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Original Research Article

# An adapted concept mapping technique to help conservation implementation – Exemplified for wolves returning to Lower Saxony in Germany

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ABSTRACT

While higher-order predators like wolves (*canis lupus*) serve important ecological roles within social-ecological systems, prior studies indicated differences in the acknowledgement of these roles by specific stakeholder groups. As diverging underlying mental models may cause these differences in the societal valuation of the species, there is a need for the development of innovative methods to systematically uncover stakeholders' interests and their conceptions about relevant conservation issues. This paper proposes a concept mapping technique as a suitable way to investigate stakeholders' mental models based on their understanding of underlying reasons, consequences and solutions for a selected conservation issue. To illustrate the utilization of the methodology, we present a case study about the conservation of returning wolves in Lower Saxony, a region within North-West Germany. In the case study, we used a concept mapping task within face-to-face interviews to investigate the mental models of nine stakeholders from the three most important interest groups of hunters, shepherds, and conservationists. After the inductive categorization of the resulting qualitative data, we ordered the resulting categories into matrices with a rank order cluster (ROC) algorithm and found different underlying reasons and consequences for the conservation conflict. Thereby, we were able to identify 19 individual solutions, which however differed concerning their consensus between stakeholder groups. Only the consequence-oriented solution of supporting livestock owners was mentioned by all stakeholder groups. Overall, we were able to subsume stakeholders' solutions into three implementation spaces (human-human focused, population-management related and consequence-oriented solutions). While the solutions indicated possible case-specific interventions, the implementation spaces may be interesting for a further investigation within other conservation cases, and may illustrate how underlying mental models may be used to determine successful strategies for conservation management.



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## 1. Introduction

Although several global initiatives like the sustainable development goals (SDGs) aim for the protection of biodiversity (Griggs et al., 2013), every effort of preserving biodiversity depends on the local implementation of concrete policies and actions (Peuhkuri and Jokinen, 1999). However, common conservation practice showed that conservation biology research only rarely gets implemented (Knight et al., 2008). While studies illustrated different reasons for this missing implementation of scientific results into conservation practice, problems with the generation of relevant knowledge and the inclusion of specific stakeholder groups represented two of the most urgent obstacles for implementation (Bertuol-Garcia et al., 2018; Gossa et al., 2015). Problems of implementation may result in a lack of practical adaptation of policies and actions for biodiversity conservation. Hence, there is a need for innovation in the field of conservation biology to overcome these challenges (Cadotte et al., 2017).

As indicated by the mentioned causes for implementation problems, social dimensions of ecological conflicts were found to be of major importance for the success of environmental management policies (Goggin et al., 2019). Therefore, a better understanding of the human dimensions of biological conservation issues like returning predators into ecosystems is needed. Ecological and social sciences can play a major role in further developing implementation practice, for example by providing methods for identifying and balancing conflicting interests in conservation issues (Bennett et al., 2017; Redpath et al., 2013). For these processes, it may be helpful to make underlying mental models of specific individuals from concerned stakeholder groups more explicit, as this may illustrate possibilities for better addressing conservation management (Goggin et al., 2019).

*Mental models* describe naturally evolving and functionally oriented internal models of external systems, which are emerging through interactions with these systems (Norman, 2014). Due to the correspondence of these internal models with the external environments, mental models may be useful for finding possibilities to further implementation practices or stakeholder integration (Inam et al., 2015). In prior studies, mental models were already found as contributors for successful stakeholder collaboration (B. Gray, 2004). But there is only a scarce methodological repertoire which may be useful for uncovering mental models. In this paper we address this challenge and specifically focus on identifying possible implementation spaces (Toomey et al., 2017). These spaces may be indicated when several stakeholders denominate similar solutions or when solutions are extracted based on the drivers and consequences mentioned by the stakeholders.

In the paper we focus on a recent case study of wolves returning to Germany. While the return of wolves is driven by the natural spread of the species into western territories, the conservation of wolves in densely populated regions is challenging and highly depends on the solution of conflicts surrounding the return of the species (Chapron et al., 2014; Randi, 2011). We adapt a methodological approach from environmental system sciences to investigate possible implementation spaces by utilizing concept maps, clustering algorithms and Venn diagrams. Interviews with stakeholder groups were conducted, in which the stakeholders drew concept maps that represent their perspective on causes, consequences and possible solutions for the biological conservation issue at hand. The qualitative data was coded and subsequently analyzed with the rank order cluster (ROC) algorithm (King, 1980). Finally, we illustrated the consensus between the stakeholders for these spaces with Venn diagrams to inspect possible implementation spaces (Scholz et al., 2015). Fig. 1 gives an overview of our approach and illustrates the needed steps for its adaptation to other contexts, which are presented in more detail below. In the following, the theoretical and methodological background is provided (Sections 2 and 3) before we present the results and discussion of our case study analysis (Sections 4 and 5).

## 2. Theoretical background

### 2.1. Implementation spaces within social-ecological systems

Conservation issues are always embedded in a bigger system of ecological and social processes, which have to be monitored and managed (Redpath et al., 2013). Generally, these processes form systems, which may be described as *social-ecological systems*. Such systems can be defined by “coherent biophysical and social factors, (…) at several spatial, temporal and organizational scales (…)” (Redman et al., 2004, p. 163). Furthermore, they involve “a set of critical resources (natural, socioeconomic, and cultural) whose flow is regulated by a combination of ecological and social systems; and a perceptually dynamic complex system with continuous adaptation” (Redman et al., 2004, p. 163). As this definition already implies, social dimensions are relevant for the existence of ecological systems, and are inevitably bound to their functioning (Waters et al., 2016).

Within the traditional view, researchers and science in general serve the purpose to assist the functioning of these social-ecological systems through their research (Toomey et al., 2017), with the application of their theories and studies as the final aim (“theory-to-application-pipeline”; Cadotte et al., 2017). However, for practice relevant conservation science, the application only starts after the completion of the scientific publication (Arlettaz et al., 2010). As only a small share of projects includes this step of conservation scientists’ work, several researchers described a research-implementation gap (Bertuol-Garcia et al., 2018; Knight et al., 2008). Toomey et al. (2017) suggested the concept of “space” as more appropriate than the word “gap”, to increase the implementation of research into practice. Utilizing this perspective, spaces would rather describe open possibilities, as gaps indicate a more deficit-based view on the challenge of implementation (Toomey, 2016; Toomey et al., 2017).

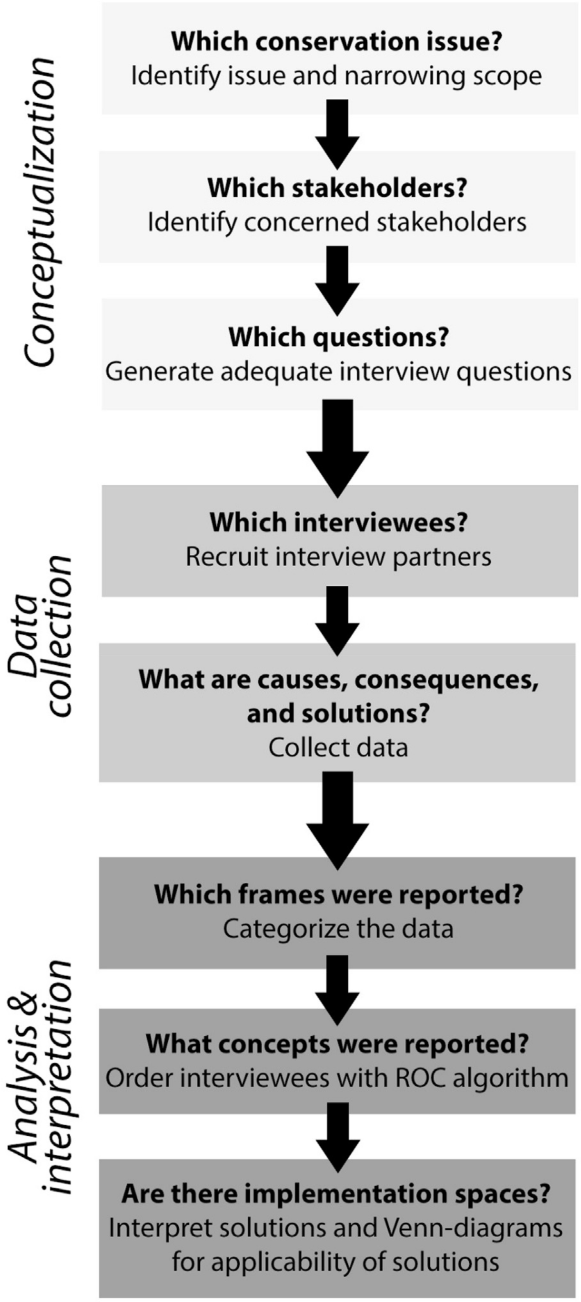


**Fig. 1.** Flowchart illustrating the key questions and tasks for utilizing interviews and concept mapping for identifying implementation spaces for a given issue based on three main steps of conceptualization, data collection, as well as analysis and interpretation.

While the consequences of such an intentional reframing have to be reflected from a socio-linguistic perspective, the concept of space allows to describe open spaces which could be filled with specific actions, rather than a hole in the bottom, which might be a pitfall (Toomey et al., 2017). Within this view, we conceptualize *implementation spaces* as a coherent collection of specific activities, aiming for the improvement of implementation into practice, involving more than one concerned actor.

### *2.2. Stakeholders' views and conservation conflicts*

Knowledge about open spaces for innovation within environmental management is crucial, as social-ecological systems often involve conflicts, which may threaten the functioning as well as the well-being of involved human and non-human entities (Redpath et al., 2013). These conflicts are difficult to handle, as they show no clear-cut solution due to the complexity and adaptability of the underlying system. For this reason, they were also described as “wicked problems” (DeFries and Nagendra, 2017).

While the outcomes of wicked environmental problems can hardly be evaluated objectively, these systems are driven by underlying, sometimes ideological beliefs (DeFries and Nagendra, 2017). Such ideological beliefs may fuel *conservation conflicts*, which are described as “situations that occur when two or more parties with strongly held opinions clash over conservation objectives and when one party is perceived to assert its interests at the expense of another” (Redpath et al., 2013, p. 100). The importance of understanding personal preconditions within the implementation of environmental management is also underlined by prior studies, which showed how more knowledge of an issue can even lead to an increased polarization of beliefs within controversial topics (Drummond and Fischhoff, 2017).

Within this post-normal world of conservation science, the co-construction and further integration of diverse knowledge sources has been found to assist conservation practice, as it may be useful for the identification of problems with further implementation at early stages (Colloff et al., 2017). Furthermore, successful implementation always should integrate different forms of knowledge, including scientific as well as local sources (Raymond et al., 2010). Stakeholders represent the most important group holding relevant local knowledge. Hence, stakeholders play a prominent role for successful implementation (Braunisch et al., 2012).

But as conceptions and beliefs often remain implicit structures of human thinking (Gallese and Lakoff, 2005), there is a need for developing methodologies to make these stakeholder conceptions more explicit. For this, we propose an adapted concept mapping technique, which showed to be a viable way to uncover peoples’ conceptions about environmental processes in prior studies (e.g. Halbe et al., 2018 and Scholz et al., 2015).

## 3. Methods

### 3.1. Systematic concept mapping as a way to uncover stakeholder mental models

Mapping techniques have diverse possible applications in conservation science. While participatory modelling has shown to be viable for fostering learning and cooperation within specific conservation issues (S. Gray et al., 2017; Ingram et al., 2018), concept mapping techniques may also be used to portray stakeholders’ perspectives on an issue at stake (Halbe et al., 2018). A *concept map* generally represents a “node-link diagram in which each node represents a concept and each link identifies the relationship between the two concepts it connects“ (Schroeder et al., 2018). Besides providing an overview of such connections between concepts, mapping techniques can also reveal more implicit ways of knowing (Hulme, 2014).

Within the scientific literature, different types of concept mapping techniques have been developed, each with different strengths and weaknesses. Generally, systematic mapping techniques aim for a more holistic view on the processes within social-ecological systems, and allow for an insight into participants’ mental models. Within such mental models, several different concepts may be linked to each other. Techniques of uncovering mental models have been applied in various application contexts, such as operational research (Vennix, 1996), environmental management (Halbe et al., 2018), or conservation practice (Moon et al., 2019).

Our approach of concept mapping was influenced by causal loop diagrams, a systems thinking approach with a long history and various application contexts (e.g., Richardson, 1986, Senge, 1990; Vennix, 1996). While a detailed description of the highly structured method can be accessed elsewhere (e.g. Inam et al., 2015; Halbe et al., 2018), we adapted the initial approach to the context of conservation issues by concentrating on reasons, consequences, and solutions with respect to a given conservation issue (Fig. 2). The concept mapping task starts by defining the objective under investigation, which is written on a sticky note in the middle of a canvas (Fig. 2, “1) Issue at stake”). In the second step, the influencing factors or reasons are added to the model. These reasons can be directly or indirectly connected to the issue at stake, which is expressed in the model with the help of causal links that are drawn with a pencil (Fig. 2, “2) Reasons”). Third, the consequences of the topic are added and linked to the issue, which again may be of direct or indirect nature (Fig. 2, “3) Consequences”). Based on these reasons and consequences of the issue, participants are asked to suggest solutions and link it to the model strukture (Fig. 2, "4) Solutions"). Participants are also animated to reflect about connections between consequences and reasons (“Feedback loops”), which facilitates a holistic discussion of possible solution strategies and their effects on the issue in the final part of the concept mapping task. Due to this stepwise process that also includes the identification of feedback loops as well as indirect causes and consequences, stakeholders are animated to tap into their implicit knowledge. In line with similar studies (e.g. Inam et al., 2015; Halbe et al., 2018), we embedded the mapping task in a interview situation, allowing for the integration of further background information. Thus, the concept maps were used as facilitation tools to support the interview process (see Halbe et al., 2015b on facilitating stakeholder processes as a distinct model use).

### 3.2. Analysis of resulting concept maps and qualitative data

As a first step of the analysis, all generated qualitative data from the concept maps and interviews had to be coded. After this, the results are analyzed using adequate visualization tools. Generally, we followed analysis steps which were initially developed by Massey et al. (1997) and further adapted by Scholz et al. (2015).

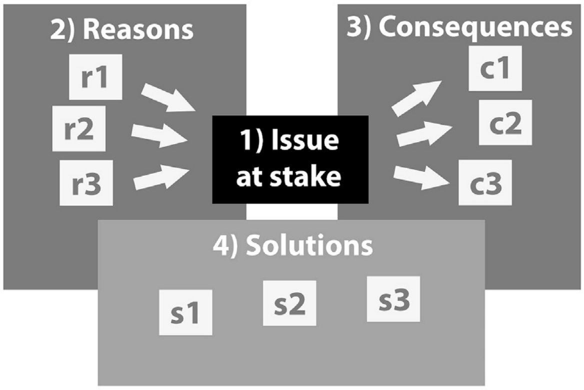


**Fig. 2.** Example structure underlying the adapted concept mapping method following Vennix (1996). After specifying the issue at stake (1), interviewees are asked for their views on reasons for the issue (2) as well as consequences (3). Finally, possible solutions for the issue are generated based on reasons and consequences (4). To differentiate between the categories we recommend "r" for reasons, "c" for consequences, and "s" for solutions.

Within this approach, an individual's qualitative interview with the underlying concept maps is first (1) inductively categorized, based on the occurrence of specific concepts within the interviews. Categorization represents one form of an inductive qualitative content analysis, and as such is a flexible and delicate method (Elo and Kyngäs, 2008). While the categories may be generated based upon the interviews, background knowledge on the conservation topic is needed to come up with sensible categories (Scholz et al., 2015).

Following this initial categorization, the occurrence of specific categories within participants is (2) placed in a binary matrix, showing the occurrence of categories for specific participants. In the matrix, rows represent an individual concept map and interview, and the columns present a category each (this can also be transposed if better for interpretation). Based on our interest in reasons, consequences and solutions, we used rX, cX and sX as names for the respective columns and inserted a "1" or "0" for a specific category mentioned or not mentioned in an individual interview.

Next, the matrix is (3) sorted using the ROC algorithm originally developed by King (1980). To this end, rows and columns are treated as binary numbers, where the first entry (a 1 or 0) is multiplied with 2 to the power of the number of columns minus one. If the matrix has n columns, the entry of the first column (1 or 0) is multiplied with $2^{n-1}$, the entry of the second column with $2^{n-2}$, and so on, until the entry of the last column is multiplied with $2^0$. Next, the columns are sorted in a descending manner. The same procedure is now applied to the rows. Afterwards, the algorithm starts over until no more changes are observed. In this way, a matrix with a block diagonal appearance can be achieved within a finite number of steps (King, 1980). A matrix with such a layout allows to observe clusters of categories within individual concept maps and interviews, and thus overlaps or differences between individuals' mental models. While the ROC algorithm may seem complicated at first glance, it can be easily applied using standard software displaying tables (for example Microsoft Excel).

Based on the resulting matrix, possible overlaps between concepts can be (4) visualized with Venn-diagrams to illustrate similarities between participants' mental models. Venn diagrams have originally been introduced by Venn (1880) and display all logical relations between a finite number of sets. To this end, closed curves contain all elements of a set, while elements belonging to two sets are placed within the intersection of the two curves. For example, a Venn diagram for three different sets is made up of three circles containing the elements of each set. The circles are arranged in a way that shared elements are placed within an intersection of the circles. In this way, overlaps of elements (categories) can be easily displayed (Massey et al., 1997; Scholz et al., 2015). For the application in the conservation cases, a circle represents the categories, which were mentioned by any group members of a specific stakeholder group. Therefore, these diagrams display in how far similar concepts are reported between the stakeholder groups. In this way, one can detect solutions that have acceptance throughout all stakeholder groups and solutions only mentioned by one (or more) stakeholder groups.

In the following, we will present an example case study for the application of our adapted concept mapping and analysis approach, which was used to uncover implementation spaces for the issue of returning wolves to North-West Germany.

## 4. Application case: returning wolves to Germany

### 4.1. Context description

Many densely populated countries in central Europe are faced with the return of large predators like wolves into ecosystems, from which they have been eradicated several centuries ago (Chapron et al., 2014). While conservationists describe the return as a success for species conservation, especially concerned stakeholder groups who are facing negative consequences strongly oppose the return of wild predators (Enserink and Vogel, 2006). One example for a negatively concerned stakeholder-group are shepherds, who are faced with negative consequences due to livestock killings (Kaczensky, 1999). In central Europe and other similarly populated regions the sustainable existence of a genetically healthy population of wolves depends on the solution of these human conflicts surrounding the return of the species (Randi, 2011). As genetic analyses showed, the existing population in Germany belongs to the central European lowland population, which shows only a weak connectivity to its neighboring populations (Hindrikson et al., 2017). As the ecological capacity has not been reached yet and wild wolves are threatened by anthropogenic factors like road-density and illegal killing, wolves are strictly protected by European legislation (Fechter and Storch, 2014; Hindrikson et al., 2017; Trouwborst, 2010).

But although wolves naturally returned to Germany following the fall of the iron curtain and the more protective regulations following the European laws, there is nevertheless a heated debate over the proper management of wolves (Gross, 2008). The situation is threatened to get complicated, especially since the expenses for the compensation of damaged animal owners and management of the species have increased exponentially (DBBW - Dokumentations-und Beratungsstelle des Bundes zum Thema Wolf, 2019). Most recently, several political parties therefore aspired for a more rigorous regulation of the species. The fundamental problem is grounded in the close spatial relation between wolves to human society within countries like Germany, as wolves have to live in co-existence with humans (Mech, 2017). This co-existence leads to social problems based on economic damages for specific stakeholder groups like shepderds (Enserink and Vogel, 2006). This also entails negative emotional reactions like anger and fear concerning the wild animal (Jürgens and Hackett, 2017).

The context is suitable as an application case, as the people have a strong uncertainty with the species in the social-ecological systems. This also leads to implementation problems. For example, the strong conservation legislation is disregarded and some wolves were illegally killed, based on the missing acceptance by some stakeholders (Hindrikson et al., 2017). As policy makers need to adapt to the situation (Ronnenberg et al., 2017), we investigated stakeholder conceptions and analyzed them for possible implementation spaces. Within the greater context of returning wolves to Germany, we selected the federal state of Lower-Saxony as sample region for our investigation. This region holds the highest density of livestock units in the country (Statistische Ämter des Bundes und der Länder, 2018). Based on livestock killings as the major driver for opposing returning wolves (Vittersø et al., 1998), a solution to the conflicts between the stakeholder groups is of severe importance in this region.

### *4.2. Research design, sample and methods*

The selection of stakeholders for the interviews was drawn based on purposeful sampling. The participants were recruited based on their affiliation to one of the stakeholder groups of hunters, shepherds or conservationists (Bryman, 2008). From these groups we recruited three persons for each stakeholder group ($n_{total} = 9$) and strived for stratifying the sample for the characteristics of age, gender and professional experience. While the main aim of qualitative research is to better understand underlying problems and not to make generalizable results for whole populations (Bryman, 2008), the sample size is adequate for our research aim of uncovering possible implementation spaces, but we suggest that future studies aiming at more general results should use larger samples.

All participants were initially contacted via personal contact, and confirmed to participate in the study. The interviews were performed at a location of choice, to allow for convenience of the interviewees. Moreover, all interviews were performed by the same interviewer, to ensure comparability between the interviews. The interviews were performed in concordance with all relevant national and ethical research guidelines, as we obtained informed consent from all participants, which were also not exposed to severe threats due to our interviews. We utilized qualitative interviews including a concept mapping drawing task (as described in Fig. 2), and later analyzed the resulting qualitative data using the ROC algorithm and Venn diagrams (see also Fig. 1).

Within the interviews, the interviewer followed a structured interview guide, which is available upon request, and recorded the whole interview with an audio recorder (Olympus − LS-P1). After a short introductory phase, which included starting questions like the demographic and professional background of the interviewee, the interviewer started with the concept mapping task. For this, the interviewer placed a sticky note in the middle of a flipchart sheet, on which “the return of the wolves” was written. Interviewees now were asked about the reasons, consequences and possible solutions for the conflict, as indicated by the exemplary structure in Fig. 1. After the concept mapping phase, interviewees were asked further questions about the return of wolves, which are not analyzed in this paper. Overall, the interviews lasted 24−80 min ($M = 43$ min; $SD = 16.3$ min).

As a first step of the analysis, the audio recordings of the interviews were transcribed (see also Section 3.2). These transcripts were then categorized, using qualitative content analysis (Bryman, 2008). In this step we combined the data from the transcripts and concept maps, as we were interested in participants' mental models, which are revealed in both data sets. The existence of a specific category was coded based on an inductive category system, which was built on the first interview and extended if new categories were found (Elo and Kyngäs, 2008). All categories were systemized by reasons, consequences, and solutions, indicated by the letters “r” (reasons), “c” (consequences), or “s” (solutions). To assist the analysis we used the Software MAXQDA 2018.

Based on the categories resulting from the qualitative content analysis, we constructed an re-ordered category matrix using the ROC algorithm (see Section 3.2 and Scholz et al., 2015). This matrix displays all categories that were reported in the interviews and concept maps, representing their occurrence per participant, which simplifies the analysis based on the possibility of sorting stakeholders with similar categories together. To be able to name each category and thus, display more information, Table 1 displays the transposed ROC-sorted table. Based on this matrix we then constructed Venn-diagrams, by looking if a category was mentioned by a member of the corresponding stakeholder group.

## 4.3. Results

### 4.3.1. ROC sorted matrix of categories

Table 1 shows the results for the categorization of the interviews ordered for participants. Based on the data, we found 40 different categories. Of the 40 categories mentioned during the interviews, there were 12 reasons (r1-12), 9 consequences (c1-9), as well as 19 solutions (s1-19) for the conflict of returning wolves to Lower Saxony. The most often (at least four times) mentioned reasons for the return of wolves were the protection status of wolves (r10; n = 8), enough food for wolves (r6; n = 5), and the fall of the Berlin wall (r7; n = 4). As consequences, the stakeholders most often mentioned effects on livestock (c9; n = 8), effects on the human population (c6; n = 5), and effects on hunting (c8; n = 5). Concerning the solutions, only the support for livestock owners (s19; n = 4) was mentioned at least four times. This indicates stronger differences in the perception of solutions than for reasons and consequences. The overall higher number of solutions underlines this finding of a great variety of named solutions.

**Table 1**
Matrix ordered with the ROC algorithm illustrating categories for reasons (r), consequences (c; bright gray) and solutions (s; dark gray) within the interviews in rows, mentioned by the interviewees from the stakeholder groups of hunters (H), shepherds (S) and conservationists (C) in columns.

| | Participants | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C02 | C01 | C03 | S03 | H01 | S01 | H02 | S02 | H03 | |
| Age | 53 | 54 | 59 | 48 | 67 | 45 | 47 | 60 | 32 | |
| Gender (F = female; M = male) | M | M | F | F | M | M | M | M | M | |
| Experience (years) | 23 | 12 | 3 | 10 | 18 | 25 | 30 | 21 | 2 | |
| Category (code) | | | | | | | | | | ∑ |
| 1. Affecting livestock (c9) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 8 |
| 2. Protection status (r10) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 8 |
| 3. Enough food (r6) | 1 | 1 | 1 | 1 | | | | | 1 | 5 |
| 4. Affecting human population (c6) | 1 | 1 | 1 | | 1 | | | | 1 | 5 |
| 5. Unemotional communication (s2) | 1 | 1 | | | 1 | | | | | 3 |
| 6. Advocacy by conservationists (c1) | 1 | | | 1 | | | | | | 2 |
| 7. Negatively affecting wildlife (c7) | 1 | | | | 1 | | | | 1 | 3 |
| 8. Positively affecting wildlife (c4) | 1 | | | | | 1 | | | 1 | 3 |
| 9. Killing of problematic wolves (s13) | 1 | | | | | 1 | | | | 2 |
| 10. Autonomous return (r5) | 1 | | | | | | 1 | | | 2 |
| 11. Synanthropic species (r1) | 1 | | | | | | | | | 1 |
| 12. Cultivation of stakeholder contact (s4) | 1 | | | | | | | | | 1 |
| 13. Transparency (s5) | 1 | | | | | | | | | 1 |
| 14. Affecting hunting (c8) | | 1 | 1 | | 1 | 1 | | | 1 | 5 |
| 15. Fall of Berlin wall (r7) | | 1 | 1 | | | | 1 | 1 | | 4 |
| 16. Willingness to compromise (s1) | | 1 | | | | | | | 1 | 2 |
| 17. Support for livestock owners (s18) | | | 1 | 1 | | 1 | 1 | | | 4 |
| 18. Livestock compensation (s17) | | | 1 | 1 | | | | | | 2 |
| 19. Public information (s6) | | | 1 | | | | | | | 1 |
| 20. Research (s16) | | | 1 | | | | | | | 1 |
| 21. Delayed management (c3) | | | | 1 | | | 1 | | | 2 |
| 22. Interdisciplinary collaboration (s8) | | | | | 1 | | 1 | | | 2 |
| 23. No natural enemies (r9) | | | | | 1 | | | 1 | | 2 |
| 24. Part of creation (r8) | | | | | 1 | | | | | 1 |
| 25. Composition of biodiversity (r11) | | | | | 1 | | | | | 1 |
| 26. Hunting law (r12) | | | | | 1 | | | | | 1 |
| 27. Losing fear of people (c5) | | | | | 1 | | | | | 1 |
| 28. Continued education (s7) | | | | | 1 | | | | | 1 |
| 29. Multidimensional problem-solving (s19) | | | | | 1 | | | | | 1 |
| 30. Zones without wolves (s11) | | | | | | 1 | | 1 | | 2 |
| 31. Closing of ecological niches (c2) | | | | | | | 1 | | | 1 |
| 32. Attribution to hunting law (s9) | | | | | | | 1 | | | 1 |
| 33. Insurances (s14) | | | | | | | 1 | | | 1 |
| 34. Neighboring countries as model (s15) | | | | | | | 1 | | | 1 |
| 35. Population development (r2) | | | | | | | | 1 | | 1 |
| 36. Faster management (s10) | | | | | | | | 1 | | 1 |
| 37. Reproduction of wolves (r3) | | | | | | | | | 1 | 1 |
| 38. Human displacement (r4) | | | | | | | | | 1 | 1 |
| 39. Tolerance (s3) | | | | | | | | | 1 | 1 |
| 40. Controlled population (s12) | | | | | | | | | 1 | 1 |
| ∑ | 13 | 8 | 10 | 7 | 14 | 7 | 11 | 6 | 11 | |

In addition to an insight into possible reasons, consequences and solutions, Table 1 allows for a investigating clusters of specific groups within the acquired sample. Like the ordering of the ROC algorithm illustrates, the conservationists (C01-03) are clustered on the left side of the table, while the hunters (H01-03) and shepherds (S01-03) are rather mixed between each other on the right. This indicates that the conservationists hold similar conceptions about the return of wolves with each other, while hunters' and shepherds' mental models seem to differ to these conceptions, and are mixed with each other.

#### 4.3.2. Venn diagrams

As described in Fig. 3A, we found severe consent between the stakeholders about reasons and consequences of returning wolves. Speaking of this consent, especially the high food supply for wolves (r6), the fall of the Berlin Wall (r7), as well as the protection status of the species (r10) were mentioned by participants from all stakeholder groups as reasons for returning wolves. Similar to this, there was also consent about effects on wildlife (c4) and livestock (c9) as main consequences of returning wolves. While the consent for the other reasons and consequences varied, it was very interesting that especially the hunters mentioned a high number of reasons and consequences (18), while the conservationists mentioned few (11), and shepherds the fewest (9).

A similar pattern emerged for the solutions. While the hunters generated 12 different solutions, conservationists came up with nine, and shepherds with five solutions. Besides the general frequency of solutions, the overall pattern between the stakeholders also differed. As shown in Fig. 3B, hunters reported a balanced mixture of human-human, population management as well as consequence oriented solutions, but conservationists and shepherds were biased for specific approaches. While conservationists rarely considered population management related solutions, none of the shepherds mentioned a human-human solution in their interviews.

#### 4.3.3. Solutions and possible implementation spaces

The 19 reported solutions also varied with respect to their objectives. Table 2 further illustrates these objectives and their possible impact on conservation implementation. A first group of solutions targets at the human dimension of conservation problems. Examples include the willingness to compromise (s1), communication between stakeholders (s2), establishment of exchange between the stakeholders (s3) or better information of the public (s6). While some solutions directly concern the stakeholders (e.g. s1 and s2), some point to the superior authorities like the responsible policy makers. This group is also directly addressed by other solutions, such as the attribution of wolves to hunting law (s9), zoning of wolves (s11), or the killing of problem wolves (s13), which directly address challenges of population management. A final group of solutions is related to the consequences of returning wolves. Within these solutions, the stakeholders mentioned insurances (s14), animal compensation (s17), or general support for livestock owners (s18).

Based on the different objectives of the solutions mentioned above, we were able to identify three central implementation spaces within our case study, which were constructed based on inductive categorization. As the solutions s1-8 point to human

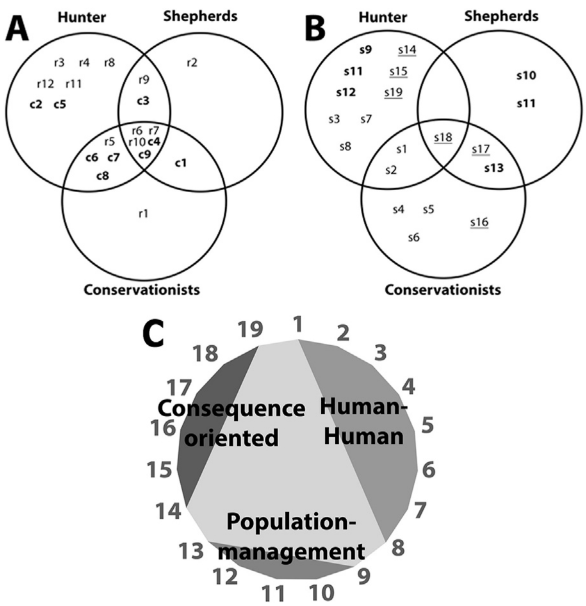


**Fig. 3.** (A) Illustration of reported categories from different stakeholder groups with reasons in regular and consequences in bold characters. (B) Illustration of reported categories for the solutions, based on referring to human-human solutions (regular characters), population management (bold characters), as well as consequence-oriented solutions (underlined characters). (C) Overview of implementation spaces as combination of several solutions aiming for the similar objectives within a given issue (numbers correspond to solutions displayed in other Figures and Tables).

interactions, they may indicate various possibilities of resolving underlying human-human conflict. Similarly, the solutions s9-13 all aim directly at population management, targeting mainly at a stricter management of existing populations. Finally, the solutions s14-19 address the direct consequences of returning wolves, which is why they may be seen as consequence oriented solutions. Based on our definition of implementation spaces as coherent accumulations of different solutions for conflicts involving diverse actors within a specific conflict, these three categories indicate the identified implementation spaces within our case study (Fig. 3C).

### 4.4. Case study discussion

As described in the results of the case study, our data allowed for an insight into stakeholders' mental models about reasons, consequences and solutions for the issue of returning wolves. While the conservationists showed relatively homogenous concepts and thus, aligned mental models between each other, shepherds and hunters showed mixed conceptions based on the ordering through the ROC algorithm. This heterogeneity was illustrated by the occurrence of the different categories, which showed a high variation. Only the categories effects on wildlife (c9) and the protection status of wolves (r10) as major consequence and reason for returning wolves were mentioned by all participants except one for each category. While this indicates heterogeneity for reasons and consequences for the issue at stake, this seems to further complicate the resolution of the conflict, as policy makers and researchers need to target very different concepts when communicating with stakeholders. Besides the importance of understanding reasons for the conflict due to differing conceptions, the case study also illustrated possible solutions for the conflict.

The overall 19 identified solutions for the conflict of returning wolves could be combined into 3 implementation spaces, allowing for the further development of ways to overcome implementation gaps. First of all, the solutions that targeted at the human-human conflict are in line with prior research about the importance of human dimensions in wildlife conflict (Madden, 2004). For the issue at hand, the possibility of creating better exchange between the stakeholders emerged as one of the main implications of the case study. This includes possibilities of direct contact (s4) and collaboration with each other (s8). These solutions directly point to stakeholders' perception of not sufficiently being involved in the process. This is why policy makers are under pressure to increase participation of concerned groups. Furthermore, the solutions s6 and s7 point to the need to further communication and public knowledge to achieve a higher acceptance of the species.

Speaking of acceptance, a stricter management of existing populations emerged as a second implementation space for our case study. While wolves showed to have positive effects on biodiversity (Ripple and Beschta, 2012), our participants reported positive as well as negative relationships of wolves with other wildlife animals (categories c7 and c4). A further look into how the stakeholders view biodiversity would be interesting for further research, as studies showed how biodiversity may be difficult to understand (Fiebelkorn and Menzel, 2013; A. Fischer et al., 2007). Similar to this, the killing of problem wolves, which is recently applied as one of the main management measures by authorities in Germany, has shown to be of minor efficacy on the long run or even bring harm to the overall aim of conservation (Santiago-Avila et al., 2018). Nonetheless, people prefer lethal management methods based on their beliefs or value structure (Bruskotter et al., 2009; Dougherty et al., 2003). Further studies also showed how specific sources of information and knowledge are connected to attitudes towards returning wolves (Arbieu et al., 2019). Attitudes and their underlying value structures are the main contributor to the acceptance of wildlife species (Whittaker et al., 2006).

**Table 2**
Overview of codes for the reported solutions, a short description and perspectives for implementation.

| Code | Description | Perspectives for implementation |
|---|---|---|
| s1 | All parties have to compromise | More realistic implementation of policies due to greater common ground |
| s2 | Objective communication between all parties | Decreasing distrust between stakeholders |
| s3 | Tolerance for other position | Enabling compromises |
| s4 | Establishing possibilities of stakeholder contact | Creating possibilities for communication |
| s5 | Transparency of status of wild wolves | Building trust between stakeholders |
| s6 | Better information for the public about status and costs of return | Increasing acceptance with clear communication |
| s7 | Content-related education for all concerned parties | Ensuring common knowledge base |
| s8 | Interdisciplinary collaboration between all concerned groups | Enabling shared mastering of conflict |
| s9 | Wolves should be attributed to hunting legislation | Possibility for stricter regulation |
| s10 | Faster management of existing populations | Early cover of wolf conflict |
| s11 | There should be zones without wolves | Strengthen public acceptance |
| s12 | Existing wolf populations need to be stricter regulated | Strengthen public acceptance |
| s13 | Problem wolves should be killed | Try to regulate harm for livestock owners |
| s14 | Insurances should cover the costs of livestock killings | Cover financial costs of livestock owners |
| s15 | Neighboring countries should be used as role models for solutions | Higher acceptance when successful |
| s16 | Further research about returning wolves needs to be done | More knowledge and better management |
| s17 | Livestock owners should be supported by compensation for every animal | General better standing of livestock owners |
| s18 | Further support for livestock owners | Directly covering some problems |
| s19 | Solutions have to integrate multiple dimensions | Strengthen acceptance of solutions |

The final implementation space of consequence oriented solutions was a rather promising result, as the Venn diagrams indicated a common ground of all participants in the further support for livestock owners (s18). Similar to the other solutions, this may cover some of the damaging consequences of returning wolves, which may be especially problematic in densely populated regions like Germany (Chapron et al., 2014). To cover the costs, the stakeholders also developed other solutions, like the implementation of a livestock compensation system. But as the costs have to be covered by public authorities, there is a need to further increase the acceptance of wolves in society.

As with other qualitative approaches, the results of the case study should only cautiously be generalized. Future studies need to investigate in how far the results may be transferred to other individuals from the stakeholder groups and other application cases. For these other application cases the transfer of implementation spaces seems very interesting. Therefore, besides the specific case-related solutions, we were able to characterize implementation spaces, which may be possible to be generalized beyond our case study.

## 5. General discussion

While the specific solutions from our case study have only a limited generalizability, the three implementation spaces may be adaptable to other conflict situations. Several implementation problems can either be addressed by changing interactions between humans to ease the social situation (implementation space 1), addressing the causes by stronger managing the conservation problem (implementation space 2), or dealing with the consequences (implementation space 3). As the study aimed at exploring possible solutions and implementation spaces or a specific case, this list of implementation spaces may not be exhaustive though. This is especially true as the selection of specific stakeholders may vary between specific conservation cases, leading to further possible implementation spaces. This should be investigated in further studies.

Generally, our study illustrated how the analysis of mental models of stakeholders can be used to better understand conservation conflicts and generate solutions as well as subsequent implementation spaces. This is in line with research indicating the importance of other knowledge sources than scientific knowledge (Raymond et al., 2010). Hence, our approach can present a promising methodological innovation for conservation science, as it may strengthen the dialogue through providing insights into the mental models of several stakeholders. But to really lead to dialogue, the findings of this study should now be used to support a more informed debate among stakeholders and policy planers in order to eventually strengthen the implementation and sustainability of specific conservation actions (Reed et al., 2014; Toomey et al., 2017). However, the process of integrating stakeholder knowledge should also be discussed critically. As it was shown in our data, some of the coded categories were contradictory to each other, which can pose challenges for stakehodler dialogues. Future studies could also include more and other stakeholders, like for example scientists, who also hold relevant knowledge (Van Heel et al., 2017). Thus, the proposed categories may be investigated regarding their agreement with scientific knowledge on the ecological system of returning wolves. Based on such an investigation, the stakeholders could be explicitly confronted with this information. This may lead some stakeholders to rethink their position. Of course, one or two discussions about some other's views on a problem will not fundamentally change how stakeholders with extreme positions view a specific topic, but at least it is a starting point for further discourse. Following this starting point, it may be possible in future attempts to bring many stakeholders together at one table and build a group model, which may foster a structured discussion between stakeholders' positions.

Based on the multidimensionality and wickedness of conservation issues, a total win-win between species and human well-being has been described as nearly impossible (DeFries and Nagendra, 2017). But to achieve sustainable solutions, which also get implemented into practice, researchers and policy makers need to further integrate some of the diverse perspectives in conservation management (Redpath et al., 2013; Reed et al., 2014). Based on this assumption, our paper presented a standardized methodology to investigate stakeholder conceptions on a given conservation issue. Furthermore, we were able to illustrate its applicability within a case study, showing how qualitative interviews and concept mapping can be used to identify solutions and possible implementation spaces.

Of course, the limits of integrating stakeholder knowledge have to be reflected (and were also illustrated by our data). For example, not all stakeholders may hold only factual knowledge about specific issues, but may also mention unsubstantiated claims. This was also found in our data, as the killing of single problem wolves was reported as a possible solution, but is contrary with scientific literature (Santiago-Avila et al., 2018). This problem could partially be solved when concept mapping is utilized in a group model building exercise. Within such a process, stakeholders develop a model together, leading to a more refined version of the underlying system (Halbe et al., 2018). For future work it could also be interesting to further investigate how narratives shape the development of specific concepts and frames (D. Fischer et al., 2018). This is also reflected in the literature as well as our results. For example the fall of the Berlin wall is mentioned in nearly every document describing the return of wolves, and was also mentioned as a prominent category by the interviewees.

We hope our methodology and results will resonate in the research community and lead to the identification of further implementation spaces, which may finally contribute to the improvement of conservation practice.

## Declarations of interest

The authors declare no conflicting interests.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.gecco.2019.e00784.

## References

Arbieu, U., Mehring, M., Bunnefeld, N., Kaczensky, P., Reinhardt, I., Ansorge, H., Nowak, C., 2019. Attitudes towards returning wolves (Canis lupus) in Germany: exposure, information sources and trust matter. Biol. Conserv. 234, 202–210.
Arlettaz, R., Schaub, M., Fournier, J., Reichlin, T.S., Sierro, A., Watson, J.E.M., Braunisch, V., 2010. From publications to public actions: when conservation biologists bridge the gap between research and implementation. Bioscience 60 (10), 835–842.
Bennett, N.J., Roth, R., Klain, S.C., Chan, K., Christie, P., Clark, D.A., et al., 2017. Conservation social science: understanding and integrating human dimensions to improve conservation. Biol. Conserv. 205, 93–108.
Bertuol-Garcia, D., Morsello, C., N. El-Hani, C., Pardini, R., 2018. A conceptual framework for understanding the perspectives on the causes of the science–practice gap in ecology and conservation. Biol. Rev. 93 (2), 1032–1055.
Braunisch, V., Home, R., Pellet, J., Arlettaz, R., 2012. Conservation science relevant to action: a research agenda identified and prioritized by practitioners. Biol. Conserv. 153, 201–210.
Bruskotter, J.T., Vaske, J.J., Schmidt, R.H., 2009. Social and cognitive correlates of Utah residents' acceptance of the lethal control of wolves. Hum. Dimens. Wildl. 14 (2), 119–132. https://doi.org/10.1080/10871200802712571.
Bryman, A., 2008. In: Social Research Methods, third ed. Oxford University Press, Oxford, New York.
Cadotte, M.W., Barlow, J., Nuñez, M.A., Pettorelli, N., Stephens, P.A., 2017. Solving environmental problems in the Anthropocene: the need to bring novel theoretical advances into the applied ecology fold. J. Appl. Ecol. 54 (1), 1–6.
Chapron, G., Kaczensky, P., Linnell, J.D.C., Arx, M. Von, Huber, D., Andrén, H., Anders, O., 2014. Recovery of large carnivores in Europe's modern human-dominated landscapes. Science 346 (6216), 1517–1519.
Colloff, M.J., Lavorel, S., van Kerkhoff, L.E., Wyborn, C.A., Carina, A., Fazey, I., Ioan], Gorddard, R., et al., 2017. Transforming conservation science and practice for a postnormal world. Conserv. Biol. : the Journal of the Society for Conservation Biology 31 (5), 1008–1017.
DBBW - Dokumentations- und Beratungsstelle des Bundes zum Thema Wolf, 2019. Wolfsverursachte Schäden, Präventions- und Ausgleichszahlungen in Deutschland 2017. Görlitz.
DeFries, R., Nagendra, H., 2017. Ecosystem management as a wicked problem. Science 356 (6335), 265–270.
Dougherty, E.M., Fulton, D.C., Anderson, D.H., 2003. The influence of gender on the relationship between wildlife value orientations, beliefs, and the acceptability of lethal deer control in cuyahoga valley national park. Soc. Nat. Resour. 16 (7), 603–623. https://doi.org/10.1080/08941920309187.
Drummond, C., Fischhoff, B., 2017. Individuals with greater science literacy and education have more polarized beliefs on controversial science topics. Proc. Natl. Acad. Sci. U. S. A 114 (36), 9587–9592.
Elo, S., Kyngäs, H., 2008. The qualitative content analysis process. J. Adv. Nurs. 62 (1), 107–115.
Enserink, M., Vogel, G., 2006. The carnivore comeback. Science 314 (5800), 746–749.
Fechter, D., Storch, I., 2014. How many wolves (Canis lupus) fit into Germany? The role of assumptions in predictive rule-based habitat models for habitat generalists. PLoS One 9 (7), e101798.
Fiebelkorn, F., Menzel, S., 2013. Student teachers' understanding of the terminology, distribution, and loss of biodiversity: perspectives from a biodiversity hotspot and an industrialized country. Res. Sci. Educ. 43 (4), 1593–1615.
Fischer, A., Young, J.C., Juliette, C., 2007. Understanding mental constructs of biodiversity: implications for biodiversity management and conservation. Biol. Conserv. 136 (2), 271–282. https://doi.org/10.1016/j.biocon.2006.11.024.
Fischer, D., Schäfer, T., Borner, J., 2018. Narrations of sustainability: how to tell the story of the socio-ecological transformation. GAIA Ecol. Perspect. Sci. Soc. 27 (3), 334–336.
Gallese, V., Lakoff, G., 2005. The brain's concepts: the role of the sensory-motor system in conceptual knowledge. Cogn. Neuropsychol. 22 (3–4), 455–479.
Goggin, C.L., Barrett, T., Leys, J., Summerell, G., Gorrod, E., Waters, S., Jenkins, B.R., 2019. Incorporating social dimensions in planning, managing and evaluating environmental projects. Environ. Manag. 1–18.
Gossa, C., Fisher, M., Milner-Gulland, E.J., 2015. The research–implementation gap: how practitioners and researchers from developing countries perceive the role of peer-reviewed literature in conservation science. Oryx 49 (1), 80–87.
Gray, B., 2004. Strong opposition: frame-based resistance to collaboration. J. Community Appl. Soc. Psychol. 14 (3), 166–176.
Gray, S., Jordan, R., Crall, A., Newman, G., Hmelo-Silver, C., Huang, J., Prysby, M., 2017. Combining participatory modelling and citizen science to support volunteer conservation action. Biol. Conserv. 208, 76–86.
Griggs, D., Stafford-Smith, M., Gaffney, O., Rockstrom, J., Ohman, M.C., Shyamsundar, P., et al., 2013. Policy: sustainable development goals for people and planet. Nature 495 (7441), 305–307. https://doi.org/10.1038/495305a.
Gross, M., 2008. Return of the wolf: ecological restoration and the deliberate inclusion of the unexpected. Environ. Pol. 17 (1), 115–120. https://doi.org/10.1080/09644010701643159.
Halbe, J., Pahl-Wostl, C., Adamowski, J., 2018. A methodological framework to support the initiation, design and institutionalization of participatory modeling processes in water resources management. J. Hydrol. 556, 701–716.
Halbe, J., Reusser, D.E., Holtz, G., Haasnoot, M., Stosius, A., Avenhaus, W., Kwakkel, J.H., 2015b. Lessons for model use in transition research: a survey and comparison with other research areas. Environ. Innov. Soc. Trans. 15, 194–210.
Hindrikson, M., Remm, J., Pilot, M., Godinho, R., Stronen, A.V., Baltrūnaité, L., Nowak, C., 2017. Wolf population genetics in E urope: a systematic review, meta-analysis and suggestions for conservation and management. Biol. Rev. 92 (3), 1601–1629.
Hulme, P.E., 2014. Bridging the knowing–doing gap: know-who, know-what, know-why, know-how and know-when. J. Appl. Ecol. 51 (5), 1131–1136.
Inam, A., Adamowski, J., Halbe, J., Prasher, S., 2015. Using causal loop diagrams for the initialization of stakeholder engagement in soil salinity management in agricultural watersheds in developing countries: a case study in the Rechna Doab watershed, Pakistan. J. Environ. Manag. 152, 251–267.
Ingram, R.J., Oleson, K.L.L., Gove, J.M., 2018. Revealing complex social-ecological interactions through participatory modeling to support ecosystem-based management in Hawai'i. Mar. Policy 94, 180–188. https://doi.org/10.1016/j.marpol.2018.05.002.
Jürgens, U.M., Hackett, P.M.W., 2017. The big bad wolf: the formation of a stereotype. Ecopsychology 9 (1), 33–43.
Kaczensky, P., 1999. Large carnivore depredation on livestock in Europe. Ursus 59–71.
King, J.R., 1980. Machine-component grouping in production flow analysis: an approach using a rank order clustering algorithm. Int. J. Prod. Res. 18 (2), 213–232.

Knight, A.T., Cowling, R.M., Rouget, M., Balmford, A., Lombard, A.T., Campbell, B.M., 2008. Knowing but not doing: selecting priority conservation areas and the research−implementation gap. Conserv. Biol. 22 (3), 610−617.
Madden, F., 2004. Creating coexistence between humans and wildlife: global perspectives on local efforts to address human−wildlife conflict. Hum. Dimens. Wildl. 9 (4), 247−257. https://doi.org/10.1080/10871200490505675.
Massey, A.P., Clapper, D.L., Blue, J.A., 1997. An interdisciplinary approach for exploring the impact of individual characteristics in the context of GSS research. Ann. Oper. Res. 72, 75−101.
Mech, L.D., 2017. Where can wolves live and how can we live with them? Biol. Conserv. 210, 310−317.
Moon, K., Guerrero, A.M., Adams, V.M., Biggs, D., Blackman, D.A., Craven, L., et al., 2019. Mental models for conservation research and practice. Conserv. Lett., e12642
Norman, D.A., 2014. Some observations on mental models. In: Gentner, D., Stevens, A.L. (Eds.), Mental Models. Psychology Press, New York, pp. 7−14.
Peuhkuri, T., Jokinen, P., 1999. The role of knowledge and spatial contexts in biodiversity policies: a sociological perspective. Biodivers. Conserv. 8 (1), 133−147.
Randi, E., 2011. Genetics and conservation of wolves Canis lupus in Europe. Mamm Rev. 41 (2), 99−111.
Raymond, C.M., Fazey, I., Reed, M.S., Stringer, L.C., Robinson, G.M., Evely, A.C., 2010. Integrating local and scientific knowledge for environmental management. J. Environ. Manag. 91 (8), 1766−1777.
Redman, C.L., Grove, J.M., Kuby, L.H., 2004. Integrating social science into the long-term ecological research (LTER) network: social dimensions of ecological change and ecological dimensions of social change. Ecosystems 7 (2), 161−171.
Redpath, S.M., Young, J., Evely, A., Adams, W.M., Sutherland, W.J., Whitehouse, A., Watt, A., 2013. Understanding and managing conservation conflicts. Trends Ecol. Evol. 28 (2), 100−109.
Reed, M.S., Stringer, L.C., Fazey, I., Evely, A.C., Kruijsen, J.H.J., 2014. Five principles for the practice of knowledge exchange in environmental management. J. Environ. Manag. 146, 337−345.
Richardson, G.P., 1986. Problems with causal - loop diagrams. Syst. Dyn. Rev. 2 (2), 158−170.
Ripple, W.J., Beschta, R.L., 2012. Trophic cascades in Yellowstone: the first 15 years after wolf reintroduction. Biol. Conserv. 145 (1), 205−213.
Ronnenberg, K., Habbe, B., Gräber, R., Strauß, E., Siebert, U., 2017. Coexistence of wolves and humans in a densely populated region (Lower Saxony, Germany). Basic Appl. Ecol. 25, 1−14.
Santiago-Avila, F.J., Cornman, A.M., Treves, A., 2018. Killing wolves to prevent predation on livestock may protect one farm but harm neighbors. PLoS One 13 (1), e0189729.
Scholz, G., Austermann, M., Kaldrack, K., Pahl-Wostl, C., 2015. Evaluating group model building exercises: a method for comparing externalized mental models and group models. Syst. Dyn. Rev. 31 (1−2), 28−45.
Schroeder, N.L., Nesbit, J.C., Anguiano, C.J., Adesope, O.O., 2018. Studying and constructing concept maps: a meta-analysis. Educ. Psychol. Rev. (30), 431−455.
Senge, P., 1990. The Fifth Discipline: The Art & Practice of The Learning Organization. Doubleday, New York.
Statistische Ämter des Bundes und der Länder, 2018. Atlas agrarstatistik NRW. Retrieved from. https://www.atlas-agrarstatistik.nrw.de/.
Toomey, A.H., 2016. What happens at the gap between knowledge and practice? Spaces of encounter and misencounter between environmental scientists and local people. Ecol. Soc. 21 (2).
Toomey, A.H., Knight, A.T., Barlow, J., 2017. Navigating the space between research and implementation in conservation. Conserv. Lett. 10 (5), 619−625.
Trouwborst, A., 2010. Managing the carnivore comeback: international and EU species protection law and the return of lynx, wolf and bear to Western Europe. J. Environ. Law 22 (3), 347−372.
Van Heel, B.F., Boerboom, A.M., Fliervoet, J.M., Lenders, H.J.R., den Born, R., 2017. Analysing stakeholders' perceptions of wolf, lynx and fox in a Dutch riverine area. Biodivers. Conserv. 26 (7), 1723−1743.
Venn, J., 1880. I. On the diagrammatic and mechanical representation of propositions and reasonings. Lond., Edinb., Dublin Philos. Mag. J. Sci. 10 (59), 1−18.
Vennix, J., 1996. Group Model Building − Facilitating Team Learning Using System Dynamics. Wiley & Sons, New York.
Vittersø, J., Kaltenborn, B.P., Bjerke, T., 1998. Attachment to livestock and attitudes toward large carnivores among sheep farmers in Norway. Anthrozoös 11 (4), 210−217.
Waters, C.N., Zalasiewicz, J., Summerhayes, C., Barnosky, A.D., Poirier, C., Gałuszka, A., et al., 2016. The Anthropocene is functionally and stratigraphically distinct from the Holocene. Science 351 (6269), 1−10.
Whittaker, D., Vaske, J.J., Manfredo, M.J., 2006. Specificity and the cognitive hierarchy: value orientations and the acceptability of urban wildlife management actions. Soc. Nat. Resour. 19 (6), 515−530.