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Understanding conservation conflicts associated with rodent outbreaks in farmland areas

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Abstract Rodent outbreaks affect many farmland areas worldwide and the negative environmental impacts of control campaigns cause intense social tensions. In such conservation conflicts, understanding stakeholders' viewpoints is critical to promote ecologically sustainable management. We used Q-methodology, a framework standing between qualitative and quantitative social research, to investigate human subjectivity and understand conflicts caused by rodent outbreaks in Spain. We interviewed farmers, conservationists, hunters, and governmental agencies, and identified five main discourses about the origins and consequences of the conflictive situation. Finding sustainable management is impaired by opposing views about causes and consequences of vole outbreaks and their management, which are at the root of the conflict. Social tensions will likely remain until the underlying conflicts between people holding different views are also managed. Decision-making should therefore focus on mitigating underlying conflicts. Using trained independent mediators would help the effective resolution of conservation conflicts caused by rodent outbreaks and their management.

Keywords Farmland pest · Human dimensions · *Microtus arvalis* · Socioecological systems · Sustainable conservation · Wildlife management

INTRODUCTION

Conflicts between humans over the management of wildlife are widespread and sometimes intense and destructive (Redpath et al. 2015). The debate about the need and legitimacy to carry out interventions on wildlife populations is heated at times, particularly in cases when one species is considered "harmful" by part of the society, who thus seeks to reduce the species' numbers to minimize the damage it causes (Hadidian et al. 2006; Meerburg et al. 2008; Vantassel 2008). Wildlife damage to humans could be direct, as in the case of large carnivore attacks (Löe and Röskaft 2004; Inskip and Zimmermann 2009), or indirect through impacts on people livelihoods, e.g., livestock loss (Skogen et al. 2008), crop damage (Stenseth et al. 2003; Singleton et al. 2010; Maurer et al. 2017), or impacts on game species (Villafuerte et al. 1998). Conflicts in these contexts arise when part of the society disagrees with the idea of reducing populations of involved wildlife species, or when the tools used to achieve this reduction are viewed as unethical or creating secondary damage (Meerburg et al. 2008; Rust 2017).

These issues are frequently complex, and the need for stronger links between social and natural sciences to better understand and manage such conflicts is recurrently underlined (Dickman 2010; Redpath et al. 2013; Bennett et al. 2017). Ecological studies may help to understand the relationships between wildlife and risk of damage, and to develop technical solutions to minimize wildlife impacts (Redpath et al. 2015). However, technical solutions are usually insufficient when conflicts are deep-rooted (Madden and McQuinn 2014). The inherent complexity of conflicts in most wildlife management contexts requires approaches that help understanding the social and psychological dynamics between individuals and groups

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(Madden and McQuinn 2014). Furthermore, views about the different aspects of the conflict are subjective, and socially accepted management may depend on values, attitudes or perceptions varying among individuals (Dickman 2010). In this context, assessing stakeholders' subjective positions and discourses about the issue is important to fully understand the sources of conflict among stakeholders and hence design mutually supported solutions (Moon and Blackman 2014; Bennett et al. 2017; Rust et al. 2017).

The management of rodent outbreaks in farmland areas is at the root of widespread conflicts worldwide (Stenseth et al. 2003; Palis et al. 2007; Meerburg et al. 2008). Rodent outbreaks can lead to substantial crop damage and impact food security (Stenseth et al. 2003; Meerburg et al. 2008), which makes them one of the main wildlife pests worldwide (Singleton et al. 2010). In addition, many rodents are reservoir species of zoonotic diseases (Han et al. 2015), and their outbreaks represent a growing public health problem (Stenseth et al. 2003; Meerburg et al. 2008; Luque-Larena et al. 2017). Despite their key ecological roles, rodents lack charisma (Delibes-Mateos et al. 2015) and are the target of intensive control campaigns worldwide (Stenseth et al. 2003; Palis et al. 2007; Jacob and Tkadlec 2010), which often negatively affect non-target wildlife (Mendenhall and Pank 1980; Coeurdassier et al. 2014; Alomar et al. 2018). A clear example occurs in northwestern Spain, where management of common vole (*Microtus arvalis*) outbreaks is the source of many social tensions (Luque-Larena et al. 2013; Roos et al. 2019). Despite heated debates and many cross accusations in media about responsibilities, there has been no study to assess viewpoints of different stakeholders, whether discourses are coherent and shared within stakeholder groups, and which aspects create more divergence or consensus.

In this paper, we used Q-methodology, a framework that stands between qualitative and quantitative social research, providing precision and statistical robustness to explore human subjectivity (Brown 1993), to assess discourses among stakeholders involved in the management of rodent outbreaks. We discuss our results in terms of assessing the level of conflict and identifying solutions to address it.

MATERIALS AND METHODS

Case study: Conservation conflicts associated with vole outbreak management in Northwestern Spain

In western Europe, the common vole is considered the most important vertebrate pest in farmland areas, producing important damage to cultivations during outbreaks, and hence bio-economic costs (Stenseth et al. 2003; Jacob and Tkadlec 2010).

We focused our study in the Castilla y León region, Spain (Fig. S1). In this lowland area dominated by farmlands, common voles were absent in the 1970s. After an increase in irrigated herbaceous crops, in particular alfalfa, the species expanded its range (Jareño et al. 2015). By the early 1990s, common voles occupied almost the whole region (Luque-Larena et al. 2013), having colonized about 5 million ha of farmland areas. Recurrent outbreaks have occurred ever since (eight by 2014 at the regional scale; Luque-Larena et al. 2015; Rodríguez-Pastor et al. 2017) with claims of substantial damage to crops and disease transmission (e.g., *Tularemia*) to humans (Luque-Larena et al. 2013, 2018). The outbreak of 2007 was the largest so far, and management included mainly the large-scale use of chemical anticoagulants (bromadiolone and chlorophacinone) costing 15 million € of public subventions (Luque-Larena et al. 2013). This raised heated conflicts with conservation NGOs and hunters because non-target fauna, including protected and game species, were killed by rodenticide (Olea et al. 2009; Sánchez-Barbudo et al. 2012). In 2008, a specific working group was created within a governmental agency, being in charge of monitoring vole abundance, making recommendations for management, and authorizing special management (including provision of rodenticides to farmers) when considered necessary. Recommendations for management currently include preventive actions when vole populations are increasing—such as destroying vole habitat, e.g., plowing plots to destroy vole burrows (Roos et al. 2019), or burning vegetation and scrapping soil in field margins—and other linear structures such as ditch or track margins, which are key reservoir habitats from which voles invade crops (Rodríguez-Pastor et al. 2016), and promoting biological control through installation of perches and nest boxes for kestrels and barn owls (Paz et al. 2013). The use of rodenticide has been considered necessary beyond those preventive measures but is forbidden since the last 2014 vole outbreak. In this context, understanding social tensions could be challenging as stakeholders' viewpoints about what causes problems could refer to different aspects (e.g., technical issues, trust about implementation, identity-based conflicts, and differences in values) and complex relationships between them.

Q-methodology

In wildlife research, poor questionnaire designs are often used, even when a qualitative approach is more appropriate (Sutherland et al. 2018). For example, when the issue under consideration is complex and when there are no previous studies on the social context of the conflict, it may be more

appropriate to select a method that did not constrain the range of responses from participants as quantitative approaches (e.g., questionnaires) may do and that help assess mental constructs that could arise without prior hypothesis from researchers. In this context, Q-methodology may constitute a good alternative as it focuses on human subjectivity to identify shared discourses among participants, and produces in-depth investigations to decipher contrasting views about a topic. Q-studies are performed not only to study complex phenomena, but also to uncover narratives among participants when not obviously stated (Dziopa and Ahern 2011; Rust 2017). Consequently, Q-methodology is increasingly used to provide insights on potentially contentious debates about environmental issues, including wildlife management (Cairns et al. 2014; Rust 2017; Bredin et al. 2018). The method was developed to analyze the relationships between individual subjective viewpoints about a topic (Brown 1993; Van Exel and De Graaf 2005). A Q-study involves an individual sorting a set of statements into an order that is significant to her/him. This arrangement represents a subjective "map" of that individual's viewpoint. Cluster analyses of all participants' sorting allow to identify viewpoints which are then regrouped and interpreted as "discourses." Typically, Q-method has six steps: (1) define the specific question to investigate; (2) collect a set of statements representing all opinions about the question (the "concourse"); (3) select a representative subset of statements (the Q-set) among the concourse according to the research question; (4) ask respondents to rank the statements along a scale ranging from "the most I agree with" to "the least I agree with" in a pseudo-normal shaped board (Fig. S2); (5) analyze Q-sorts to identify 'factors' or discourses shared among respondents; (6) interpret discourses using additional information collected during open discussions with respondents after the Q-sorting.

In our case, we aimed to address "the problems caused by vole outbreaks and their management." The concourse of statements was collected through a search in a wide range of press articles or blogs published online between 2006 and 2017 (n = 57 articles from 25 different newspapers and blogs). Articles were selected through searching in Google with keywords like "vole" (*topillos* in Spanish), "plague" (*plaga*) and "Castilla y Leon." Selected blogs and articles were inspected and coded with Nvivo 10.0 (QSR International Pty Ltd., 2012). We extracted a total of 263 statements related to all aspects of vole outbreaks and their management. We restricted the concourse to a subsample (the Q-set) based on the stakeholder group to which the statements referred to (farmers, conservationists, regional authorities, society at large, or various of those simultaneously), and the content (whether the statement focused on the origin and consequences of the outbreak, actions against voles, or relationships between actors). We structured the statements onto these dimensions, selecting a total of 32 statements, aiming to reflect the whole variety of comments in those dimensions while avoiding repetitions. We performed pilot tests of the selected Q-set with academics working on vole outbreaks, farmers and hunters (n = 6) to ensure a full comprehension of statements and that no vole related issues were omitted. Modifications of the original set were carried out following pilots, until we reached the final selection (Table 1, see Table S1 for the Spanish formulation of the statements).

We interviewed 63 respondents from four distinct groups of actors: (1) farming related respondents (n = 44), including farmers (n = 35), employees of farming cooperatives (n = 5), and employees of one farming association with strong lobby function (n = 4); (2) conservationists (i.e., members of conservation NGOs involved in environmental projects in the affected areas, n = 7); (3) hunters (n = 14), distinguishing those who were also farmers (hereafter "hunter–farmer," n = 8) from others (hereafter "hunter–non farmer," n = 6); and (4) employees of the regional governmental agency involved in pest (including vole) management (n = 6).

Initial participants were selected through collaborators in former vole projects and those that had potentially a leading role in production of discourses (NGO managers, leaders of farming associations, technicians of farming cooperatives directly advising farmers about methods to use in the field, head of governmental agencies working in the issue). Then a "snow-ball" procedure was carried out within each group to search further potential participants (Brown 1993; Oñate and Peco 2005). We aimed at people from the areas most affected by vole outbreaks (municipalities in the Palencia and Valladolid Provinces, within "Tierra de Campos," Luque-Larena et al. 2013, see Fig. S1), from a variety of social backgrounds. Unbalanced sample size among groups (see above) partly reflects differences in the numbers of people from different groups in the area. For example, the number of employees of governmental agencies in charge of vole monitoring, or the number of members of conservation NGOs directly dealing with this conflict in Northern Spain is much smaller than that of farmers (actually the seven conservationists interviewed represented a quasi-exhaustive panel of specialists about this case study in the area). In other cases, sample size was limited by logistics or availability of identified people (e.g., we only interviewed members from one of the farming associations due to the lack of arrangements with others). Finally, sample size also reflected variation in responses. As sample size in qualitative research is based on saturation, we analyzed the data daily and stopped interviews when we observed that no new factors (discourses) appeared with further data. Including new farmers

Table 1 Idealized Q-sorts of the 5 discourses identified by the Q-method (D1–D5). For each discourse, statistics (stat.) about the clustering analysis are presented, as well as the value associated to each statement

		D1	D2	D3	D4	D5
Stat.	Eigen values	8.6	7.9	7.3	6.8	4.5
Stat.	Percentage of variance explained	13.7	12.5	11.6	10.7	7.2
Stat.	Number of loadings Q-sort	10	9	11	9	4
N°	Statements					
1	Voles put farmers' capital and assets at risk	3	1	3	2	1
2	Although they are the victims, farmers are accused of being responsible for voles' presence	0	− 2	2	− 2	1
3	Vole control adversely affects game species and hunters	− 2	0	0	2	4
4	Current agricultural activities facilitate the presence of voles	− 1	4	1	0	− 1
5	The regional government neither control the burnings nor the use of poison	− 4	3	− 2	0	2
6	Voles are a public health problem	4	2	2	2	3
7	The regional government repeats the same mistakes in each outbreak	2	2	− 1	1	1
8	Conservationists do not allow the use of poison	2	− 1	0	0	− 2
9	The regional government is too slow in taking decisions and then it has no choice but to use measures that endanger wildlife	1	4	0	4	4
10	The regional government does not act forcefully enough when there are vole outbreaks, as allows itself to be pressured by conservationists	2	− 2	− 2	3	0
11	Any measure other than biological control causes unacceptable harm to the environment	− 3	0	− 1	− 3	0
12	The regional government treats vole outbreaks in a non-transparent manner	1	1	− 1	− 1	2
13	Voles are now a permanent natural hazard for farmers, such as drought or hail	3	0	2	2	− 3
14	Farmers do not implement preventive measures in a global and coordinated manner	− 3	3	3	1	− 1
15	The use of predators to control vole populations is not sufficiently promoted	− 2	2	1	− 2	2
16	Farmers and conservationists don't know how to work together	− 1	1	4	0	3
17	Voles cannot be controlled using mechanical measures (such as motor graders, plows, or burnings)	− 3	0	− 2	− 3	− 3
18	No one considers the interests of others	1	1	3	− 2	0
19	There is a lack of involvement from the society, which does not feel interested in this problem	0	0	1	− 2	0
20	The CAP (Common Agricultural Policy) is incompatible with certain actions against voles	0	2	− 2	− 1	0
21	Measures used against voles are negative for the image of the region, which may have an impact on tourism	− 1	0	− 3	− 4	3
22	There's not enough research to identify possible solutions to problems associated with voles	− 1	3	1	4	− 2
23	Biological control aims to increase kestrel populations rather than to kill the voles	− 2	− 2	− 3	0	− 2
24	The regional government does not have a line of economic aid to palliate the serious damage caused by the vole outbreaks	1	− 1	0	1	− 2
25	There isn't enough intervention from Brussels (European Union) to solve the problem of voles	0	− 1	0	− 1	− 1
26	Conservationists exaggerate the damages caused by rodenticides	0	− 3	2	0	− 3
27	The regional government does not pay sufficient attention to farmers' requests to control of voles	4	− 2	− 1	3	1
28	No matter what the farmers do with the voles, conservationists will protest	3	− 3	4	3	0
29	The conservationists and the regional government released voles to feed the birds of prey	0	− 4	− 4	− 3	1
30	The conservationists have not provided any useful solution to the problem of voles	2	− 3	0	1	2
31	Nothing works to control voles	− 4	− 1	− 4	− 1	− 4
32	Poison is the only solution that works against voles	− 2	− 4	− 3	− 4	− 4

contributed regularly to the emergence of new viewpoints, whereas including new hunters did not. When the emerging viewpoints remained stable, we thought we had encapsulated most of viewpoints' diversity. In fact, the first three factors were already identified with less than half of our total respondents.

Interviews were performed face to face, between November and December 2017. Most interviews ($\sim$ 90%) were conducted by V. Lauret and the rest by M. Delibes-Mateos. All participants freely agreed to get involved in the Q-sorting, and anonymity and confidentiality were assured to them. Each respondent was asked to order the 32 statements into 9 categories ranging from − 4 (most disagree) to + 4 (most agree). The board (see Fig. S2) forced participants to assign two statements each to − 4 and + 4; three statements each to − 3 and + 3; four statements each

to − 1, + 1, − 2, and + 2; and six statements to 0. The range of the categories partly depends on the number of statements, and on the shape of the distribution board. For example, Brown (1993) stipulated that most Q-analysis containing 40–50 statements should employ a relatively flattened distribution with a range of − 5 to + 5. Van Exel and De Graaf (2005) also specified that in case the involvement of the respondents is expected to be low, a steeper distribution would leave more room for ambiguity in the middle of the distribution. Here, we had only 32 statements and we expected respondents to have well-articulated opinions on the topic, so we aimed to have a relatively flat distribution to provide more room for strong (dis)agreement with statements (Van Exel and De Graaf 2005), so we restricted our range to − 4 to + 4. In any case, both the range and the distribution shape of the board are arbitrary and should have no effect on the analysis (Brown 1993).

After sorting the statements, we asked participants to explain in their own words their ordination, with a particular focus on statements placed in the most extreme values (i.e., + 4 and − 4). Finally, during this post-sorting interview, we asked information about the professional activity of the participants and, in the case of farmers, whether they had been personally affected or not by voles.

Statistical analysis

We applied a Principal Components Analysis (PCA) on a matrix including each Q-sort as a column and statements as rows (Brown 1993; Bredin et al. 2018). We used the R package *qmethod* to run the analysis (Zabala 2014), analyzing from three to nine factors and using *varimax* automatic rotations. Based on eigenvalues, variance explained, number of Q-sorts loading in each factor (i.e., how many respondents significantly contribute to that discourse), and our personal judgement, we finally restricted our analyses to 5 factors. Similar factor selection procedure is widely used in Q literature (Sandbrook et al. 2010; Cairns et al. 2014; Gall and Rodwell 2016; Bredin et al. 2018). Once the factors were defined, each statement had a loading score (z-score) representing its relative proximity to each factor (Zabala 2014). From this, we obtained the most representative sorting of each factor (hereafter called "idealized Q-sorts"). We provide the idealized Q-sorts of the five factors (Table 1), and from these, interpretation of each discourse was jointly discussed and agreed by coauthors. During discussion of the results, we used post-sorting interviews of people significantly loading into each discourse to correctly drive our interpretation. Literal transcriptions of some of these participants' comments are used as examples to illustrate our results. Finally, analyses allowed identifying consensus and distinguishing statements (i.e., those for which idealized scores for each factor were closer or more divergent).

RESULTS

The five analyzed factors accounted for 55.7% of the variance between participants and represented views of 43 respondents among 63 interviewed. The 21 remaining participants displayed views that were shared among the five factors but did not significantly load in any of them. We interpret below the five factors (hereafter Discourses 1–5) ranked by amount of variance explained.

First discourse (D1)—"Everyone is to blame, except the farmers"

In this discourse, most blame regarding vole outbreaks and their management is put on government and conservationists. On the one hand, government is accused of not taking care of farmers' demands to control voles, partly because of pressures from conservationists (Statement (S) 27, S10). The public health side of the problem, which is, by nature, responsibility of the government, is also highlighted (S6). On the other hand, conservationists are also seen as being responsible for the problem because having negative attitudes toward farmers (S28), and because they neither allow the use of poison (rodenticide) nor give alternative solutions (S8, S30). The agricultural sector is seen as the victim of recurrent vole outbreaks, suffering crop damage (S1, S13), whereas their contribution to the problem is negated (S14). The ecological impacts of vole management are also minimized (S5 and S11).

Discourse 1 reflects the view of 10 respondents who statistically loaded in this factor. Among them, 4 were office employees for the farming association, and 6 were farmers and members of the farming association (Table 2). As an example of this discourse, people who loaded here mentioned in the post-sorting interviews that "Farmers are the main actors in the countryside and the regional government only cares about cities"; that "Farmers do what they can, which means nothing because the government forbids everything"; "It's always farmers versus conservationists, always. They are incompatible with agriculture"; and "With the current situation, farmers are dying, and agriculture and the rural world are dying with them."

Second discourse (D2)—"An environmental disaster caused by agricultural practices"

This second discourse maintains that the problem arises from the current agricultural system (S4), and therefore

Table 2 Professional categories of all respondents to our survey, and number of respondents that significantly loaded in the associated discourses (D1–D5). The participants that did not load significantly in any discourse had opinions that were shared among the five discourses

Professional category	Number of respondents	D1	D2	D3	D4	D5
Farmers of the farming association	15	7	0	0	4	0
Other farmers	20	1	2	4	2	2
Hunters non-farmers	6	0	1	1	1	2
Conservationists	7	0	5	1	0	0
Technicians of farming cooperative	5	0	0	1	1	0
Employees of governmental agency	6	0	1	4	0	0
Employees of farming association	4	2	0	0	1	0
Total	63	10	9	11	9	4

places responsibility on farmers for not fighting voles through preventive measures (S14). The detrimental consequences of current vole management on the ecosystem are highlighted, as well as the idea that those would be limited if the government acted more responsibly (S9, S5, and S7). The idea that conservationists are part of the problem and the use of poisoning are strongly rejected (S29, S26, S28, S30, S10, and S32, respectively), whereas biological measures are seen as useful to control voles (S15). However, there is a clear recognition of the lack of research to identify efficient solutions (S22). The legal limitations to implement certain measures are also highlighted (S20).

Discourse 2 reflects the view of 9 respondents who loaded significantly in it; 5 of them were from conservation NGOs, 2 were non-syndicated farmers, 1 was a hunter–farmer, and 1 worked in the governmental agency in charge of pest management (Table 2). Comments in the post-sorting interviews included that "Farmers do not recognize their responsibility in this"; "Agricultural practices destroy biodiversity"; "The origin of vole outbreaks lies on the intensive agricultural system"; and "The regional government does not confront farmers' opinions because they are their electoral college."

Third discourse (D3)—"The problem lays on relationships between parties"

This discourse places emphasis on relationships between groups of actors. According to this discourse, confronted parties have difficulties to work together, as each one does not consider the interests of others (S16, S18). It recognizes the economic recurrent problem caused by voles to farmers (S1, S13), and also the public health implications (S6). Concerning management, there is a belief that a solution alternative to poisoning could be found, if barriers among groups are overcome (S31, S32). This discourse incriminates both farmers and conservationists for the current situation: it blames conservationists for their negative attitude toward farmers (S28) and for exaggerating damage caused by vole management (S26), but also farmers for their lack of coordination in applying preventive measures (S14). In contrast, regional government is not blamed.

Discourse 3 reflects the views of 11 respondents who loaded significantly in it, including 4 farmers (non-syndicated), 4 members of the governmental agency in charge of vole management, 1 member of a conservation NGO, 1 hunter–non-farmer, and 1 technician of an agricultural cooperative (Table 2). Some citations from post-Q interview of loading respondents include: "There is a huge lack of communication and with such extreme positions no agreement will be found"; "Empathy is the key, no progress without it"; "Farmers have to admit environmental rights"; and "Conservationists must understand that farmers cannot accept to lose their crops, cannot survive without making profit."

Fourth discourse (D4)—"The government needs to find the balance"

In this discourse, the statements that generate most agreement are government related: the discourse emphasizes the inadequate acting of the regional government, their insufficient response to farmers' demands, and their lack of strength during the decision-making process which is seen as too slow and influenced by conservationists (S9, S10, and S27). While the negative effects of vole control methods on wildlife are recognized (S3), the discourse blames conservationists for abusive protestation and considers that some environmental damage may be acceptable (S11, S28). According to this discourse, environmental damage has to be balanced against the harm to farmers and public health issues, which are also recognized (S1, S6, and S13). There is a belief that voles can be managed without poison (S17, S32), but there is not enough information about the best solution (S22). The social aspect of the conflict is minimized (disagreement with S2, S18, and S19).

Discourse 4 reflects views of 9 respondents: 6 farmers, including 4 syndicated and 1 hunter–farmer; 1 hunter–non-farmer; 1 employee of a farming association; and 1 technician from an agricultural cooperative (Table 2). Citations from post-Q interviews include, "The regional government is the one in charge, it has to act but it does nothing, it just

cares about its reelection"; "Conservationists like to have voles, thanks to them they can have subventions"; and "Pesticides and rodenticides are highly damaging to biodiversity, but if the outbreak is too intense, controlled poisoning could be used, but it is not an easy decision."

Fifth discourse (D5)—"It is a matter of public concern that goes beyond agriculture"

This discourse is characterized by the low emphasis accorded to the agricultural aspects associated with the vole problem. Most agreement is put on wildlife damage caused by vole management (S3, S9, S26), on voles being a public health issue (S6), or on the negative impact of vole outbreaks and their management on the region's image and tourism (S21). In other words, it emphasizes the public concern about the vole problem, and the lack of consensus between farmers and conservationists is recognized (S16). In contrast, there is disagreement with the idea that no solutions exist other than poisoning (S32, S17), or with voles being a natural risk for farmers (S13).

Discourse 5 includes 4 respondents: 2 hunters-not farmers and 2 non-syndicated farmers (Table 2). In their post-sorting interviews, they stated, for example, that "People are concerned about the public health aspect"; or "Diseases from the outbreak spread to running water."

Positions of different stakeholders

There was large overlap in the discourses of different stakeholder groups (Fig. 1). Most divergence was found between discourses of interviewed conservationists and those of members or employees of the farmers' association (Fig. 1), which loaded mostly in D2 and D1, respectively (Table 2). Most employees of the governmental agency loaded in D2. On the other hand, there seemed to be a wide diversity in farmers' and hunters' discourses (Fig. 1), some of them did not significantly load into any specific discourse (Table 2), and hence did not appear to have a common discourse that would drive divergence.

Consensus and distinguishing statements

All discourses agreed about the existence of a public health concern (S6, mean value = + 2.6, Standard Deviation (SD) ± 0.9, Fig. 3) and recognized vole damage to the crops (S1, mean value = + 2.0 ± 1.0, Fig. 3). They also globally disagreed on poisoning being the only effective control method (S32, mean value = − 3.4 ± 0.9, Fig. 3). On the other hand, the impact of vole outbreaks on the region's image (S21) and the fact that the local government considers farmers' demands were the two most distinguishing statements (e.g., S27 was strongly supported by D1 and D4, while the three other discourses disagreed, Figs. 2 and 3). Interestingly, agreement with S29 ("The conservationists and the regional government released voles to feed the birds of prey.") varied strongly among discourses. Indeed, while D2, D3, and D4 rated it as -3.67 (± 0.47), D1 and D5 assigned it a mean value of 0.50 (± 0.5). This statement was one of the most commented ones during the post-sorting interviews, with some people considering it as an absurd myth, but a few others supporting that it may be true.

Besides, during post-sorting interviews, 10 respondents regretted the lack of technical information delivered to farmers, and many mentioned that outreach sessions about the ecological aspects of vole outbreaks would be valuable (e.g., biological cycle of rodents, climatic conditions helping the outbreaks, efficiency of chemical and mechanical treatments). Even if motivations arguing for this measure were different, we considered it as a potential consensus as people requesting it loaded in different discourses (Discourses 1, 2, and 3) or did not load in any, and came from different groups of stakeholders (e.g., farmers, conservationists, employee of cooperative, and governmental agency).

DISCUSSION

Conflicts over the management of small mammals that damage agriculture occur in vast areas worldwide. They threaten people's livelihoods, but many are keystone species and their declines associated with large-scale eradication programs have resulted in serious negative impacts for biodiversity on valuable ecosystems across the world (Delibes-Mateos et al. 2011). In addition, control tools like poisoning or habitat destruction negatively affect other non-target species of conservation concern (Sánchez-Barbudo et al. 2012). Our study helps understanding the poorly described social–psychological drivers, which are essential to build solutions that enjoy community receptivity (Madden and McQuinn 2014).

We showed that there exist shared discourses about vole outbreaks and their management. Although most discourses were held by people from different groups (except D1, which was only held by farmers), we suggested that the viewpoints about voles and their management were not homogeneous among or within groups. Indeed, farmers held a wide variety of viewpoints (Fig. 1) and many of them did not seem to conform to shared discourses (Table 2). However, we observed that certain stakeholders were more likely to hold particular discourses: i.e., syndicated farmers in D1 ("Everyone is to blame, except the farmers"), conservationists in D2 ("An environmental disaster caused by agricultural practices"), governmental

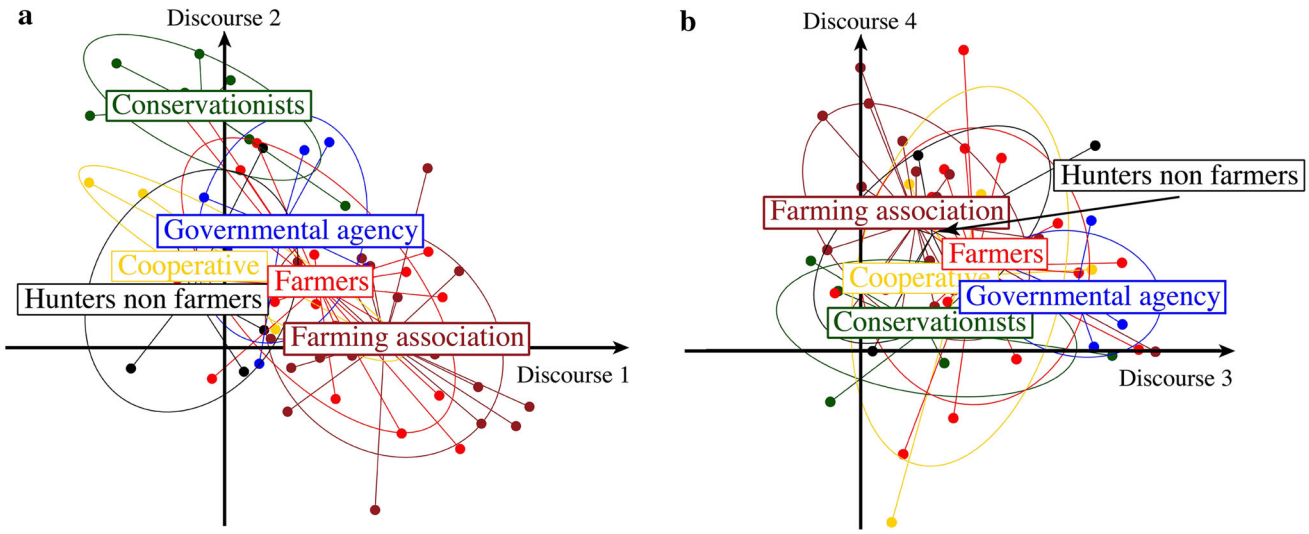

Fig. 1 Scatterplot of the 63 respondents in relation to Discourses 1 versus 2 (**a**) and Discourses 3 versus 4 (**b**). Respondents of different stakeholder groups are depicted using different colors. Here, "Hunter–farmers" are included within farmers as their viewpoints appeared to have greater proximity with those of farmers. Relative contribution of each axis to the coordinates of a dot represents the relative proximity of this respondent to the discourse

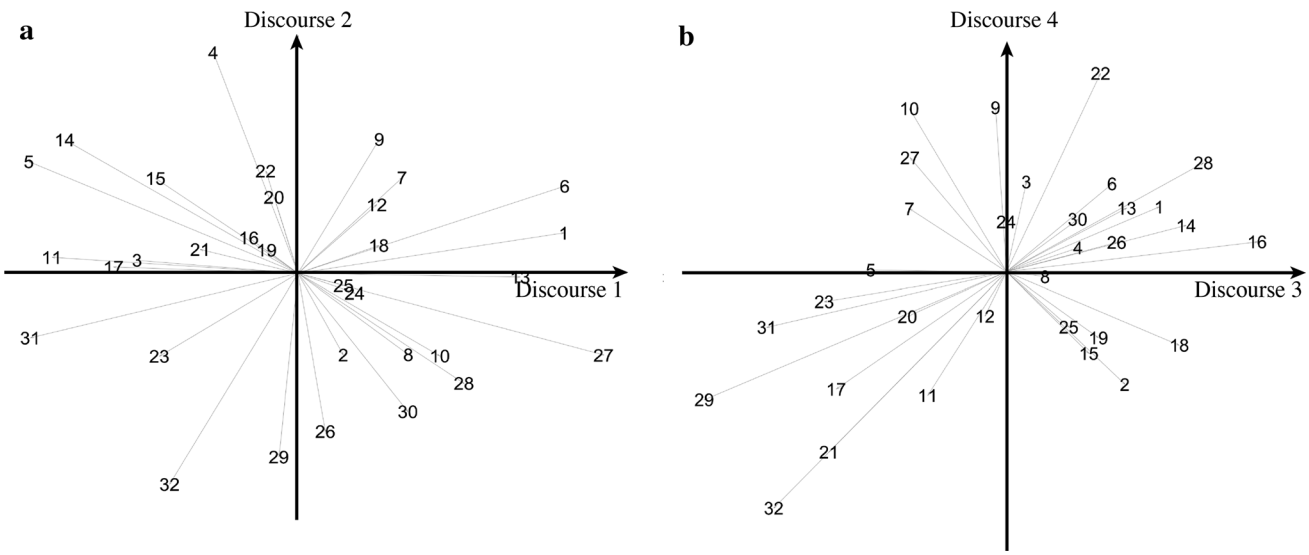

Fig. 2 Scatterplots showing the contribution of the 32 statements to Discourses 1 versus 2 (left) and Discourses 3 versus 4 (right). Relative contribution of each axis to the coordinates of a number represents the relative proximity of this statement to the discourse

agencies in D3 ("The problem lays on relationships between parties"). The small sample size in some of these categories may underestimate a larger diversity of opinions that would have been obtained on a larger sample size in each category. Yet, our sampling design reflected the amount of people from different groups in the area, as well as saturation in responses (see Methods section for more details). In any case, our approach did not specifically look for the whole of each stakeholder group representativeness, and therefore a future quantitative survey could assess this in the future. In the meantime, we noticed that discourses of members of farming associations were more extreme (i.e., including a more negative position toward conservationists and the government) than those of farmers at large (Fig. 1), which is common in other conflicts related to wildlife management (Nilsen et al. 2007). The main driving axis of rodent-related conflicts in farmland areas could occur between conservationists and farming associations, rather than with farmers themselves. This probably reflects the need of leaders in conservation conflicts to strongly

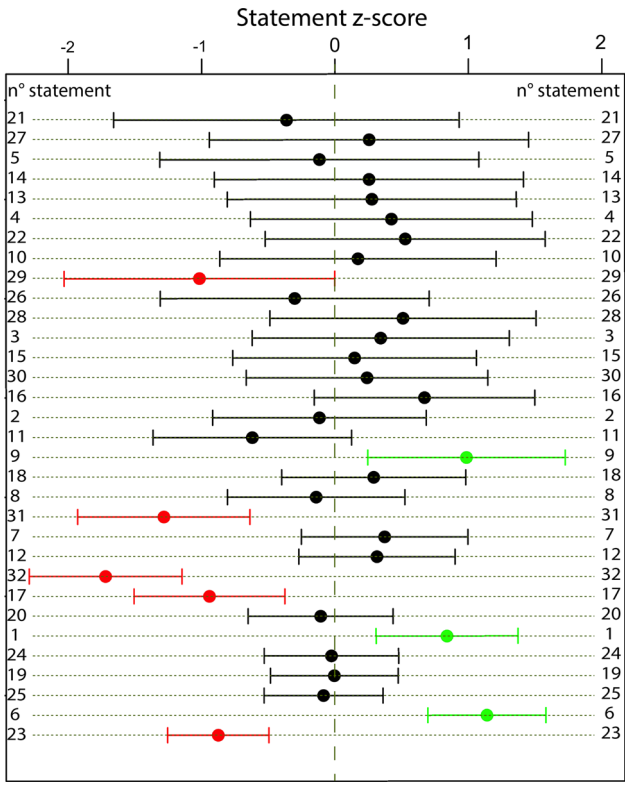

Fig. 3 Average (± SD) idealized score (z-score) of the 32 statements (see Table 1) among the five discourses, ranked from the most distinguishing (those with higher among-discourses variability) to the most consensual (with lower among-discourses variability). Statements in gray have standard variation that do not overlap 0

defend the beliefs and values of the group in order to protect its identity and cohesiveness (Haslam et al. 2010).

Conflicting discourses usually do not only differ in the representation of other actors, but also in the portrayal of some central issues (Hodgson et al. 2018). In our study, there was little consensus about impact of rodenticides on non-target wildlife species. Some discourses maintained that conservationists exaggerate such negative impacts. Disagreements about the effects of poisoning on the ecosystem are worrying as anticoagulant rodenticides have devastating consequences for wildlife and biodiversity at large in many regions worldwide (Sánchez-Barbudo et al. 2012; Coeurdassier et al. 2014; Fernandez-de-Simon et al. 2018). Another distinguishing point was related to the popular belief that voles were released by conservationists to feed birds of prey, which was not rejected by people holding the "blame everyone but farmers" or "it is a matter beyond agriculture" discourses. Wildlife-release rumors are often used in conservation conflicts to communicate people's frustration because their livelihood is threatened by wildlife (Skogen et al. 2008; Delibes-Mateos 2017). In our case-study, scientific evidence indicates that vole colonization was driven by an increase in irrigated crops (Jareño et al. 2015; Rodríguez-Pastor et al. 2016; Luque-Larena et al. 2018). Since the farming system is unlikely to change in the short term, this means that voles are currently an inherent part of the ecosystem, and that recurrent outbreaks will continue to occur. Nevertheless, people globally agreed that finding shared solutions that are more compatible with biodiversity conservation is possible. Some respondents emphasized in post-sorting interviews the lack of technical information delivered to farmers to help them understand outbreak dynamics. This suggests that efforts to transfer scientific and technical information on vole outbreaks to affected stakeholders may be helpful. However, considering the fundamental opposition between certain discourses about stakeholders' roles, conflicts could remain even when technical solutions to reduce damage are developed and transferred, until underlying conflicts between actors are managed as well (Dickman 2010).

For decision-making in conservation context, top-down approaches would likely lead to worse social outcomes than approaches that involve mediation or dialogue (Redpath et al. 2017). In our study, employees of governmental agencies put most emphasis on the relationships between stakeholders being at the root of the vole problem rather than the lack of technical solution. Being in charge of pest management, one would suggest that the governmental agency might play a key mediating role in the conflict. However, our results also show that governmental decision-makers are far from holding a neutral position in the view of the other parties involved. On one hand, the government is accused in some discourses of promoting farmers' interests at the expense of ecological considerations, justified by the fact that farmers represent the main electoral college in the area. In contrast, other discourses see the government as forgetting farmers' considerations, focusing on urban rather than rural areas (Skogen et al. 2008; Dickman 2010) or giving way to ecologists' pressures to make decisions. Therefore, it is unlikely that a mediation by governmental agencies would be efficient. Additionally, they may lack the skills or capacity to design and lead effective processes of conservation conflict mitigation. Training professional, neutral mediators should be a priority for the resolution process of many conservation conflicts, including this one.

Madden and McQuinn (2014) showed that conservation conflicts usually include three levels of conflict: (1) the dispute, which is the tangible manifestation of a conflict; (2) underlying conflict, which is a history of unresolved disputes, and results from past interactions between or decisions made by the parties; and (3) identity-based conflict, which involves values, beliefs or sociopsychological needs that are central to the identities of at least one of the collectives involved. Our study reveals that disputes about vole outbreaks and their management may be fueled by

underlying and identity issues. How past decisions were made and implemented seems to have shaped some people's attitudes. Some farmers, in particular those within farming associations, perceived decisions by policy-makers and pressures of conservationists as threatening farmers' livelihoods and ultimately their identity. Similar conservation conflicts in farmland areas occur worldwide and underlying conflicts suffer from lack of consideration. Stakeholders may focus their reactions on the new dispute (e.g., the new vole outbreak), while underlying and identity-based conflicts are often ignored. Addressing such conflicts is essential to build trust between stakeholders and to create a neutral setting that help to work jointly in a constructive manner (Madden and McQuinn 2014). Further developments in this direction would hopefully lead to conflict mitigation and stakeholders' reconciliation, which would argue for ecologically sustainable and socially accepted management.

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