balance, which in this case might serve as a heuristic. The relatively strong role of education in the case of low emotional involvement suggests that the level of education could be considered a proxy for the accessibility and availability of heuristics that simplify decision making.

Our study demonstrates that the application of social psychological attitude–behaviour theories can provide important insights into the way value judgments arise. In this case, value-based criteria such as 'balance' and 'naturalness' played an important role in the formation of attitudes towards concrete biodiversity management measures. Recently, the number of studies that take public attitudes towards biodiversity management into consideration has been increasing (Conforti and Cascelli de Azevedo, 2003; Lindsey et al., 2005;

McFarlane et al., 2006). Approaches that examine the factors underlying these attitudes, i.e., individuals' values and perceptions, can contribute to an understanding of public views that is transferable across situations, and thus facilitate the design of environmental management policies and adapted communication strategies that are more likely to find acceptance among the general public. Simple surveys of attitudes that neglect the role of values, perceptions and cultural background variables, however, might produce misleading conclusions. We therefore advocate the incorporation of these approaches into mainstream conservation biology to enable effective integration of public attitudes into an inclusive process of biodiversity policymaking and nature conservation.

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