Using Decision Modeling with Stakeholders to Reduce Human–Wildlife Conflict: a Raptor–Grouse Case Study

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Abstract: *The successful resolution of human-wildlife conflicts requires the participation of local communities and other stakeholder groups in formulating management decisions. In the uplands of the United Kingdom, a controversial conservation issue concerns the relationship between the conservation of a legally protected raptor, the Hen Harrier (*Circus cyaneus*) and the management of a gamebird, the Red Grouse (*Lagopus lagopus scoticus*). We used multicriteria analysis to evaluate the perspectives of two groups of stakeholders, grouse managers and raptor conservationists, and the acceptability to them of different management solutions to this conflict. Both groups quantified the relative importance of evaluation criteria and used these as a basis for comparing different upland and Hen Harrier management options. In relation to upland management, grouse managers placed more importance on economic criteria than did raptor conservationists, who valued natural-environment criteria more highly. Intensively managed grouse moors, involving the control of harrier numbers, were ranked most highly by grouse managers and managed nature reserves by raptor conservationists, but both groups also ranked legally managed grouse moors highly. When evaluating Hen Harrier management options, grouse managers considered time scale and cost the most important criteria, whereas raptor conservationists considered the effects on harrier populations to be most important. Harrier quota schemes were the management solution most favored by grouse managers, whereas raptor conservationists preferred allowing harriers to attain natural densities. Notably, however, one technique that has already been partly tested in the field—the use of diversionary feeding was scored highly by both groups and thus holds promise for some form of compromise. This exercise highlighted the value of these objective techniques for developing dialog and trust between stakeholder groups, and it highlighted the need to conduct further research to test the effectiveness of different management options. There was broad agreement that the workshop moved the prior positions of individual stakeholders and was a valuable tool in helping to resolve human-wildlife conflicts.*

Key Words: conflict resolution, decision modeling, gamebird predation, Hen Harrier, predator management

Utilización de Modelos de Decisión con Grupos de Interés para Reducir Conflictos Humanos-Vida Silvestre: un Estudio de Caso Rapaz-Codorniz

Resumen: *La solución exitosa de conflictos humanos-vida silvestre exige la participación de comunidades locales y otros grupos de interés para la formulación de decisiones de manejo. Un tema controvertido de conservación en las tierras altas del Reino Unido se refiere a la relación entre la conservación de una rapaz legalmente protegida (*Circus cyaneus*) y el manejo de una ave de presa cinegética (*Lagopus lagopus scoticus*). Utilizamos análisis de criterios múltiples para evaluar las perspectivas de dos grupos de interés (manejadores de* Lagopus lagopus scoticus *y conservacionistas de rapaces) y su aceptabilidad de diferentes soluciones de manejo de este conflicto. Ambos grupos cuantificaron la importancia relativa de los criterios de evaluación y los usaron como base para comparar diferentes opciones de manejo de tierras altas y de* Circus cyaneus*. En*

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relación con el manejo de tierras, los manejadores de Lagopus lagopus scoticus *dieron mayor importancia a los criterios económicos comparado con los conservacionistas de rapaces, quienes evaluaron más alto a los criterios ambientales. Los brezales con codornices intensamente manejados, incluyendo el control del número de* Circus cyaneus*, fueron clasificados más alto por manejadores de codornices y las reservas naturales por los conservacionistas de rapaces, pero ambos grupos también clasificaron altamente a los brezales legalmente manejados. Al evaluar las opciones de manejo de* Circus cyaneus*, los manejadores de codornices consideraron la escala de tiempo y el costo como los criterios más importantes mientras que los conservacionistas de rapaces consideraron los efectos sobre las poblaciones de rapaces como más importantes. Las soluciones de manejo más favorecidas por los manejadores de codornices fueron los esquemas de cuotas de rapaces, mientras que los conservacionistas de rapaces prefirieron permitir que las rapaces alcanzaran densidades naturales. Sin embargo, es notable que una técnica que ha sido parcialmente probada a campo (el uso de alimentación alternativa) fue altamente calificada por ambos grupos y, por lo tanto, es promisorio para alguna forma de compromiso. Este ejercicio resaltó el valor de estas técnicas objetivas para desarrollar el diálogo y la confianza entre grupos de interés y resaltó la necesidad de realizar más investigación para probar la efectividad de diferentes opciones de manejo. Hubo un consenso general de que el taller modificó las posiciones previas de grupos de interés individuales y que fue una herramienta valiosa en la resolución de conflictos humanos-vida silvestre.*

Palabras Clave: *Circus cyaneus*, depredación de aves cinegéticas, manejo de depredadores, modelos de decisión, resolución de conflictos

Introduction

It is increasingly recognized that local communities and other stakeholder groups must be involved in decision making about conservation policies, particularly when these decisions affect the economic or social well-being of local people (Western & Wright 1994; Hulme & Murphree 2001). Difficulties arise, however, when the opinions and perceptions of stakeholders are quantified, particularly on contentious issues, where their views are often polarized and communication between groups is limited. One way to assess the acceptability of different management options is to quantify the views of stakeholders through the use of multicriteria analyses (Edwards-Jones et al. 2000). A wide variety of techniques have been developed to deal with decisions involving multiple criteria. Here we used an approach involving hierarchical decision trees (Moore et al. 2001) and multicriteria decision analysis (Department of the Environment, Transport and the Regions 2000). Similar techniques have been used previously to assess the value of land-management decisions and the use of mountain and water resources (Moss et al. 1996; McDaniels et al. 1999; Bayfield et al. 2000; Gregory 2000). To our knowledge, however, decision modeling has yet to be applied to situations of human-wildlife conflict (Messmer 2000; Conover 2002).

One of the most contentious conservation issues in the United Kingdom in the last decade concerns the conflict between the conservation of legally protected raptors, in particular the Hen Harrier (*Circus cyaneus*), and the commercial hunting of Red Grouse (*Lagopus lagopus scoticus*) (Thirgood et al. 2000*a*). Red Grouse live on moorland dominated by heather (*Calluna vulgaris* L.) moorland, and the aim of grouse management is to sustainably maximize the number of grouse available for shooting in autumn. Raptors are perceived to reduce grouse harvests, and they are often killed as a consequence. The killing of raptors was considered an essential component of traditional moorland management during the late nineteen and early twentieth centuries. Legal protection of raptors in the United Kingdom was established in 1954 and subsequently reinforced in 1979 with the European Union Birds Directive and again in 2000 with the United Kingdom's CROW Act. Despite this legislation and the efforts of government agencies and nongovernmental conservation organizations, the illegal killing of raptors continues on many moorland areas and is considered to be one of the principal threats to U.K. populations of Hen Harriers, Peregrine Falcons (*Falco peregrinus*), and Golden Eagles (*Aquila chrysaetos*) (Etheridge et al. 1997; Scottish Raptor Study Groups 1997; Watson 1997).

The perception of grouse managers that raptors can, in some circumstances, reduce the size of the grouse harvest has been supported by recent research (Redpath & Thirgood 1997, 1999; Thirgood et al. 2000*b*, 2000*c*). This work strongly suggests that high densities of Hen Harriers and Peregrine Falcons limit grouse populations at low density and reduce shooting bags. Grouse densities of >60 grouse/km^2 are required for driven shooting, where hunters stand in blinds while the grouse are driven overhead by lines of human beaters. Driven grouse shooting generates the greatest income for grouse moor owners, so high densities of raptors may lead to significant loss of income and potentially a change in land use and loss of moorland habitat. Heather moorland habitat has declined in surface over the past century, primarily because of commercial afforestation and increased densities of sheep and deer (Ratcliffe & Thompson 1988; Thompson et al. 1995).

The management of moorland areas for grouse shooting maintains large areas of internationally important heather-dominated moorland that benefits a range of upland bird species (Thompson et al. 1995; Robertson et al. 2001; Tharme et al. 2001). High densities of raptors therefore present a conservation dilemma. In these circumstances, their predation on grouse can potentially lead to changes in land use with negative consequences for biodiversity. A number of potential management solutions to the conflict between raptors and grouse have been suggested, ranging from habitat manipulation to lethal control (Thirgood et al. 2000*a*, 2002; Redpath et al. 2001; Smith et al. 2001; Watson & Thirgood 2001). Stakeholders have remained polarized in their views, however, and by 2001 an impasse had been reached in the interpretation of research and the implementation of solutions.

Potential solutions to the raptor-grouse conflict in the United Kingdom are likely to succeed only if they are acceptable to both grouse managers and conservationists. Our aim was to reengage the stakeholders in a constructive dialog by applying an objective approach. We used multicriteria analysis with two groups of stakeholders—grouse managers and raptor conservationists—to examine attitudes toward various management options to evaluate which measures were most acceptable. We also wished to identify areas where a consensus could be established.

Raptor conservation is only one component of land management in U.K. uplands. Therefore, decisions about the best way to deal with this specific conflict must be considered in the wider context of what is important to the two main stakeholder groups in terms of land management. For this reason we first asked the raptor conservationists and grouse managers to valuate moorland managed for grouse relative to other potential alternative management options. Thus, there were two separate decision-making exercises: the management of moorland and the management of harriers within moorland primarily managed for grouse.

Approach

We held a 2-day workshop in February 2002 at Tarland in northeastern Scotland. The workshop was attended by five grouse managers (GM), including gamekeepers, landowners, and a representative of the Game Conservancy Trust, and five raptor conservationists (RC), including volunteer members of Raptor Study Groups and representatives of the Royal Society for the Protection of Birds. We invited individuals who were known to have strong views on raptor management in the uplands and would be able to articulate those views in a workshop environment. The workshop was run by two facilitators (P.B. and N.B.) and was attended by two raptor and grouse specialists (S.R and S.T.) and two external observers not from the United Kingdom (B.A. and R.G.). The facilitators coordinated the technical side of the workshop: they ensured that the participants understood the decision models they were using, and they maintained consistency during discussions and helped interpret initial findings. The specialists provided relevant information on published work, and the international observers provided examples of potential ways forward when discussions became stalled.

A large number of criteria influence how stakeholders decide between alternative options for the management of both moorlands and raptors. One way to quantify such decisions is to create a hierarchical decision tree and to rank the relative importance of the elements at each level of the hierarchy, thus enabling different criteria to be ranked in order to indicate which are the highest priorities. These decision trees can also be used as a framework for a multicriteria decision analysis (MCDA), making choices between alternatives using the relative weights of each of the criteria to provide an overall weighted score for each alternative (Department of the Environment, Transport and the Regions 2000). These approaches provide an audit trail for decisions based on multiple criteria by identifying the criteria used, their relative weightings, the individuals who made the assessments, and the range of opinions within the stakeholder group. Thus, the basis of a decision can be defined in considerable detail and potentially can be reexamined at a later date with the same protocol.

In the first part of the workshop, we asked stakeholders to identify and rank the importance of various elements for valuing the moorland environment of a notional upland estate of 10,000 ha in northeastern Scotland. A provisional list of elements important for the valuation of moorland and their organization in a decision tree was developed prior to the workshop by a small expert group. The list was modified and completed following discussion with the workshop stakeholders, and it was this final list (accepted by the participants) that was used for analyses. The first branch of the tree identified four major factors associated with the moorland environment—social and political, economic, landscape, and natural resources—and each of these four factors was split into a number of issues, which were further split into criteria (Fig. 1). The definitions of each of the factors, issues, and criteria are available from S.R. from http://banchory.ceh.ac.uk/staffdetails/personal_pages/redpath/redpath.htm.

At each branch of the tree, the importance of the various elements was ranked by the stakeholders, with a score of 5 given to the alternative considered most important and then scores from 1 (unimportant) to 5 (equally important) for all other alternatives. The reason for ranking importance could be either for positive (beneficial) or negative (detrimental) reasons of the stakeholders, but direction was not considered at this stage, only relative importance. Direction was included in the

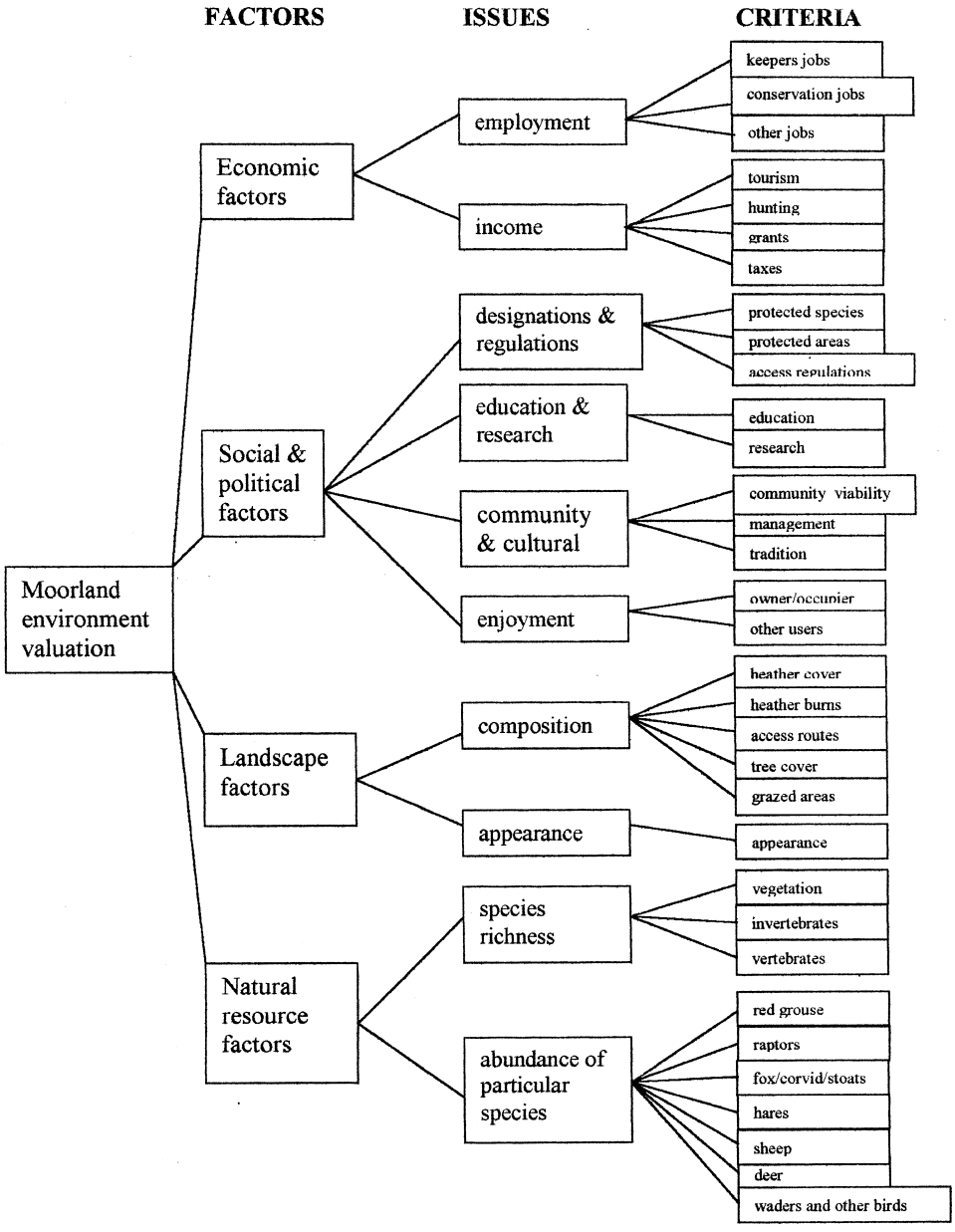

Figure 1. Decision tree used to split the criteria used to assess the value of moorland environment. Each branch of the tree was scored separately.

analyses subsequently, when stakeholders assessed the consequences of management options for each of the elements of value. Each individual workshop participant scored the elements separately. The four factors were scored first, then issues, and finally criteria. These scores were then presented (anonymously) to the group, and the results were discussed. Individuals were allowed to alter their scores following the group discussion, and these revised scores (or original if unchanged) were used in the subsequent analysis. To compare the relative importance the stakeholders placed on each criteria, scores for each element were transformed to a unitary value by first dividing each score by 5, then combining each of the three scores of its branch. For example, the overall value for "keepers jobs" was a product of the values for "economic factors," multiplied by the value for "employment," multiplied by the value for keepers jobs. This method permitted ready comparison of all the criteria on a unitary scale of importance, regardless of the number of branches at each node.

These criteria formed the basis for a comparison of alternative management regimes using MCDA. Prior to this comparison, each element was weighted by calculating the proportion that each value represented for the whole node. This ensured that the weights of any given node always added to one. For each weighted criterion the stakeholders first gave a score of 100 to the management option viewed as most likely to achieve their required aim, and then scored the other options relative to that on a scale of 0 to 100. There could be more than one score

Table 1. General description of the seven alternative management options for upland heather moorland considered by the two stakeholder groups.

				Management practices[b]					
Option	*Description*	*Manager*	*Intensity*[a]	*legal predator control*	*illegal raptor control*	*heather burning*	*parasite control*	*tree regeneration*	*grazing animals*
A	intensive I	keeper	high	much	much	much	much	some	some
B	intensive II	keeper	high	much	none	much	much	some	some
C	intensive III	keeper	high	much	some	much	much	some	some
D	extensive I	keeper	low	some	some	some	none	some	much
E	extensive II	keeper	low	some	some	some	none	much	some
F	nature reserve I	warden	high	some	none	some	none	some	some
G	nature reserve II	warden	low	none	none	none	none	much	some

[a] *Intensity is an overall measure of the level of management effort.*
[b] *Management practices are divided into three groups reflecting intensive management (much), some management (some), or no management (none).*

of 100 if options were equally preferred. Because the two groups had different perspectives, it was necessary for them to clearly indicate the basis of their choice. Thus, in relation to raptor numbers, for example, the raptor conservation group viewed abundant raptors as positive and aimed for "maximum raptor numbers," whereas grouse managers viewed abundant raptors as negative and aimed for "maximum sustainable raptor numbers."

Seven different management options were chosen to reflect different management practices currently employed in U.K. uplands, ranging from intensively managed grouse moor to nature reserves (Table 1). Three types of intensive management of moorland were considered, differing only in the level of illegal killing of raptors. In these cases, outcome differences between these options would be the abundance of grouse and the abundance of raptors, whereas all other aspects (e.g., landscape structure) would be similar. There were two options with few gamekeepers per square kilometer that differed in the number of grazing animals. The likely outcome of these options would be low grouse abundance for both but better-quality heather habitat in the option with fewer grazing animals. Finally, there were two hypothetical areas managed as nature reserves, of which one was intensively managed by wardens and the other of which received little management. In these cases, income would come from tourism rather than hunting, and the outcome in terms of habitat would differ in relation to the degree of management. The main difference between gamekeepers and wardens resides in their motivation and the management goals of either maximizing grouse numbers or maximizing biodiversity, respectively. Individuals of both stakeholder groups scored the options for each of the individual criteria separately (so each individual scored 7×33 assessments) and then held group discussions to obtain consensus scores for each of the assessments. Overall scores for the seven management options were obtained by multiplying the criteria weightings by the option scores and then taking an average of the group members' scores. As with the evaluating criteria, the average scores for each of the seven management options by both groups were presented to the participants and the results were discussed.

During the second day of the workshop we repeated the procedure as outlined above, but this time the two groups considered the criteria and options for the management of Hen Harriers on grouse moors. In total, seven different management options were considered (see legend for Figure 5), ranging from allowing harriers to breed naturally, without human interference; to legal quota schemes organized by government agencies; to illegal killing by gamekeepers (for further details on each management option see Thirgood et al. 2000*a*; Redpath et al. 2001; Smith et al. 2001; Watson & Thirgood 2001). The aim of the management options would be to minimize predation on grouse, either by reducing predation rates (option C) or reducing harrier numbers (options B, D, E, F, and G). For this part of the workshop, a simpler decision tree was created, including the relevant criteria necessary to evaluate the different options. Again, a preliminary list had been created previous to the workshop, which participants modified to include new criteria. As before, stakeholders were asked to give a preference ranking for each harrier-management option based on each of the criteria. A total score for each option could then be computed based on the relative weightings of the criteria. Definitions of the criteria used are available from S.R. through http://banchory.ceh.ac.uk/staffdetails/personal_pages/redpath/redpath.htm.

Scores for each of the options for moorland management and Hen Harrier management are presented as boxplots indicating the distribution of scores within each stakeholder group and thus the degree of consensus within each group. Our presentation is qualitative and observational because we viewed this workshop as an initial step in the process of resolving the grouse-raptor conflict.

Results

Moorland Management

Four factors, 10 issues, and 33 criteria were considered by participants in judging the value of moorland (Fig. 1). The original scores for each criterion are available from S.R. through http://banchory.ceh.ac.uk/staffdetails/personal_pages/redpath/redpath.htm. Most of the criteria were valued highly by all individuals, indicating the importance given to them by both groups. However, the relative importance of each criterion varied between both stakeholder groups. Criteria related to income and employment emerged as the most important to the grouse managers, whereas criteria related to species diversity and abundance tended to be most important to the raptor conservationists (Fig. 2). Both groups considered raptor abundance of similar importance (fourth most important), although it was a negative factor for grouse managers and a positive factor for raptor conservationists.

Using these criteria, the two groups then ranked the seven moorland management options quite differently (Fig. 3). Grouse manager scores indicated that intensively managed grouse moors were favored, with the highest scoring option being the grouse moor with some limited raptor control. In contrast, raptor conservationists favored managed nature reserves, although the second most highly ranked option was intensively managed grouse moorland without raptor control. For the GM group the least favored option was nature reserve with little management. The lowest ranked option for the RC group was extensively managed land with some raptor control and a high density of grazing animals.

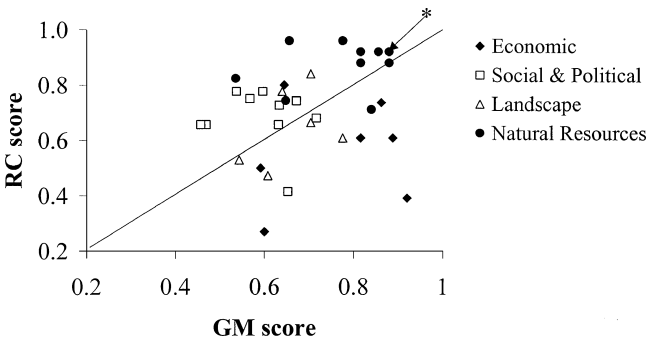

Figure 2. Relationship between the scores by grouse managers (GM) and raptor conservationists (RC) for each of the criteria used to value moorland. The line indicates where points would fall if there was perfect agreement between the groups about the importance of the criteria. The point for raptor abundance is marked with an asterisk. This criterion was valued as negative for GM and positive for RC. Points are shown for the four main factors and indicate that, relative to the other group, RC tended to score social and political and natural resource criteria higher, whereas GM scored economic criteria higher.

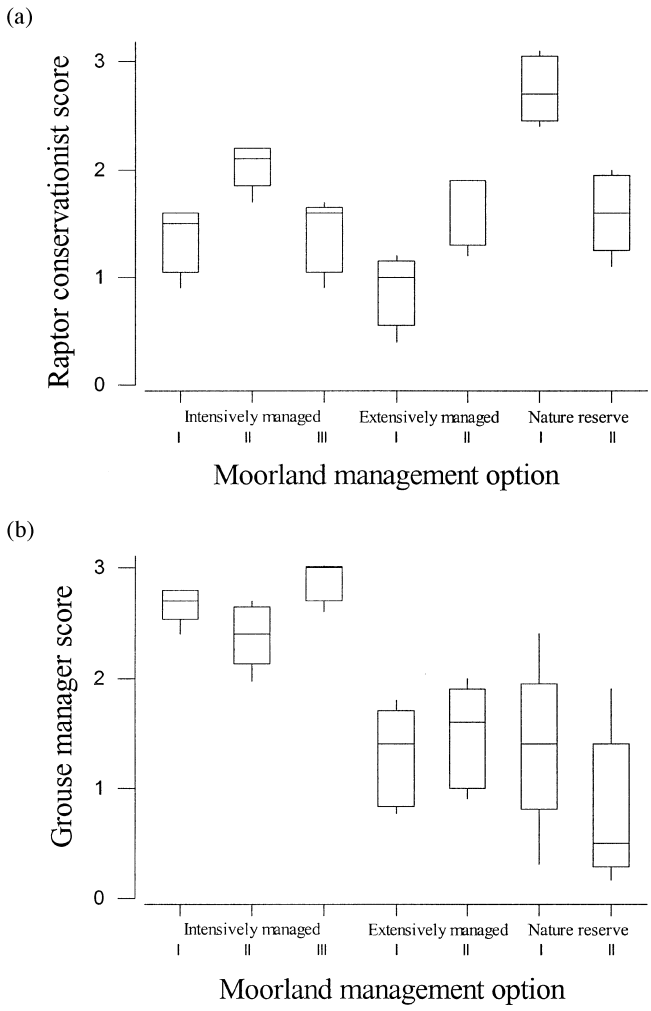

Figure 3. Weighted scores by (a) grouse managers and (b) raptor conservationists for each of the seven options for moorland management. Table 1 provides definitions of each of the management options; mean, first, and third quartiles and upper and lower values are shown. Scores range from 0, least valuable option, to 3, most valuable option.

Hen Harrier Management

Eight criteria were considered by the participants to evaluate the different options for managing Hen Harriers on grouse moors (Fig. 4). One of these criteria, the acceptability of the management, was subdivided further into criteria of acceptability to the public, to grouse managers, and to raptor conservationists. All criteria were considered important by both groups, but there were differences between the groups in the ranked order. Grouse managers viewed economic and time issues as more

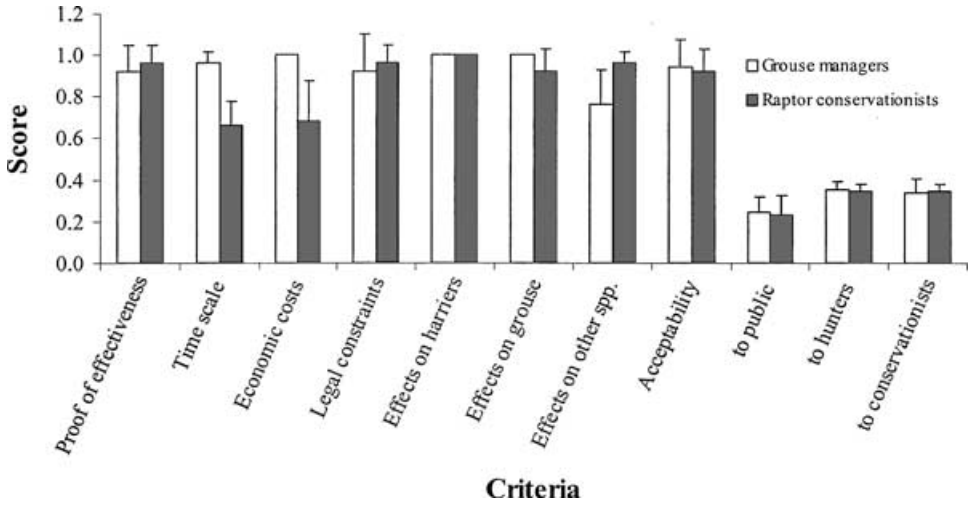

Figure 4. Average scores (+SD) for each of the criteria considered important in assessing the options for harrier management. Scores range from 0, least important, to 1, most important. Scores for "acceptability" are split in relation to the importance of the acceptability to different stakeholder groups.

important than did the raptor conservationists group (Fig. 4). Seven management options were evaluated in relation to the above criteria. There were divergent views over the most appropriate way to manage Hen Harrier populations (Fig. 5) when considering each management option separately. Grouse managers favored the quota schemes, followed by the use of deterrents and supplementary feeding. Raptor conservationists favored allowing harriers to settle naturally, followed by supplementary feeding. Within the groups there was individual variation in the scoring for each option (Fig. 5). In the GM group there appeared to be broad agreement in the scores for the quota schemes and allowing unmanipulated raptor densities but more divergent views over the use of habitat manipulation, supplementary feeding, and deterrents to manage Hen Harriers. In contrast, the RC group had more consistent scores over the first three options—natural densities, habitat manipulation, and supplementary feeding—but less agreement over quota schemes.

Discussion

Harrier-Grouse Conflicts in Upland Britain

The decision models described here quantified the perceptions of two groups of stakeholders, raptor conservationists and grouse managers, concerning the conflict between raptor conservation and grouse management in the United Kingdom. This has been a hotly contested issue around which opinions have been polarized (Hughes et al. 1998; Potts 1998; Mitchell 2000; Thirgood et al. 2000*a*). We also attempted to place the management of raptors in a wider context by quantifying stakeholder perceptions about the value of heather moorland. Most criteria related to moorland value were scored highly by both stakeholder groups, indicating that a range of topics was considered important. However, obvious differences between the two groups did emerge. Grouse managers tended to place more value on economic criteria, whereas raptor conservationists valued biodiversity criteria more highly. Raptor abundance was viewed by both groups as one of the most important criteria for judging the value of moorland, but raptor conservationists viewed high numbers of raptors as positive, whereas grouse managers viewed them as negative.

Ranking scores indicated that both stakeholder groups favored moorland that was managed either by gamekeepers (GM) or wardens (RC). This result highlights the fact that it was not management itself that was seen as negative by the RC group but the type of management conducted by gamekeepers. One moorland management option that was ranked highly by both groups was that of managed grouse moors where raptors were not illegally killed. Raptor conservationists believed that legally managed grouse moorland was beneficial in terms of species richness and abundance. However, grouse managers thought this management option was only viable in the short term as, ultimately, raptor numbers would increase and driven grouse shooting would therefore become uneconomical. This group perceived that if hunting were no longer viable, land management would change (e.g., to plantation forestry) to derive income. If that were the case, changes in land use would result in loss of moorland habitat, with a consequent loss of grouse, Hen Harriers, and biodiversity.

The process of attempting to quantify perceptions of the value of moorland highlighted differences between stakeholder groups in their perceptions of raptors. The raptor issue was then considered in more detail by examining different options for managing Hen Harriers, which was the raptor species of major concern for both groups. All of the 10 evaluated criteria were scored as important (Fig. 3). However, some clear differences again emerged between the stakeholder groups in relation to the ranking of some criteria. The time scale over which the management option would become effective and the cost

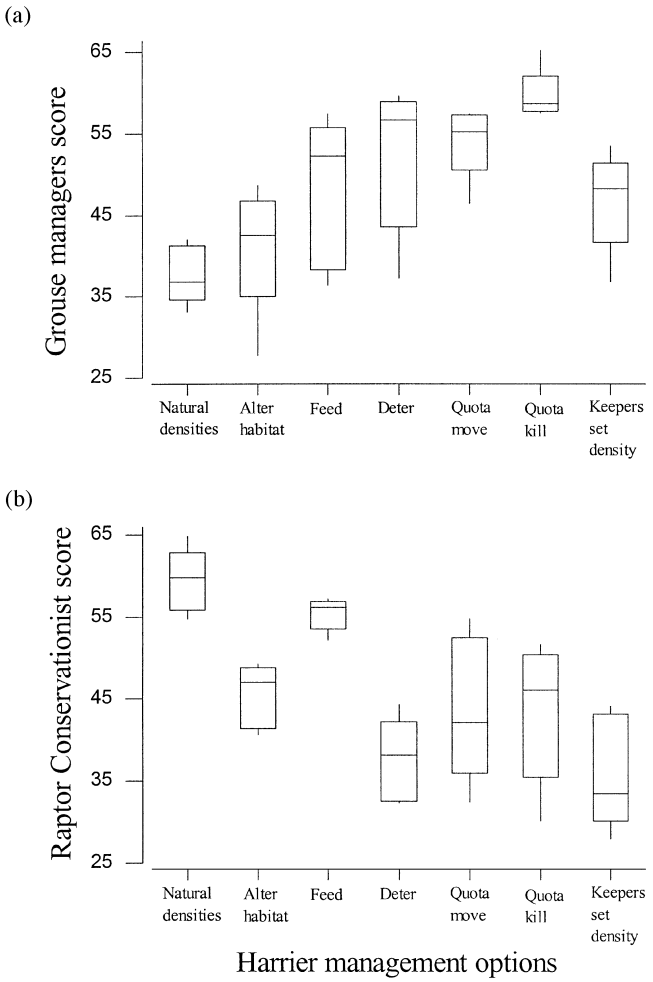

Figure 5. Weighted scores for (a) grouse managers and (b) raptor conservationists for each of the following options for managing harriers on moorlands: natural densities, allow natural (unmanipulated) densities of harriers; alter habitat, reduce harrier numbers through habitat manipulation to reduce prey; feed, reduce harrier predation on grouse through supplementary or diversionary feeding; deter, reduce harrier numbers with deterrents; quota move, reduce harrier numbers by removing and translocating excess birds (according to a legally approved quota); quota kill, reduce harrier numbers by destroying eggs from excess birds (according to a legally approved quota); keepers set density, reduce harrier numbers by allowing keepers to set harrier densities. Values are explained in legend of Fig. 3. Scores range from 60, most valuable option, to 30, least valuable option.

of implementing the technique were more important to grouse managers than raptor conservationists, whereas raptor conservationists considered the effect of the management on species other than grouse or harriers to be more important than did grouse managers. Both groups viewed legal constraints as very important for starkly different reasons: for raptor conservationists current legal constraints were critically important and should, if anything, be reinforced, whereas for grouse managers they were viewed as an impediment to desired management practices. Both groups considered acceptability to the general public to be less important than acceptability to the two stakeholder groups. There was general agreement that if the two stakeholder groups considered a management technique acceptable then the general public would also.

There was a clear divergence between the two groups as to the most favored option for managing Hen Harriers on grouse moors, and considerable discussion of the relative value of the different options followed presentation of the results of the decision modeling to the stakeholders. Interestingly, the current system in which keepers often set the densities of harriers was not valued highly by grouse managers. Although this group thought harriers had to be managed, they would rather this process be done by an external agency. Of the other management solutions, the GM group scored the quota schemes most highly and with highest within-group agreement, followed by the use of deterrents and supplementary feeding. Grouse managers considered habitat manipulation an undesirable management option, expressing the view that the time scale for this technique was too long and that the technique was unlikely to be effective in reducing Hen Harrier numbers. Among raptor conservationists there was considerable within-group agreement about the two favored options: natural harrier densities and supplementary feeding. There was less agreement over the quota schemes with a wide spread of individual scores. Raptor conservationists were also concerned about the potential impact of habitat manipulation on wider biodiversity in the uplands, although this technique was valued highly for this group. Supplementary feeding was the only management option that was scored relatively highly by both groups. However, the GM group was concerned that the long-term consequences of this technique had not been explored fully and would not be accepted widely by the grouse-management community until further research was conducted (Redpath et al. 2001). These doubts were reflected in the wide variability of scores for this option in the GM group despite its high overall rank.

Several important points were evident during the discussion of the results. First, most participants were surprised by some of the results, particularly concerning the relatively high value of supplementary feeding by both groups. Second, it was widely perceived that the process highlighted areas for compromise and common ground between the stakeholder groups. Nevertheless, participants believed that despite the potential agreement about the best options for reducing conflicts between raptors and grouse, a lack of trust between stakeholders would prevent implementation. Further, they believed that there

was little hope for a long-term solution until there was more dialog and understanding between the two groups. Additionally, they thought objective research was needed to test the effectiveness of some of the management options, in particular the use of deterrents and habitat manipulation to reduce Hen Harrier numbers. Finally, there was broad agreement that any future workshops should consider a combination of management techniques rather than relying on a single method to solve the problem.

Decision Modeling and Human-Wildlife Conflicts

Decision modeling provided an objective view of the two groups' opinions that can be compared in the future to different stakeholder groups or to the same groups if new scientific information becomes available. One of the drawbacks of this workshop was that, although the methods were quantitative, the data set was too small to allow quantitative analysis. For example, an evaluation of whether within-group variation was really different in one group relative to another could have important implications for the acceptance of decisions made by "decision makers" and the wider audience within each stakeholder group. In addition, the scores reached by the individuals within each group were not derived independently because the process required some open discussion to ensure that individuals were scoring criteria according to a set definition. Any future application of the technique to larger groups who agree to criteria and then score them independently could result in a more powerful, formal statistical analysis. Stakeholders suggested that similar workshops with different representation, including policymakers or the leaders of stakeholder groups, should be conducted to better evaluate the perceptions of the groups in a broader context.

The major advantages of using decision models to evaluate solutions for the raptor-grouse conflict were that they facilitated communication between the two groups of stakeholders and enabled both sides to achieve a better understanding of the perceptions of the other group. At the end there was general agreement that the process had altered the prior positions of individuals. Subsequent decision-model exercises should aim to quantify the prior- and post-meeting positions of the participants, which would allow insight into the degree of individual changes. Importantly, participants believed that this was a valuable process in which other stakeholders should engage. Thus, decision models enable a combination of criteria to be evaluated simultaneously, and although stakeholder viewpoints may be extremely polarized in relation to individual criteria, when several equally important issues are combined, the results may be unexpected. The process also provides a clear audit trail showing how results were achieved, which helps participants better understand their own and the other stakeholders' positions. In addition, the participants had immediate, real-time feedback on the results that may help to reduce the tendency to maintain preconceived positions. Finally, with the use of computer models, personal animosity and mistrust are reduced because people work within a neutral framework rather than a framework perceived as adversarial.

We believe that the application of decision modeling with stakeholders is a useful step on the road to resolving or at least reducing the conflict between raptor conservation and grouse management in the United Kingdom. This particular issue may be unusual in the degree to which rigorous scientific studies have been conducted to quantify the conflict and test management solutions. However, the general principle of quantifying the perceptions of polarized stakeholders as a means of searching for acceptable solutions has wider relevance for the emerging discipline of human-wildlife conflict resolution (Messmer 2000; Conover 2002). Together with rigorous protocols for analyzing empirical data (Anderson et al. 1999) and methods of incorporating uncertainty into ecological risk assessment (Harwood 2000), decision modeling may facilitate a more objective approach to the resolution of human-wildlife conflicts, particularly if performed repeatedly and on large enough groups to allow quantitative and statistical conclusions to be drawn.

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