Received: 22 July 2020 | Revised: 1 February 2021 | Accepted: 23 February 2021

DOI: 10.1111/csp2.399

PERSPECTIVES AND NOTES

Conservation Science and Practice
A journal of the Society for Conservation Biology
Open Access

WILEY

Integrated framework for stakeholder participation: Methods and tools for identifying and addressing human–wildlife conflicts

Hannes J. König[1] | **Silvia Ceaușu**[2] | **Mark Reed**[3] | **Helen Kendall**[3] | **Karoline Hemminger**[1,4] | **Henrik Reinke**[1,5] | **Emu-Felicitas Ostermann-Miyashita**[1,4] | **Elena Wenz**[1] | **Luca Eufemia**[1,4] | **Till Hermanns**[1] | **Moritz Klose**[6] | **Marcin Spyra**[7] | **Tobias Kuemmerle**[5,8] | **Adam T. Ford**[9]

[1]Junior Research Group Human–Wildlife Conflict & Coexistence, Leibniz Centre for Agricultural Landscape Research (ZALF), Müncheberg, Germany

[2]Centre for Biodiversity and Environment Research, University College London, London, UK

[3]Centre for Rural Economy, School of Natural and Environmental Science, Newcastle University, Newcastle upon-Tyne, UK

[4]Faculty of Life Sciences, Thaer-Institute of Agricultural and Horticultural Sciences, Humboldt Universität zu Berlin, Berlin, Germany

[5]Geography Department, Humboldt University Berlin, Berlin, Germany

[6]World Wide Fund For Nature, WWF Deutschland, Berlin, Germany

[7]Department of Sustainable Landscape Development, Martin-Luther-University Halle-Wittenberg, Halle, Germany

[8]Integrative Research Institute on Transformations in Human-Environment Systems (IRI THESys), Humboldt University Berlin, Berlin, Germany

[9]Department of Biology, University of British Columbia, Kelowna, British Columbia, Canada

Correspondence
Hannes J. König, Leibniz Centre for Agricultural Landscape Research (ZALF), Eberswalder Str. 84, D-15374 Müncheberg, Germany.
Email: hannes.koenig@zalf.de

Funding information
Leibniz Centre for Agricultural Landscape Research; Marianne and Dr. Fritz Walter Fischer-Foundation

Abstract

As wild areas disappear and agricultural lands expand, understanding how people and wildlife can coexist becomes increasingly important. Human–wildlife conflicts (HWCs) are obstacles to coexistence and negatively affect both wildlife populations and the livelihood of people. To facilitate coexistence, a number of frameworks have been developed to both understand the drivers of conflict and then to find solutions that mitigate conflict. However, each framework has different foci and strengths in particular stages of analysis. Here, we propose an integrated framework that leverages the individual strengths of previously fairly isolated methodologies, allowing for holistic HWC analysis. The framework for participatory impact assessment (*FoPIA*) provides a toolset for developing wildlife scenarios, selecting assessment indicators and assessing the impact of different scenarios. The social-ecological framework of ecosystem services and disservices

Contributed manuscript to the special section "Methods for integrated assessment of human-wildlife interactions and coexistence in agricultural landscapes." Guest editors: König, H.J., Carter, N., Ceaușu, S., Kiffner, C., Lamb, C., Ford, A. T.

(*SEEDS*) analyzes the ecosystem services trade-offs related to scenarios, and the *3i* stakeholder analysis approach, supports the identification of stakeholders and provides a mechanism to explore, in detail stakeholders' interests, relative influence, and how outcomes of research are likely to impact different stakeholders. We apply these approaches to eastern Germany, where the increase in several wildlife populations (i.e., wild boar, common crane, gray wolf, and European bison) has contributed to conflict with people. We demonstrate the complementarity of FoPIA, SEEDS, and 3i in identifying stakeholder needs and showing how wildlife dynamics may affect coexistence and create imbalanced ecosystem service and disservice distributions. The integrated framework introduced here provides guidelines for analyzing the multistage process of stakeholder participation and enables a comprehensive approach to the complex challenge of HWCs.

KEYWORDS

coexistence, decision support, disservices, ecosystem services, human–wildlife interactions, stakeholder participation, wildlife governance

1 | INTRODUCTION

Human–wildlife conflicts (HWCs) can be triggered when humans and wildlife compete for the same resources—be this food or space. Conflicts also arise among people when stakeholders express different values or behaviors toward wildlife (Dickman, 2010; Woodroffe, Thirgood, & Rabinowitz, 2005). This tension is particularly acute in agricultural landscapes, where natural lands have been modified to maximize the production of agricultural commodities (i.e., food, feed, and bioenergy) or other ecosystem services to support human livelihoods (cf. MEA, 2005; TEEB Synthesis, 2010). Coexistence in these agricultural landscapes is tenuous because wildlife threaten crop production (Nilsson, Bunnefeld, Persson, & Månsson, 2016), the spread of zoonotic diseases to livestock (Gortazar, Ferroglio, Hofle, Frolich, & Vicente, 2007), and human safety (Morehouse & Boyce, 2017).

Coexistence is defined as a dynamic but sustainable state in which humans and wildlife co-adapt to living in shared landscapes where human interactions with wildlife are governed by effective institutions that ensure long-term wildlife population persistence, social legitimacy, and tolerable levels of risk (Carter & Linnell, 2016). Within this definition of coexistence, we recognize two main stakeholder groups: those who are directly impacted by wildlife (e.g., land users such as farmers and foresters and conservationists who "speak" for or "represent" wildlife), and those who can influence decisions (e.g., policy makers, scientists, NGOs).

While HWCs often entail competition between people and animals for space or resources (Inskip & Zimmermann, 2009; Seoraj-Pillai & Pillay, 2017), an emerging view sees HWC as the outcome of conflicts between stakeholder groups (König et al., 2020; Redpath, Bhatia, & Young, 2015). The values, attitudes, and beliefs of different stakeholders generate competing demands for management practices that permit, control, or exclude wildlife species (Hill, 2015; Peterson, Birckhead, Leong, Peterson, & Peterson, 2010). For this reason, technical or financial solutions addressing the damage caused by wildlife may be insufficient if they do not address underlying inter-stakeholder conflicts. However, such solutions may lead to a negotiated outcome if they are sought before the conflict becomes entrenched.

Combining a range of different stakeholders' views is beneficial for the development and assessment of policies and management practices that foster the coexistence of humans and wildlife in agricultural landscapes. Such coexistence can likely be achieved through a holistic perspective in which socioeconomic and ecological aspects are given deep consideration (Hill, Webber, & Priston, 2017; Nyhus, 2016). Finding solutions that mitigate conflicts and foster coexistence thus requires stakeholder-inclusive and participatory methods that capture both the ecology of wildlife populations and the social and economic background, needs, and wants of stakeholders (König et al., 2020). Moreover, anticipating conflicts and creating structures to preempt HWCs rather than resolve them will lead to lower costs for stakeholders and governments (Agarwala, Kumar, Treves, & Naughton-Treves, 2010; Ceausu, Graves, Killion, Svenning, & Carter, 2019).

When analyzing the anticipated conflicts and alternative coping strategies, scenario techniques provide a powerful tool to explore the alternative development pathways, possible scenario impacts and potential trade-offs between different stakeholder views (König et al., 2013). In the context of policy-making, sustainability impact assessment has become a prominent tool to conduct ex ante sustainability impact assessments of policy and management scenarios along the three sustainability dimensions (economic, social, environmental; Hermanns et al., 2017).

Conceptual frameworks are frequently proposed to address the complexity of HWCs (König et al., 2020). The emphasis on multidisciplinary approaches has attracted a broad range of expertise and interests, which has led to many frameworks and approaches to addressing particular parts of the multistage process of building human–wildlife coexistence. For example, some frameworks address procedural aspects (Henle et al., 2013) or information gathering (Treves, Wallace, & White, 2009), while others focus on organizing and interpreting existing information (Lischka et al., 2018). Some frameworks aim at understanding the psychology and attitudes of stakeholders (Carter, Riley, & Liu, 2012; McCleery, 2009; Snyder & Rentsch, 2020), determining the required level of damage prevention and approaches to its implementation in resolving HWCs (König et al., 2020), quantifying and prioritizing co-benefits (Rees, Carwardine, Reeson, & Firn, 2020), analyzing interactions between people and wildlife (Morzillo, de Beurs, & Martin-Mikle, 2014), using ecological theory to assess predator–prey (i.e., carnivore-livestock) interactions (Lamb et al., 2020; Wilkinson et al., 2020), or integrating HWC with other ecological frameworks (Crespin & Simonetti, 2019). However, there may be an emergent value of bringing together the strengths and foci of these different frameworks to find new solutions to the complexity of HWC in agricultural areas.

In this essay, we show how integrating three existing frameworks can lead to new insights and approaches to HWC mitigation that would not be possible using any one of the frameworks in isolation. Specifically, we identify frameworks whose strengths lie in three different stages of HWC analysis: (a) impact assessment of wildlife expansion and population growth scenarios, (b) a systems analysis of wildlife-related services and disservices for different stakeholders, and (c) an analysis about stakeholders' interests and influence in HWC and the likely impact of HWC research. While impact assessment can be useful in providing insights about change effects (here: wildlife populations), a systems analysis provides information about spatio-temporal scales (when and where effects take place) and governance (legal frameworks); whereas stakeholder analysis helps to identify the perceptions and role of different actors in HWC.

Our integration consists of three main steps (see Figure 1.). In Step 1, we use the Framework for Participatory Impact Assessment (FoPIA) to develop scenario narratives, define assessment criteria and conduct scenario assessments in line with the need to integrate expert opinions and stakeholder perceptions and preferences. FoPIA was originally developed to assess ex ante the impact of alternative land use policies in Europe (Helming et al., 2011; Morris, Tassone, De Groot, Camilleri, & Moncada, 2011) and various non-European countries (e.g., China, Indonesia, India, Kenya, Tanzania, Tunisia; König et al., 2013, 2014, 2017). In Step 2, we organize and analyze the information collected in Step 1 using the concept of ecosystem disservices and services (SEEDS; Ceausu et al., 2019), which allows a systemic perspective on HWC. The social-ecological framework of ecosystem services and disservices (SEEDS) adapts the components of social-ecological systems (Ostrom, 2007, 2009) to the context of human–wildlife interactions by defining six key elements: wildlife units, ecosystem services, ecosystem disservices, ecosystem service recipients, ecosystem disservice recipients, and governance. Finally, in Step 3, we analyze the relative interest, influence, and impact of HWC research on participating stakeholder groups using the 3i framework (Reed, Bryce, & Machen, 2018). This enables an assessment of different stakeholder interests in HWCs, their ability to influence the outcomes of these conflicts, and their perceptions on how research results are likely to affect their management.

Our integrated, trifold framework uses impact assessment, trade-off and stakeholder analyses to help identify solutions that create better conditions for human–wildlife coexistence in agricultural landscapes. Thus, we contribute to the advancement of integrated impact assessment tools (Reidsma et al., 2011) that combine different formats of stakeholder engagement, scenario techniques and knowledge transformation into a decision support framework for wildlife management. The framework is meant to be used by researchers and conservation practitioners to support the implementation process of conservation strategies that aim to minimize HWCs at the landscape scale.

To illustrate our integrated framework, we assess the impact of growing populations of four species (wild boar, common crane, gray wolf, and European bison) which generally thrive well in agricultural landscapes in the state of Brandenburg (Germany). Using these examples, our integrated framework allows us to (a) analyze and identify the potential trajectories and interactions that could lead to HWC and (b) derive possible recommendations to reduce the potential for future conflict around these four wildlife species in the context of Brandenburg state.

2 | CASE-STUDY CONTEXT

Due to successful conservation policies, demographic change, and economic dynamics in central Europe,

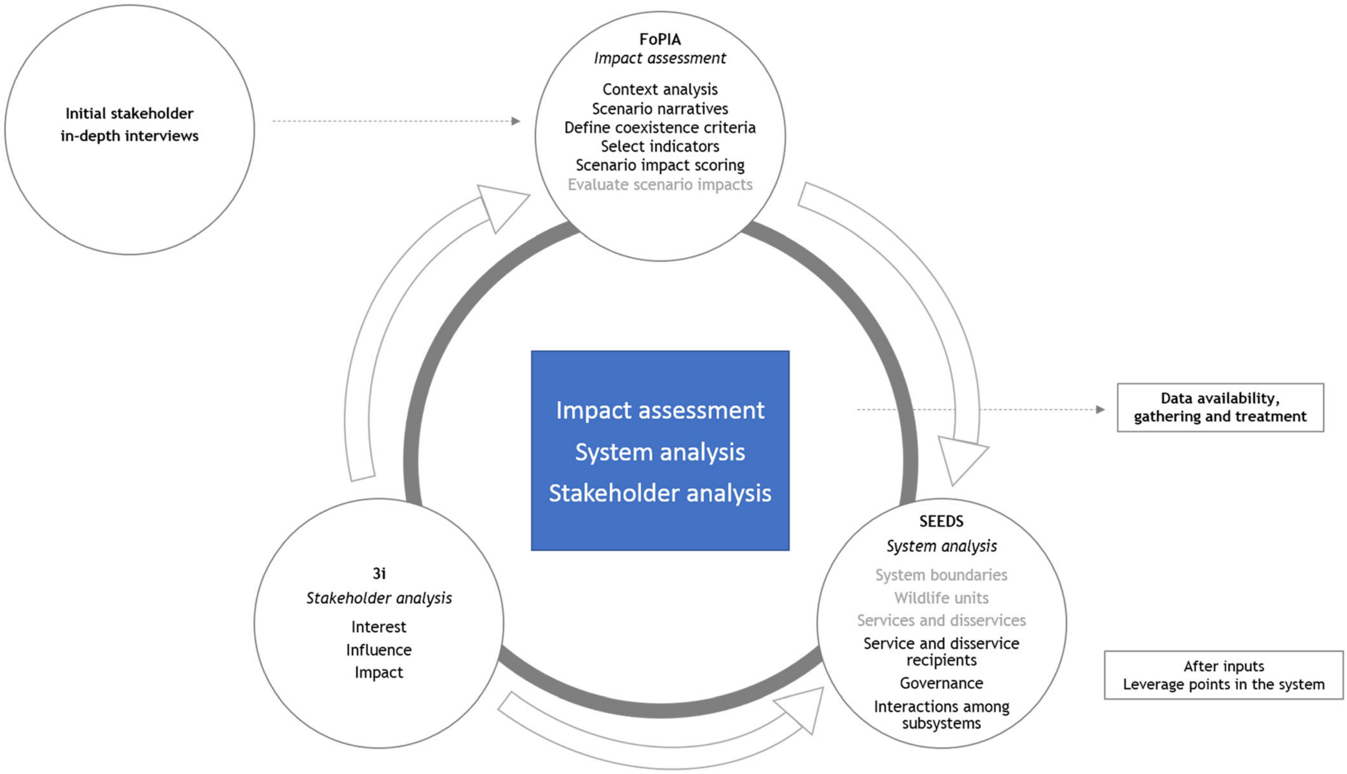

FIGURE 1 Logical flow of the trifold assessment framework—using FoPIA, SEEDS, and 3i to conduct stakeholder-informed analysis of human–wildlife conflicts. Framework steps in paler color (grey) refer to redundant analytical steps. This applies for the FoPIA and SEEDS framework where system boundaries, wildlife units and assessment criteria were defined in FoPIA and taken up in SEEDS. Of note is that the term "impact" in the context of FoPIA refers to possible and potential effects of scenarios on selected impact criteria; the term "impact" is differently used in the context of the 3i framework where impact reflects on the possible effects HWC research has on individual stakeholder groups

several wildlife species are predicted to expand their range in the future (Chapron et al., 2014; Massei et al., 2015). These species are now persisting in suitable habitats that had recently become depopulated by people as a result of structural changes and migration to cities (Tsunoda & Enari, 2020). In addition, policies that protect species such as wolves and bears have resulted in lower rates of human-caused mortality, thereby hastening the species' population growth and expansion. Overall, the recent influx of biodiversity to Europe's rural landscapes is predicted to lead to self-sustaining ecosystem processes, healthier ecosystems, and an increase in cultural ecosystem services (Ceausu et al., 2015; Navarro & Pereira, 2012). However, these biodiversity changes are also expected to lead to disservices to some rural stakeholders.

Brandenburg is the fifth largest state in Germany, with an area of approximately 29,700 km^2 and a population of 2.44 million people, which is low compared to other states in Germany. Brandenburg is characterized by rural areas dominated by agriculture and forestry. Official data[1] on local species and populations indicate the increasing abundance of four wildlife species in Brandenburg (Figure 2): the wild boar (*Sus scrofa*), common crane (*Grus grus*), gray wolf (*Canis lupus*), and European bison (*Bison bonasus*). These species have the potential to exacerbate human–wildlife and human–human conflict by disrupting farming activities and rural lifestyles. This situation requires an understanding of the human–wildlife system as a whole and the anticipation of stakeholder attitudes and behaviors in particular.

3 | METHODS AND TOOLS FOR IDENTIFYING AND ADDRESSING HUMAN–WILDLIFE CONFLICTS

3.1 | Step 1—Scenario impact assessment with FoPIA

The first major step in our integrated framework is applying FoPIA. This approach follows a sequence of three methodological stages: (a) scenario development,

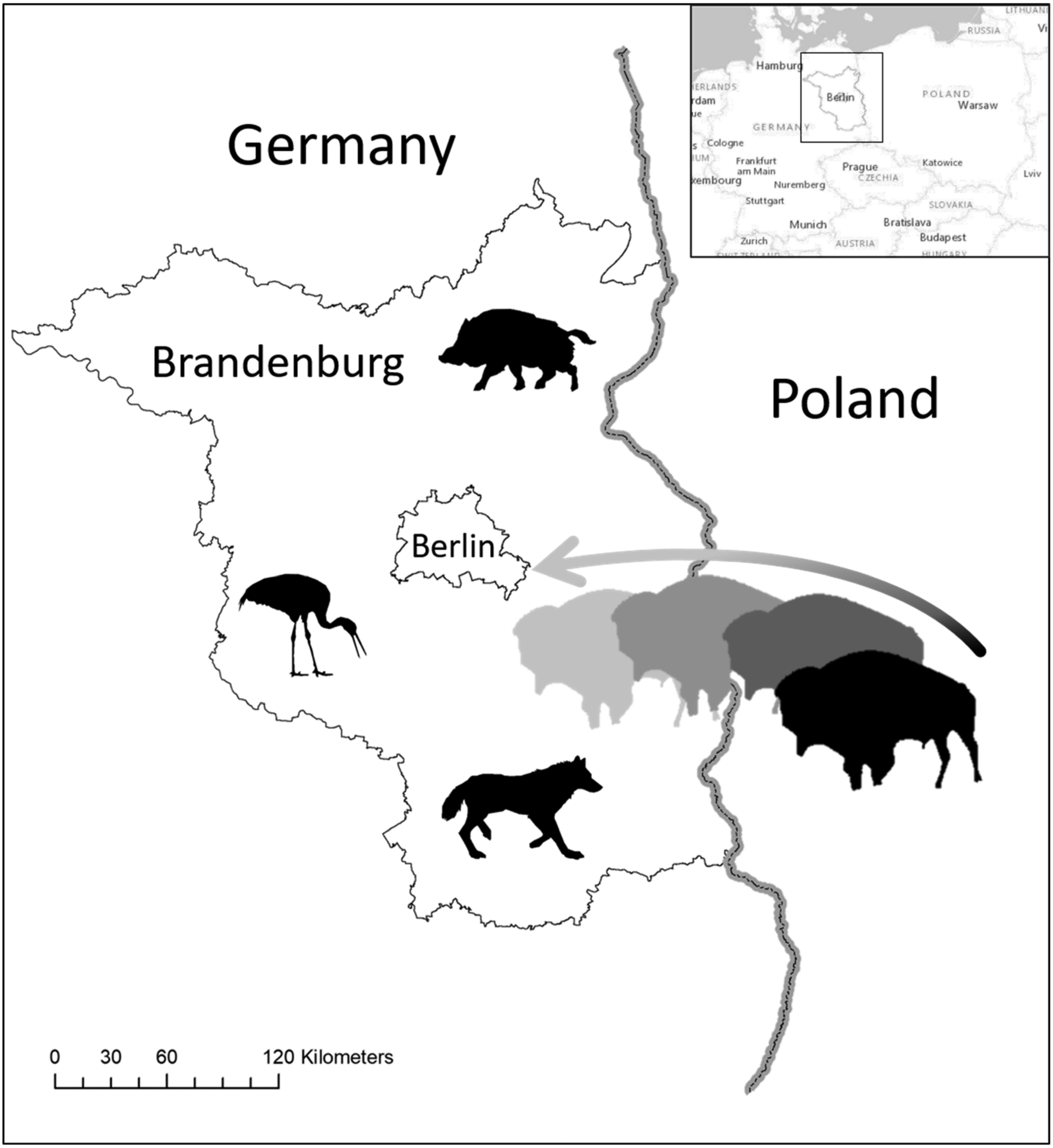

FIGURE 2 Map of the study site of Brandenburg state, which surrounds the German capital of Berlin and borders Poland. Frequent wildlife crossings occur in the study site, and it is home to iconic species, such as European bison, wolves, cranes, and wild boars. The species icons roughly illustrate their presence/distribution

(b) sustainability analysis, and (c) impact assessment (König et al., 2013). The adaptation of FoPIA to the specific context of HWCs included a conceptual task conducted by researchers, following a broad literature review on indicators, and the consultation of experts (n = 12). Experts that work in the field of HWC and were contacted through an email survey on wildlife population trends and indicators conducted in October 2019, and a one-day workshop in November 2019 with the same group of experts. The aim of the workshop was to fine-tune the conceptual adaptation of FoPIA to the regional wildlife and land use context.

3.1.1 | FoPIA Stage 1: Scenario development

Scenarios are commonly used to envisage alternative options or development pathways in impact assessments (Alcamo, 2001; Reed et al., 2013). For the scenario development in this study, we outlined general assumptions of the possible and likely population growth of wild boar, crane, gray wolf, and European bison over the next 5 years until 2025. The time horizon chosen matches the national legislation period of 5 years and should help envisage policy relevant scenario impacts in support of current wildlife management activities. We derived the following narrative and scenario assumptions:

- With more than 100,000 animals harvested, Brandenburg state has the highest number of wild boar in all of Germany's federal states according to the annual hunting statistics in 2019/20 (www.jagdverband.de). We assume that without interventions, the boar populations will likely expand further due to their naturally high reproductive rates, their high adaptability to rapidly changing environments (Stillfried et al., 2017), and the increasingly milder winters (Vetter, Ruf, Bieber, & Arnold, 2015). We are aware of the recent outbreak of the African Swine Fever (ASF) in Germany (September 2020). However, based on the relatively slow expansion and rather areas-specific zones of ASF, we do not expect a collapse of the boar population in the coming years.
- The populations of staging, breeding, and overwintering cranes are continuously growing in Brandenburg. We expect further crane population increases due to a general shift in the main migration flyway from Poland to Germany, wetland restoration, milder winters and available food in farmlands throughout the year (Nilsson et al., 2016).
- Brandenburg currently has the highest number of wolves of any German state, with >300 individuals (as of the 2018/19 wolf monitoring year) with 41 packs www.dbb-wolf.de). Since 2007, wolf numbers have risen continuously and are expected to increase further due to suitable habitat conditions and high prey densities (Reinhardt et al., 2019).
- European bison (or wisents) were hunted to extinction in Germany centuries ago. In the mid-80s, 20 European bison were relocated in western Poland to form a new, free-ranging European bison population near the German border. In 2019, the herd had grown to more than 300 animals, and because, in principle, ample habitat for European bison exists in eastern Germany (Kuemmerle et al., 2018), authorities are currently getting prepared for a likely return of bison to Brandenburg.

3.1.2 | FoPIA Stage 2: Sustainability analysis

To assess the impact of scenarios (here: expanding wildlife populations) on regional sustainability, FoPIA provides a balanced set of nine assessment criteria (Helming et al., 2011; Pérez-Soba et al., 2008) that are aligned to the three dimensions of sustainable development (social, economic, ecological). Based on a literature review on sustainability indicators (Burkhard, Kroll, Nedkov, & Müller, 2012; Maes et al., 2016; Paracchini, Pacini, Jones, & Perez-Soba, 2011; Sun et al., 2019; Uthes, Kelly, & König, 2020), we selected 25 assessment indicators that generally apply to human–wildlife interactions (see Table 1).

3.1.3 | FoPIA Stage 3: Scenario impact assessment

This study is the first to apply the adapted FoPIA to a HWC context, for which a target group of five stakeholders who operate in regional management or on the ground were individually interviewed. The main stakeholder selection criteria for this first FoPIA test-case, was that we considered actors who represented major land use sectors related to wildlife conflicts, this included for example, agriculture for crop and livestock production, forestry, hunting, and conservation. The participants included one organic farmer who cultivates crops and raises free-range suckler cows, one state forest manager who works as a regional district manager, one local conservationist who has long been active in the Nature and Biodiversity Conservation Union (NABU), one local (wild boar) hunter who served for a long time as a board member of a local hunting club, and one semitranshumant shepherd with a mixed group of sheep, goats and horses ($n > 1,500$ animals in total).

We conducted in-depth, semi-structured face-to-face interviews (taking 1.5–2 hr each) with open questions in a predefined order that were administered by the same person, and the responses were transcribed (Crouch & McKenzie, 2006). In the first part of the interview, the questions addressed the anticipated effects of the selected wildlife species (wild boar, cranes, gray wolves, and European bison) on each assessment criterion and scenario narrative (i.e., assuming that each wildlife population will continue to grow and/or expand in range

Conservation Science and Practice
A journal of the Society for Conservation Biology
Open Access
WILEY

TABLE 1 Assessment criteria structured along three sustainability dimensions (social, economic, and environmental). Short definitions are provided along with the average stakeholder-based weights. From the list of identified assessment indicators, one indicator per criterion (marked with *) was selected for this study

	Assessment criteria	Definition	Perceived importance (mean; 0 = not important; 10 = extremely important)	Possible assessment indicator(s) (concrete/measurable)
Social 1	Work	Employment provision for all in activities based on natural resources.	8.6 (range 8–10)	• Working conditions (quality)* • Employment rate (%) • Labor costs (€)
Social 2	Quality of life	Well-being referring to health, comfort, and happiness standards experienced by an individual or society.	8.8 (range 8–10)	• Happiness* • Physical and mental health
Social 3	Cultural identity	Landscape esthetics and values associated with the local culture.	8.0 (range 6–9)	• Recreational value* • Landscape attractiveness • Cultural heritage
Economic 1	Agricultural production	Provision of land for agricultural production activities.	7.6 (range 5–10)	• Crop yields (t/ha)* • Livestock yields (units/ha)* • Gross margin • Productivity • Opportunity costs • Transaction costs
Economic 2	Forest production	Forestry activities.	6.6 (range 5–10)	• Tree/forest condition* • Game harvests (units/100 ha) • Tree/timber harvests (m^3/ha) • Rejuvenation (quality)
Economic 3	Local economy	Opportunities for residential, social and productive human activities to occur.	7.2 (range 5–9)	• Local business (income/€)* • Regional products (*n*: count)
Environmental 1	Diversity of habitat	Variation in the habitats represented within a landscape or region.	8.2 (range 8–10)	• Habitat quality* • Diversity of habitats
Environmental 2	Wildlife species	Number of different species represented within a landscape or region.	8.2 (range 7–8)	• Number of different species* • Number of threatened species • Population status
Environmental 3	Ecosystem processes	The role of a wildlife species in the regulation of ecological processes for a natural and balanced ecosystem.	8.6 (range 8–10)	• Supporting ecosystem processes, contributing, for example, to predator–prey balance, nutrient cycle

through the year 2025; see Figure 3). In the second part of the interview, the stakeholders were asked to weight how they perceived the relevance of each assessment criterion (on a scale of 0–10, where 0 = not important to 10 = extremely important; see Table 1).

Figure 3 shows the averaged impact wildlife was expected to have on each criterion. As can be seen, wild boars were predicted to have little positive effects and to have negative impact on agricultural production and work costs. Cranes were predicted to have mainly positive impacts on cultural services, such as quality of life (happiness) and cultural identity (recreational value), and to have slightly negative impacts on agricultural production and related work efforts. Wolves were predicted to have positive effects on forests due to their predation of tree-browsing deer and negative effects on agricultural production related

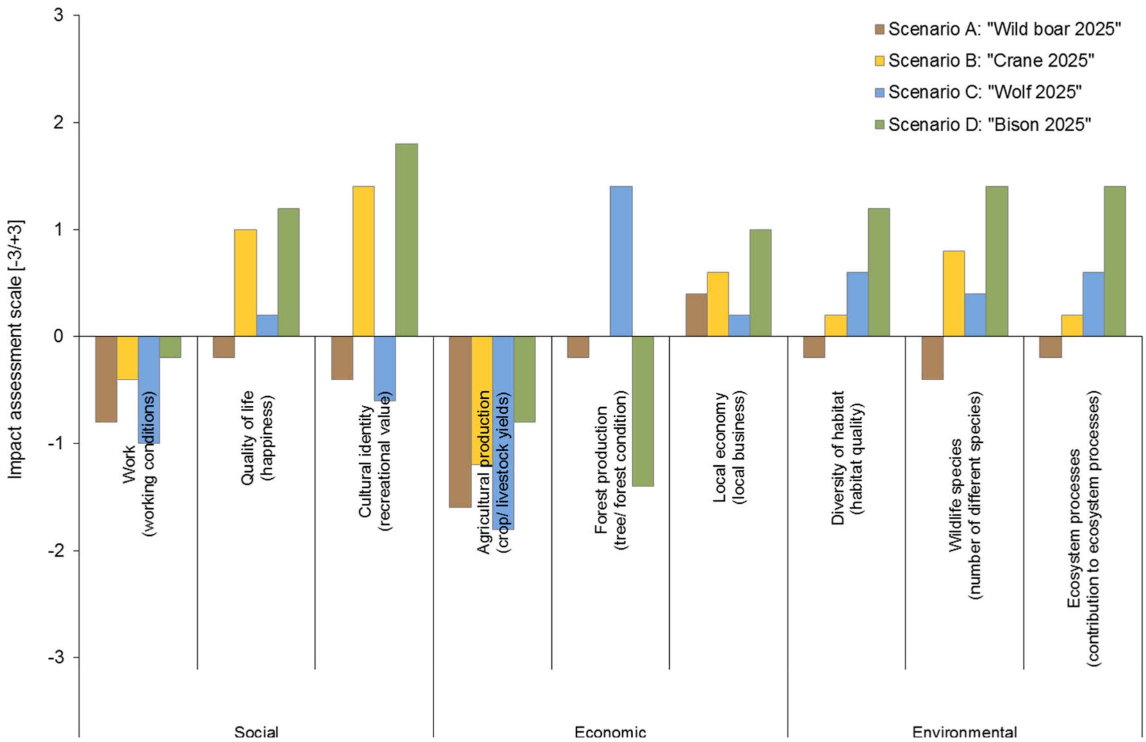

FIGURE 3 Wildlife-related services and disservices: impacts of different population growth and range expansion scenarios for four selected species according to social, economic, and environmental assessment criteria and associated indicators (see Table 1)

to livestock losses and increased work effort. Finally, European bison were predicted to have positive effects on all environmental indicators, the local economy, and, similarly to the crane, the social indicators of quality of life (happiness) and cultural identity (recreational value).

In terms of social impact, the stakeholders expressed positive effects such as enjoyment (i.e., observing wildlife). This was particularly true for cranes and European bison, mainly because these species can be observed more frequently during the daytime, and observations of nocturnal species such as the wolf and wild boar are more difficult. In terms of work costs, there was only one response, stating that the return of the wolf could help reduce the high number of game/prey, mainly roe deer (*Capreolus capreolus*), red deer (*Cervus elaphus*), and increasingly also wild boar numbers and consequently reduce the workload for local hunters. The highest number of negative effects was attributed to an increasing wolf population. Negative social impacts mainly included fear for the safety of children and pets related to the presence of wolves and, in one case, the return of the European bison. In terms of workload, the increased effort required from hunters (in terms of organization and time) due to increased numbers of wild boar were further mentioned. Moreover, the time needed to assess and repair damage caused by cranes, wolves and wild boars, especially in the agricultural sector, was expected to increase.

Economic benefits for forest management were mentioned, including the regulation of deer populations by wolves, which would lead to a reduction in tree damage (bark stripping, browsing). In addition, local businesses, such as butcher shops and stores that sell damage prevention (e.g., fences) and hunting equipment, were identified benefactors. Furthermore, the tourism sector was expected to benefit from increasing crane and European bison populations, which could lend itself to unique regional branding and provide eponyms for small businesses. Negative impacts in agriculture were perceived by all stakeholders in relation to the increased livestock depredation by wolves; crop and grassland damage by wild boars, cranes and European bison; and costs related to preventing and addressing such damage. In forestry, tree damage due to browsing and bark stripping by European bison was seen as problematic by all stakeholders. Furthermore, the local economy could suffer from the transmission of pathogens by wild boars, for example, ASF outbreaks force farmers to kill domestic pigs, and wolves might have negative effects on deer farms.

The reported ecological impacts pertaining to increasing wildlife populations were more heterogeneous. For example, rooting and digging by wild boars, if not too extensive, was perceived to enhance soil quality and provide new habitats for plants that depend on open/disturbed soils for seedlings to grow. The return of large herbivores, such as the European bison, was expected to keep landscapes open and enhance soil quality through fertilization, with positive effects on grassland. In addition, the return of wolves was thought to contribute to an improved prey–predator balance and better wildlife health. Few negative effects on biodiversity were anticipated. A possible loss of specific habitats (e.g., dry grass) was related to a decrease in shepherding due to increased wolf presence, and wolves' strong impact on prey species was also mentioned. The possibility of damage to peat lands and swamps as well as negative impacts on amphibians and ground-nesting birds were mentioned in relation to higher wild boar densities.

Considering the weighted preferences of each criterion (Table 1, third column) wildlife would contribute to the favored ecosystem service criteria in various ways, for example, quality of life (8.9, social indicator "happiness"), agricultural production (7.6, economic indicator "crop/livestock units"), and ecosystem processes (8.6, ecological indicator "supporting ecological processes").

3.2 | Step 2–System description and analysis through SEEDS

Step 1 of our integrated framework led to a wealth of information on different aspects of human–wildlife coexistence, including the identification of benefits (i.e., ecosystem services) and costs (i.e., ecosystem disservices) of HWC for different stakeholders. However, it remains unclear how these services and disservices affect the spatio-temporal distribution of HWC and how different stakeholder are affected. To fill this gap, we applied SEEDS, as demonstrated below, by organizing and analyzing the information collected in the FoPIA (Figure 1).

The system boundaries delineate the scope of the SEEDS analysis and refer to both spatial boundaries and the stakeholder groups and policy areas relevant for understanding human–wildlife interactions. Spatially, the system is located in Brandenburg, which is adjacent to Berlin and frequently visited by people coming from many parts of Germany. The wildlife species analyzed here are subject to European-level legislation (EEC, 1979, 1992) and are of interest to international conservation initiatives such as rewilding (Deinet et al., 2013). Therefore, the socioecological system needs to include not only local stakeholders but also regional, national and European stakeholders who are likely to benefit from wildlife ecosystem services and who advocate for conservation measures.

In line with FoPIA we used the same group of stakeholders across the four selected wildlife species (wild boar, crane, wolf, European bison) to assess the groups most likely to benefit from ecosystem services (ecosystem service recipients) and those most likely to experience ecosystem disservices (ecosystem disservice recipients) (Figure 4). Local non-farming businesses include businesses that sell fences, hunting equipment or wild meat and that are perceived to benefit through increased demand related to wildlife encroachment or increased hunting activity. Conservationists include people involved in conservation as amateur naturalists, NGO members, scientists and other professions. Their personal and professional interests may vary, and they may be focused on different taxa and habitats, leading to different perceptions of services and disservices within a landscape. For example, wild boar activity can support soil processes that favor certain plants, but they can also be detrimental to ground-nesting birds (Figure 4). Some ecosystem services and disservices, such as quality of life and decreased safety, are experienced throughout the population. In this case, the stakeholder group was identified as the general public, which includes all of the other stakeholder groups as well.

Examining both the spatial and temporal scales at which wildlife services and disservices are experienced is important for understanding the dynamics in human–wildlife systems (Figure 4). In this case, we took as reference point the time scales relevant to policy-makers and political actors. We use three categories for the temporal scale: short term (1–2 years—shorter than a political or policy appointment/term in office), medium term (3–7 years) and long term (over 7 years—longer than most political or policy appointments/terms in office; Figure 4). The temporal scale of ecosystem services or disservices is the estimated time period when they are first experienced. For example, farmers will experience the disservice of livestock depredation as a short-term effect of an increasing wolf population, while conservation effects, such as improved trophic balance, will be experienced only in the long-term (Figure 4).

We define four spatial scale levels: local, regional, national, and European (Figure 4). The local level represents Brandenburg state, the regional level includes Berlin and adjacent federal states within Germany, and the national and European levels represent Germany and Europe, respectively. We assigned these levels based on the residency of the stakeholder group receiving the services and disservices. For example, impacted farmers include local residents in Brandenburg, while tourists include residents from surrounding administrative units. We considered cultural identity to be a service that benefits stakeholders across three spatial scales: local, regional and national. Considering the European legislation regarding biodiversity conservation and cross-national conservation movements (e.g., rewilding), we considered

	Wildlife units	Services/Disservices	Service/Disservice recipients	Spatial scale	Temporal scale	Governance
Wild boar	• High reproductive rates • Absence of predators with the exception of the wolf • Able to profit from intensive agriculture (maize) • Milder winters	• Soil services • Wild meat • Prey	• Foresters • Hunters • Local non-farming businesses • Conservationists	L L L L, R, N, E	LT LT ST LT	• Cropland has mostly private owners • State owns approximately half of the forests • Crane, wolves and bisons are strictly protected • Farming interests are organized around associations of farmers • Hunters are organized in traditional hunter associations • Forestry interests are mainly represented by agents working at the highest level of the federal forest department of the State of Brandenburg • Conservationists are organized in several NGOs amng which the most influential is NABU
		• Crop damage • Grassland damage • Increased labour and prevention costs • Transmission of pathogens • Biodiversity and habitat damage	• Crop farmers • Livestock farmers • Hunters • Conservationists	L L L L, R, N, E	ST ST ST LT	
Crane	• Incresed migration • Able to profit from intensive agriculture (maize) • Milder winters • Wetland restauration	• Quality of life • Cultural identity	• General public • Tourists • Tourism business • Local non-farming businesses	L, R, N R L L	ST, LT MT MT ST	
		• Crop damage • Increased labour and prevention costs	• Crop farmers	L	ST	
Wolf	• Exponential growth • High prey densities • Available habitat	• Positive effects on forest production • Improved trophic balance and wildlife health • Reduced forest management costs • Reduced hunting efforts	• Forest managers • Forest owners • Hunters • Conservationists • Local non-farming businesses • General public	L L L L, R, N, E L L, R	LT LT MT LT ST LT	
		• Livestock losses • Increased labour and prevention costs • Perceived decreased in safety of children and pets • Negative effects on deer farms • Reduction of species of interest for hunters • Reduction in grassland habitats due to reduced shepharding	• Livestock farmers • Deer farmers • Hunters • General public • Conservationists	L L L L L, R, N, E	ST ST MT ST LT	
European bison	• Medium reproductive cycle • Expected to migrate from Poland • Available habitat	• Quality of life • Cultural identity • Grassland fertilization • Maintainance of open landscapes	• General public • Tourists • Tourism businesses • Local non-farming businesses • Livestock farmers • Conservationists	L, R, N R L L L L, R, N, E	LT MT MT LT LT LT	
		• Crop damage • Increased labour and prevention costs • Forest damage • Perceived decrease in safety	• Crop farmers • Forest managers • Forest owners • General public	L L L L	LT LT LT LT	

FIGURE 4 Human–wildlife system analysis based on the social–ecological framework of ecosystem services and disservices (SEEDS; E, European; L, local; LT, long term; MT, medium term; N, national; R, regional; ST, short term)

services and disservices related to conservation to span all spatial scales.

Brandenburg residents will overwhelmingly experience ecosystem disservices at the local level and in the immediate future, especially economic losses and increased work efforts. In terms of timescale, these costs will continue to be experienced in the medium and long-term. It is unlikely that people outside of Brandenburg will experience or pay the costs of these disservices to any significant extent. Brandenburg residents will experience an increase in regulating services such as soil services and the maintenance of open landscapes in the medium and long-term. They will also experience an increase in cultural services associated with cranes or European bison in the immediate future.

The tourism opportunities provided by increased biodiversity can also benefit local residents, but these tourism opportunities will likely be experienced on a longer time scale, as the rebranding of Brandenburg and the growth of tourism infrastructure will take a longer time. By the time residents notice these benefits, their opinions regarding these wildlife species might already be consolidated and difficult to change. At the same time, the economic benefits might be very differently distributed among the residents, with local hotels, guesthouses and restaurants benefiting more directly than local farmers. The tourists visiting Brandenburg will have an improved experience through the presence of cranes and European bison and through the knowledge that they are experiencing biodiverse landscapes where wolves, some of Europe's most emblematic carnivores, roam. Therefore, although cultural services will be produced locally, urban residents in Germany, especially Berlin, will be the ones who experience these services without any of the costs associated with crop and livestock depredation. Thus, the regional and national scales become relevant for the human–wildlife system in Brandenburg. Moreover, as rewilding becomes a topic of continental relevance in Europe, it is likely that these systems will also involve stakeholders at the continental level (Ceausu et al., 2015).

These spatial and temporal asymmetries between the experiences of services and disservice recipients have the potential to lead to human–human conflict around wildlife. For example, most of the stakeholders involved in our study perceived the recent population growth of cranes to be something positive. In contrast, the stakeholder group suffering from this increase, farmers, felt abandoned in process of addressing the substantial crop damage caused by cranes as one local farmer described:

> "Crane critters sound plaintive to me, and I feel annoyed that I can't really do anything about the crop damage they cause, as they are strictly protected"

(statement of a local farmer).

Based on our interviews, we also identified an important hierarchy of the services and disservices that is likely to dominate how people react to wildlife changes. Our participatory process highlighted that stakeholders are particularly concerned about "quality of life," "work," and the continued provisioning and integrity of "ecosystem processes." Agricultural land use was given the highest weight, above that of forestry, in the economic dimension, based on the argument that wildlife-induced damage is more severe for farms than for forests. This assertion might also be related to ownership and property rights because farms are usually run by private owners, while approximately half of German forests are state property.

3.2.1 | SEEDS: Governance analysis

The institutions and organizations that will be most affected include four groups: hunters, farmers, forestry agents, and conservationists. While the first group is represented by the German hunter association (DJV), including approximately 249,000 members in 2018 (https://www.jagdverband.de/), the second is represented by medium-scale, organic farmers with >600 ha destined for mixed cropping/cereal and livestock farming (e.g., Demeter https://www.demeter.de/ and Bioland https://www.bioland.de/ueber-uns.html). The third group includes agents working at the highest level of the federal forest department of the state of Brandenburg (https://forst.brandenburg.de/lfb/de/), and the fourth includes conservationists who belong to the most influential German NGO, NABU (https://en.nabu.de/). The stakeholder organizations and their positioning relative to governing and decision-making structures determine to a large extent their interest, influence and impact over conservation policies and management, which will inform and be further analyzed through the 3i framework.

Conservation policies are extensively based on European-level legislation such as the Habitat and Bird Directives (EEC, 1979, 1992). This legislation has been shown to be effective at improving the conservation status of targeted species (Sanderson et al., 2016). European legislation and other international biodiversity conventions constrain policy options at the national and regional scales in terms of lethal control and hunting (Trouwborst, Fleurke, & Linnell, 2017), especially in the case of wolves, European bison, and cranes. This might make local stakeholders feel disenfranchised and resentful. However, there are open policy options regarding the direction of compensation laws for agricultural and forestry losses, and alternatives can be trialed and improved before wildlife damage increases significantly. Livestock owners could also be supported in undertaking measures that reduce the vulnerability of their animals to wolf depredation, such as acquiring guard dogs or building better night shelters for their animals (Rigg et al., 2011). In this way, the imbalance in the benefits and costs of increased wildlife could be partially addressed by reducing the burden of ecosystem disservices for farmers and foresters. In terms of conservation outcomes, management plans could harmonize neighboring conservation areas even across borders to support the ecological needs of large-range species such as wolves and bison.

The increase in wildlife services can have economic benefits (Naidoo, Fisher, Manica, & Balmford, 2016) as well as health (Engemann et al., 2019) and cultural benefits (Booth, Gaston, Evans, & Armsworth, 2011). One way to avoid future conflict and navigate biodiversity change is to capture and distribute the benefits of these new wildlife services as broadly as possible through policies at the local, regional and national levels. Promoting a sense of ownership and enjoyment surrounding the new additions to Brandenburg landscapes through school programs and raising awareness, will ensure that the resident population will benefit fully from these new wildlife services. As Brandenburg is already a tourism destination, the possibility of using wildlife services as a driver of increased tourism activity offers credible opportunities that could be implemented by local authorities in collaboration with local businesses.

3.3 | Step 3—Analyzing stakeholder interest and preferences with the 3i approach

The final step of our integrated framework consists of assessing stakeholder interests, relative influence and the likely expected impact of research results, using the 3i approach (Table 2).

In Figure 1, we show how the three steps can be used iteratively. This includes the option to re-assess impacts in FoPIA and SEEDs analyses using revised system boundaries and scenarios based on insights from stakeholders identified in the 3i analysis (Dougill et al., 2006; Reed et al., 2009). However, as indicated in Figure 1, FoPIA may initially be informed via interviews with selected stakeholders, as was done in this research, before

TABLE 2 Stakeholder categories and self-assessment according to their level of interest, relative influence, and how research results are likely to lead to impacts for different stakeholders

Stakeholder category	Description	Example organizations/ groups	Number of example organizations/ groups identified	Interest (low, medium, high)	Influence (low, medium, high)	Impact (low, medium, high)
Arable farmers and their representative groups; here: Local organic farmer, Naturland and Demeter organic farming assoc.	Farmers who use their land to produce food (crops, meat, etc.) and biomass and their representative bodies	Brandenburg's Farmers' Association; German Farmers' Association (DBV) Bioland, Demeter, Naturland (organic farming associations)	6	Medium level of interest. Main focus is economic returns, whereas wildlife-induced damages are in third place after climatic (1) and market (2) effects that affect the farm economic situation	Rather low and only informal influence through connections to regional research institutions	Medium level of impact of research on setting standards for effectively implementing damage prevention measures
Conservationists and their representative groups; here: Conservationist, member of NABU (largest conservation NGO in Germany)	Conservation groups who own land on which they implement conservation measures	WWF, NABU, DBU, Brandenburg Wilderness Foundation, Heinz Sielmann Foundation, and so forth	>10	Highly interested in research on the status of biodiversity	Medium to high level of influence through the (direct) provision of monitoring data, awareness raising and public support, and political connections	High level of impact, by funding biodiversity projects, meeting strategic priorities and targets, ensuring benefits for nonhuman species and future generations
Forest owners and their representative groups; here: Regional forest district manager of the state forest administration	Forest owners who manage their land for wood production, conservation, hunting or recreation	Private forest owner association & entrepreneurship State forest administration, community forest management	5	Medium level of interest. Responsible for wildlife management and conservation (monitoring/ hunting). Interested in research on population density, biodiversity conservation and wildlife (i.e., deer) carrying capacities	Medium level of influence through direct exchanges with the state forest research unit, wildlife monitoring, habitat and tree damage data, participation in/ implementation of biodiversity research projects	Medium level of impact of research, for example, through studies on tree damage due to deer, which determines hunting measures

TABLE 2 (Continued)

Stakeholder category	Description	Example organizations/ groups	Number of example organizations/ groups identified	Interest (low, medium, high)	Influence (low, medium, high)	Impact (low, medium, high)
Hunters and their representative groups; here: Local hunter with rented hunting grounds, member of the German Hunting Association (DJV)—the largest hunting assoc. in Germany	Hunters who manage game professionally or for recreational purposes	German/federal hunting association (DJV/LJV) Ecological hunting association (ÖJV) Independent hunter	3	Medium to high level of interest in wildlife research/damage studies; main interest is recreation, wildlife management	Low to medium level of influence (implicit/ indirect): Providing data on local/regional wildlife populations; political connections	Medium to high level of impact, as hunting regulations are partly based on wildlife research, which may affect recreational benefits and meat harvest
Livestock farmers/ keepers and their representative groups; here: Independent, local shepherd, no organization	Livestock keepers who use land to farm or raise animals	Cattle rancher (suckler cows, dairy farms) Horse keeper Shepherd (fenced/ free range)	5	Medium level of interest in research on effective damage prevention through fencing, wildlife behavior, animal health (livestock health, transmission of pathogens through wildlife)	Low level of influence (implicit/indirect) through rare participation in research projects	Medium level of impact: Optimizing workflow, implementing effective fencing, and providing information on animal health

conducting a more in-depth stakeholder analysis using the 3i's approach. In this way, we started with a predefined group of stakeholders and conducted in-depth interviews to inform the FoPIA wildlife scenario narratives. We then conducted the stakeholder analysis by interviewing the same five stakeholders (organic farmer, NGO-conservationist, state-forester, private (wild boar) hunter, one semi transhumant shepherd) to (a) reflect on their individual "interest, influence, and impact" on HWC research and (b) assess the broader range of relevant (including potentially marginalized) stakeholders who are affected by, or influence HWCs in Brandenburg state. In this way, we were able to identify leverage points in the system that could be used to manage HWC more effectively in the state.

This stakeholder analysis allowed us to systematically identify and assess the relative interest and influence of stakeholders/groups who are affected by or have the capacity to affect decisions and research outcomes (Reed et al., 2009). Traditional stakeholder analysis based on the identification and classification of stakeholders according to their "interest and influence" in research has received criticism for being over simplistic and neglecting the importance of qualitative insights regarding the nature of stakeholder interest and influence or potential stakeholder benefits from the research, which is valuable for informing engagement (Reed et al., 2018; Reed & Curzon, 2015). Generally, stakeholder analysis is often used to prioritize high-interest and high-influence stakeholders ("*key players*"), justifying the exclusion of disinterested or low interest stakeholders in the research and decision-making processes.

The 3i approach broadens the scope of stakeholder engagement and deepens the analysis in two ways: first, through the addition of "impact" as a third criterion, and second, by considering each criterion—interest, influence and impact—on two levels in order to uncover deeper dynamics that may drive what is observable on the surface of the analysis (FastTrackImpact, 2019). The approach then asks three questions (in positive and negative forms) to structure the identification of stakeholders based on the three criteria (adapted to the HWC context):

1. *Interest*: Who is interested in HWC, and what is the nature of their interest? Who should be interested (based on their influence and/or impact), who is currently disinterested, and why are the latter not interested?
2. *Influence*: Who has the power to (indirectly) facilitate or block particular outcomes from HWCs?
3. *Impact*: Who is likely to benefit most, and who might be compromised or harmed by HWC?

The self-assessment of interest, influence and impact concerning HWC differed among the five stakeholder groups participating in this study, which are described and categorized as shown in Table 2 along with examples of organizations in each group. The 3i stakeholder analysis revealed that except for conservationists, who showed high interest, all participating stakeholders showed medium interest, indicating that HWC is a topic of concern but not one of utmost priority, as there are other topics of greater interest, such as the climate, markets, and price stability in the case of the organic farmer. While conservationists and foresters showed medium to high influence through the direct provision of monitoring data, their political connections and exchanges with research units, the organic farmers, hunters and livestock keepers showed low influence due to their informal and limited connections and rare participation in research projects.

Conservationists were the only stakeholder group that expected a high impact via funding for biodiversity projects and benefits for nonhuman species and future generations, while the remaining stakeholder groups expected a medium level of impacts. For practical reasons—as the main focus was to conceptualize the integrated framework, it was not possible to convene a workshop for this project.

While self-assessment by stakeholders provided valuable insights into the interests, influence and likely impacts on each stakeholder group, in future research, this would ideally be a starting point for a wider analysis of the stakeholder landscape, with the initial stakeholder group working together in a workshop setting to enable a more objective assessment and systematic representation of stakeholder interests in HWC initiatives.

4 | CONCLUSION

Human–wildlife systems are complex, and it is unlikely that a single conceptual framework can successfully address this complexity to identify and mitigate them. Here, we show that by combining three existing conceptual frameworks, we can advance the analysis of HWC beyond what one single framework can offer. The field of conservation has increasingly recognized the importance of diverse disciplinary perspectives in dealing with HWCs and, more generally, with conservation issues. This recognition has diversified expertise among conservation scholars who have enriched the field with conceptual and empirical advances on specific aspects of HWC. The step of integrating this diverse knowledge should not be ignored, and we provide here an approach that exemplifies the potential gains from knitting together existing conceptual frameworks.

As exemplified here through the case of Brandenburg state, Germany, the anticipatory analysis of human–wildlife systems can help managers steer adaptations and prepare stakeholders for biodiversity change. Avoiding human–human conflict surrounding wildlife species requires efforts to maintain communication between stakeholders and avoid the entrenchment of opposing views. For instance, there are already signs that stakeholders shouldering costs of the increased crane presence feel ignored by those who value that presence. The analysis identified an imbalance between the temporal and spatial scales at which ecosystem services and disservices are experienced and the need to address this imbalance through anticipatory policies such as encouraging tourism activities and implementing compensation schemes. These compensation schemes should be designed through the cooperation of businesses, conservation scientists, interested stakeholders, and local authorities in order to achieve the desired outcomes and correct any problems. However, the broad expertise needed to apply the three frameworks at the same time, the trade-offs between in-depth interviews and higher number of participants and interactive elements of group discussions shows the limitations when implementing and applying our framework. The trade-off between number and depth of interviews means that in-depth interviews will allow researchers to sample only a small numbers of people within each stakeholder group. Increasing the number of interviews will allow for a larger sample of interviewees but a more superficial understanding of each person's motivations and values. Therefore, our approach should be understood more as a holistic quick-scan tool, which can be used to identify and unfold major HWC issues—which may be subject for more detailed investigations at a finer scale if needed.

The results of this study highlight possible trade-offs related to wildlife that may occur between different stakeholder preferences in Brandenburg state. Follow up activities could focus on the assessment of alterative coping strategies used to target and minimize the negative impacts of HWC. Most promising coping strategies may also be subject to an economic quantification in terms of all relevant costs, including direct costs for coping measures, opportunity, and transaction costs (Barua, Bhagwat, & Jadhav, 2013). The realization of these follow up activities can be taken up by researchers and conservation practitioners, whereas results cannot be achieved without buy-in and collaboration from local/regional authorities, businesses, and other stakeholders.

Considering stakeholder needs is crucial for achieving a high level of acceptance of a proposed coping strategy and undertaking policy action solutions (Reed, 2008); moreover, research has taken on a new role in facilitating stakeholder participation processes in the domain of research-based decision support (König et al., 2015; La Rosa, Lorz, König, & Fürst, 2014; Spyra et al., 2018). Communicating the necessity of respective measures to stakeholders and citizens alike has been shown to be important for the success and acceptance of conservation measures, for example, species recovery. Thus, a key challenge that remains for conservationists and environmental managers is designing conservation measures that are as transparent and inclusive as possible, with the ideal aim of creating opportunities for stakeholders to actively engage in conservation activities (e.g., citizen science in opportunistic wildlife monitoring, engaging hunters in camera trap wildlife monitoring and conflict mitigation measures) and benefit from wildlife services. While HWC is partly the outcome of ecological process (Lamb et al., 2020), conflict also arises from human–human interactions that value different aspects of the wildlife services-disservices spectrum (Marshall, White, & Fischer, 2007). Wildlife management should, therefore, aim to address these stakeholder conflicts through round tables or joint conservation actions. The integrated, trifold framework introduced in this study can provide guidelines for systematically analyzing the multistage process of stakeholder participation and enable a holistic approach to tackling the complex challenge of HWCs.

ACKNOWLEDGMENTS

We thank the Marianne and Dr. Fritz Walter Fischer-Foundation and the Leibniz Centre for Agricultural Landscape Research for providing financial support for this study. We are particularly grateful for the stakeholders who were spending their time and sharing their valuable knowledge with the research team. We would also like to thank the anonymous reviewers for taking their time to read and assess this essay.

CONFLICT OF INTEREST

There is no conflict of interest.

AUTHOR CONTRIBUTIONS

The idea of this Essay was developed by Hannes König who wrote the major part of this manuscript. Silvia Ceausu was mainly responsible for the SEEDs part, Mark Reed and Helen Kendall for the 3i part. Luca Eufemia and Henrik Reinke contributed to the development of the tables. The other co-authors all contributed equally to specific parts to the essay such as analysis and development of figures, literature review and writing.

DATA AVAILABILITY STATEMENT

All relevant data are included in this article. Further details may be provided by the authors upon request.

ORCID

Hannes J. König https://orcid.org/0000-0002-4980-7388
Silvia Ceauşu https://orcid.org/0000-0002-6278-6075
Mark Reed https://orcid.org/0000-0002-8958-8474
Helen Kendall https://orcid.org/0000-0002-3921-0609
Karoline Hemminger https://orcid.org/0000-0003-1321-2224
Henrik Reinke https://orcid.org/0000-0003-3835-2864
Emu-Felicitas Ostermann-Miyashita https://orcid.org/0000-0002-5270-5737
Luca Eufemia https://orcid.org/0000-0002-0211-8526
Till Hermanns https://orcid.org/0000-0002-5211-5091
Marcin Spyra https://orcid.org/0000-0002-0551-9915
Tobias Kuemmerle https://orcid.org/0000-0002-9775-142X
Adam T. Ford https://orcid.org/0000-0003-2509-7980

ENDNOTE

[1] Crane: https://www.nabu.de/tiere-und-pflanzen/aktionen-und-projekte/vogel-des-jahres/1978-kranich/; European bison: http://dzika-zagroda.pl/?page_id=11&lang=en; Wolf: https://lfu.brandenburg.de/info/wolf; Wild boar: https://mluk.brandenburg.de/mluk/de/landwirtschaft/jagd/jagdstatistik.

REFERENCES

Agarwala, M., Kumar, S., Treves, A., & Naughton-Treves, L. (2010). Paying for wolves in Solapur, India and Wisconsin, USA: Comparing compensation rules and practice to understand the goals and politics of wolf conservation. *Biological Conservation*, *143*, 2945–2955.

Alcamo, J. (2001). *Scenarios as tools for international assessments* (no. 5). Copenhagen, Denmark.

Barua, M., Bhagwat, S. A., & Jadhav, S. (2013). The hidden dimensions of human–wildlife conflict: Health impacts, opportunity and transaction costs. *Biological Conservation*, *157*, 309–316.

Booth, J. E., Gaston, K. J., Evans, K. L., & Armsworth, P. R. (2011). The value of species rarity in biodiversity recreation: A birdwatching example. *Biological Conservation*, *144*, 2728–2732.

Burkhard, B., Kroll, F., Nedkov, S., & Müller, F. (2012). Mapping ecosystem service supply, demand and budgets. *Ecological Indicators*, *21*, 17–29.

Carter, N. H., & Linnell, J. D. C. (2016). Co-adaptation is key to coexisting with large carnivores. *Trends in Ecology & Evolution*, *31*, 575–578.

Carter, N. H., Riley, S. J., & Liu, J. (2012). Utility of a psychological framework for carnivore conservation. *Oryx*, *46*, 525–535.

Ceausu, S., Graves, R. A., Killion, A. K., Svenning, J. C., & Carter, N. H. (2019). Governing trade-offs in ecosystem services and disservices to achieve human–wildlife coexistence. *Conservation Biology*, *33*, 543–553.

Ceausu, S., Hofmann, M., Navarro, L. M., Carver, S., Verburg, P. H., & Pereira, H. M. (2015). Mapping opportunities and challenges for rewilding in Europe. *Conservation Biology*, *29*, 1017–1027.

Chapron, G., Kaczensky, P., Linnell, J. D., von Arx, M., Huber, D., Andren, H., Lopez-Bao, J. V., Adamec, M., Alvares, F., Anders, O., Balciauskas, L., Balys, V., Bedo, P., Bego, F., Blanco, J. C., Breitenmoser, U., Broseth, H., Bufka, L., Bunikyte, R., Ciucci, P., Dutsov, A., Engleder, T., Fuxjager, C., Groff, C., Holmala, K., Hoxha, B., Iliopoulos, Y., Ionescu, O., Jeremic, J., Jerina, K., Kluth, G., Knauer, F., Kojola, I., Kos, I., Krofel, M., Kubala, J., Kunovac, S., Kusak, J., Kutal, M., Liberg, O., Majic, A., Mannil, P., Manz, R., Marboutin, E., Marucco, F., Melovski, D., Mersini, K., Mertzanis, Y., Myslajek, R. W., Nowak, S., Odden, J., Ozolins, J., Palomero, G., Paunovic, M., Persson, J., Potocnik, H., Quenette, P. Y., Rauer, G., Reinhardt, I., Rigg, R., Ryser, A., Salvatori, V., Skrbinsek, T., Stojanov, A., Swenson, J. E., Szemethy, L., Trajce, A., Tsingarska-Sedefcheva, E., Vana, M., Veeroja, R., Wabakken, P., Wolfl, M., Wolfl, S., Zimmermann, F., Zlatanova, D., & Boitani, L. (2014). Recovery of large carnivores in Europe's modern human-dominated landscapes. *Science*, *346*, 1517–1519.

Crespin, S. J., & Simonetti, J. A. (2019). Reconciling farming and wild nature: Integrating human–wildlife coexistence into the land-sharing and land-sparing framework. *Ambio*, *48*, 131–138.

Crouch, M., & McKenzie, H. (2006). The logic of small samples in interview-based qualitative research. *Social Science Information*, *45*, 483–499.

Deinet, S., Ieronymidou, C., McRae, L., Burfield, I. J., Foppen, R. P., Collen, B., & Bohm, M. (2013). *Wildlife comeback in Europe: The recovery of selected mammal and bird species. Final report to Rewilding Europe by ZSL*. London, England: BirdLife International and the European Bird Census Council.

Dickman, A. J. (2010). Complexities of conflict: The importance of considering social factors for effectively resolving human–wildlife conflict. *Animal Conservation*, *13*, 458–466.

Dougill, A. J., Fraser, E. D .G., Holden, J., Hubacek, K., Prell, C., Reed, M. S., & Stringer, L. C. (2006). Learning from doing participatory rural research: Lessons from the Peak District National Park. *Journal of Agricultural Economics*, *57*, 259–275.

EEC. (1979). *Council directive 79/409/EEC on the conservation of wild birds*.

EEC. (1992). *EU habitats directive (92/43/EEC)*.

Engemann, K., Pedersen, C. B., Arge, L., Tsirogiannis, C., Mortensen, P. B., & Svenning, J. C. (2019). Residential green space in childhood is associated with lower risk of psychiatric disorders from adolescence into adulthood. *Proceedings of the National Academy of Sciences of the United States of America*, *116*, 5188–5193.

FastTrackImpact. (2019). *3 i's advanced stakeholder analysis*. Retrieved from https://www.fasttrackimpact.com/post/2019/11/19/3-i-s-stakeholder-analysis-advanced-analysis-reveals-more-than-ever-before-about-who-yo

Gortazar, C., Ferroglio, E., Hofle, U., Frolich, K., & Vicente, J. (2007). Diseases shared between wildlife and livestock: A European perspective. *European Journal of Wildlife Research*, *53*, 241–256.

Helming, K., Diehl, K., Bach, H., Dilly, O., König, B., Kuhlman, T., … Wiggering, H. (2011). Ex ante impact assessment of policies affecting land use, part a: Analytical framework. *Ecology and Society*, *16*, 27.

Helming, K., Diehl, K., Kuhlman, T., Jansson, T., Verburg, P. H., Bakker, M., … Wiggering, H. (2011). Ex ante impact assessment of policies affecting land use, part B: Application of the analytical framework. *Ecology and Society*, *16*, 29.

Henle, K., Ring, I., Klenke, R. A., Jepsen, N., Kranz, A., Neßhöver, C., & Rauschmayer, F. (2013). A generic framework for the development of conflict reconciliation action plans. In R. A. Klenke, I. Ring, A. Kranz, N. Jepsen, F. Rauschmayer, & K. Henle (Eds.), *Human–wildlife conflicts in Europe* (pp. 215–219). In: Springer, Berlin, Heidelberg.

Hermanns, T., Helming, K., König, H. J., Schmidt, K., Li, Q., & Faust, H. (2017). Sustainability impact assessment of peatland-use scenarios: Confronting land use supply with demand. *Ecosystem Services*, *26*, 365–376.

Hill, C. M. (2015). Perspectives of "conflict" at the wildlife–agriculture boundary: 10 years on. *Human Dimensions of Wildlife*, *20*, 296–301.

Hill, C. M., Webber, A. D., & Priston, N. E. C. (2017). *Understanding conflicts about wildlife: A biosocial approach*. New York, NY: Berghahn.

Inskip, C., & Zimmermann, A. (2009). Human-felid conflict: A review of patterns and priorities worldwide. *Oryx*, *43*, 18–34.

König, H., Podhora, A., Zhen, L., Helming, K., Yan, H., Du, B., … Uthes, S. (2015). Knowledge brokerage for impact assessment of land use scenarios in Inner Mongolia, China: Extending and testing the FoPIA approach. *Sustainability*, *7*, 5027–5049.

König, H. J., Graef, F., Schindler, J., Fasse, A., Mutabazi, K. D., Lambert, C., … Sieber, S. (2017). Combining participatory, qualitative and quantitative methods for impact assessment of food value chains into an integrated framework. *Food Security*, *9*, 1309–1321.

König, H. J., Kiffner, C., Kramer-Schadt, S., Furst, C., Keuling, O., & Ford, A. T. (2020). Human–wildlife coexistence in a changing world. *Conservation Biology*, *34*, 786–794. https://doi.org/10.1111/cobi.13513

König, H. J., Uthes, S., Schuler, J., Zhen, L., Purushothaman, S., Suarma, U., … Wiggering, H. (2013). Regional impact assessment of land use scenarios in developing countries using the FoPIA approach: Findings from five case studies. *Journal of Environmental Management*, *127*, S56–S64.

König, H. J., Zhen, L., Helming, K., Uthes, S., Yang, L., Cao, X., & Wiggering, H. (2014). Assessing the impact of the sloping land conversion programme on rural sustainability in Guyuan, Western China. *Land Degradation and Development*, *25*, 385–396.

Kuemmerle, T., Levers, C., Bleyhl, B., Olech, W., Perzanowski, K., Reusch, C., & Kramer-Schadt, S. (2018). One size does not fit all: European bison habitat selection across herds and spatial scales. *Landscape Ecology*, *33*, 1559–1572.

La Rosa, D., Lorz, C., König, H. J., & Fürst, C. (2014). Spatial information and participation in socio-ecological systems: Experiences, tools and lessons learned for land-use planning. *iForest – Biogeosciences and Forestry*, *7*, 386–389.

Lamb, C. T., Ford, A. T., McLellan, B. N., Proctor, M. F., Mowat, G., Ciarniello, L., … Boutin, S. (2020). The ecology of human–carnivore coexistence. *Proceedings of the National Academy of Sciences*, *117*, 17876–17883.

Lischka, S. A., Teel, T. L., Johnson, H. E., Reed, S. E., Breck, S., Don Carlos, A., & Crooks, K. R. (2018). A conceptual model for the integration of social and ecological information to understand human–wildlife interactions. *Biological Conservation*, *225*, 80–87.

Maes, J., Liquete, C., Teller, A., Erhard, M., Paracchini, M. L., Barredo, J. I., … Lavalle, C. (2016). An indicator framework for assessing ecosystem services in support of the EU Biodiversity Strategy to 2020. *Ecosystem Services*, *17*, 14–23.

Marshall, K., White, R., & Fischer, A. (2007). Conflicts between humans over wildlife management: On the diversity of stakeholder attitudes and implications for conflict management. *Biodiversity and Conservation*, *16*, 3129–3146.

Massei, G., Kindberg, J., Licoppe, A., Gačić, D., Šprem, N., Kamler, J., … Náhlik, A. (2015). Wild boar populations up, numbers of hunters down? A review of trends and implications for Europe. *Pest Management Science*, *71*, 492–500.

McCleery, R. A. (2009). Improving attitudinal frameworks to predict behaviors in human–wildlife conflicts. *Society and Natural Resources*, *22*, 353–368.

MEA. (2005). *Millennium ecosystem assessment. Ecosystems and human well-being: Biodiversity synthesis*. Washington DC: World Resource Institute.

Morehouse, A. T., & Boyce, M. S. (2017). Troublemaking carnivores: Conflicts with humans in a diverse assemblage of large carnivores. *Ecology and Society*, *22*, 4.

Morris, J., Tassone, V., De Groot, R., Camilleri, M., & Moncada, S. (2011). A framework for participatory impact assessment' (FoPIA): Involving stakeholders in European policy-making, a case study of land use change in Malta. *Ecology and Society*, *16*, 411373.

Morzillo, A. T., de Beurs, K. M., & Martin-Mikle, C. J. (2014). A conceptual framework to evaluate human–wildlife interactions within coupled human and natural systems. *Ecology and Society*, *19*, 44.

Naidoo, R., Fisher, B., Manica, A., & Balmford, A. (2016). Estimating economic losses to tourism in Africa from the illegal killing of elephants. *Nature Communications*, *7*, 13379.

Navarro, L. M., & Pereira, H. M. (2012). Rewilding abandoned landscapes in Europe. Ecosystems, *15*, 900–912.

Nilsson, L., Bunnefeld, N., Persson, J., & Månsson, J. (2016). Large grazing birds and agriculture—Predicting field use of common cranes and implications for crop damage prevention. *Agriculture, Ecosystems and Environment*, *219*, 163–170.

Nyhus, P. J. (2016). Human–wildlife conflict and coexistence. *Annual Review of Environment and Resources*, *41*, 143–171.

Ostrom, E. (2007). A diagnostic approach for going beyond panaceas. *Proceedings of the National Academy of Sciences of the United States of America*, *104*, 15181–15187.

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science*, *325*, 419–422.

Paracchini, M. L., Pacini, C., Jones, M. L. M., & Perez-Soba, M. (2011). An aggregation framework to link indicators associated with multifunctional land use to the stakeholder evaluation of policy options. *Ecological Indicators*, *11*, 71–80.

Pérez-Soba, M., Petit, S., Jones, L., Bertrand, N., Briquel, V., Omodei-Zorini, L., … Groot, R. (2008). *Land use functions - a multifunctionality approach to assess the impact of land use changes on land use sustainability*. Berlin-Heidelberg: Springer.

Peterson, M. N., Birckhead, J. L., Leong, K., Peterson, M. J., & Peterson, T. R. (2010). Rearticulating the myth of human–wildlife conflict. *Conservation Letters*, *3*, 74–82.

Redpath, S. M., Bhatia, S., & Young, J. (2015). Tilting at wildlife: Reconsidering human–wildlife conflict. *Oryx*, *49*, 222–225.

Reed, M. S. (2008). Stakeholder participation for environmental management: A literature review. *Biological Conservation*, *141*, 2417–2431.

Reed, M. S., Bryce, R., & Machen, R. (2018). Pathways to policy impact: A new approach for planning and evidencing research impact. *Evidence and Policy: Journal of Research, Debate, and Practice*, *14*, 431–458.

Reed, M. S., & Curzon, R. (2015). Stakeholder mapping for the governance of biosecurity: A literature review. *Journal of Integrative Environmental Sciences*, *12*, 15–38.

Reed, M. S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., … Stringer, L. C. (2009). Who's in and why? A typology of stakeholder analysis methods for natural resource management. *Journal of Environmental Management*, *90*, 1933–1949.

Reed, M. S., Kenter, J., Bonn, A., Broad, K., Burt, T. P., Fazey, I. R., … Ravera, F. (2013). Participatory scenario development for environmental management: A methodological framework illustrated with experience from the UKuplands. *Journal of Environmental Management*, *128*, 345–362.

Rees, M. W., Carwardine, J., Reeson, A., & Firn, J. (2020). Rapidly assessing cobenefits to advance threat-management alliances. *Conservation Biology*, *34*, 843–853.

Reidsma, P., König, H., Feng, S., Bezlepkina, I., Nesheim, I., Bonin, M., … Brouwer, F. (2011). Methods and tools for integrated assessment of land use policies on sustainable development in developing countries. *Land Use Policy*, *28*, 604–617.

Reinhardt, I., Kluth, G., Nowak, C., Szentiks, C. A., Krone, O., Ansorge, H., & Mueller, T. (2019). Military training areas facilitate the recolonization of wolves in Germany. *Conservation Letters*, *12*, e12635.

Rigg, R., Find'o, S., Wechselberger, M., Gorman, M. L., Sillero-Zubiri, C., & Macdonald, D. W. (2011). Mitigating carnivore–livestock conflict in Europe: Lessons from Slovakia. *Oryx*, *45*, 272–280.

Sanderson, F. J., Pople, R. G., Ieronymidou, C., Burfield, I. J., Gregory, R. D., Willis, S. G., … Donald, P. F. (2016). Assessing the performance of EU nature legislation in protecting target bird species in an era of climate change. *Conservation Letters*, *9*, 172–180.

Seoraj-Pillai, N., & Pillay, N. (2017). A meta-analysis of human–wildlife conflict: South African and global perspectives. *Sustainability*, *9*, 34.

Snyder, K. D., & Rentsch, D. (2020). Rethinking assessment of success of mitigation strategies for elephant-induced crop damage. *Conservation Biology*, *34*, 829–842. https://doi.org/10.1111/cobi.13433

Spyra, M., Kleemann, J., Cetin, N. I., Navarrete, C. J. V., Albert, C., Palacios-Agundez, I., … Fürst, C. (2018). The ecosystem services concept: A new Esperanto to facilitate participatory planning processes? *Landscape Ecology*, *34*, 1715–1735.

Stillfried, M., Gras, P., Börner, K., Göritz, F., Painer, J., Röllig, K., … Kramer-Schadt, S. (2017). Secrets of success in a landscape of fear: Urban wild boar adjust risk perception and tolerate disturbance. *Frontiers in Ecology and Evolution*, *5*, 157.

Sun, C., Xu, S., Qi, W., Chen, C., Deng, Y., Pei, N., & König, H. J. (2019). Biodiversity constraint indicator establishment and its optimization for urban growth: Framework and application. *Environmental Research Letters*, *14*, 125006.

TEEB Synthesis. (2010). *Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions and Recommendations of TEEB*. London and Washington, DC: Earthscan.

Tsunoda, H., Enari, H. (2020) A strategy for wildlife management in depopulating rural areas of Japan. *Conservation Biology*, *34*, 819–828.

Treves, A., Wallace, R. B., & White, S. (2009). Participatory planning of interventions to mitigate human–wildlife conflicts. *Conservation Biology*, *23*, 1577–1587.

Trouwborst, A., Fleurke, F. M., & Linnell, J. D. C. (2017). Norway's wolf policy and the Bern convention on European wildlife: Avoiding the "manifestly absurd". *Journal of International Wildlife Law Policy*, *20*, 155–167.

Uthes, S., Kelly, E., & König, H. J. (2020). Farm-level indicators for crop and landscape diversity derived from agricultural beneficiaries data. *Ecological Indicators*, *108*, 105725.

Vetter, S. G., Ruf, T., Bieber, C., & Arnold, W. (2015). What is a mild winter? Regional differences in within-species responses to climate change. *PLoS One*, *10*, e0132178.

Wilkinson, C. E., McInturff, A., Miller, J. R. B., Yovovich, V., Gaynor, K. M., Calhoun, K., … Brashares, J. S. (2020). An ecological framework for contextualizing carnivore–livestock conflict. *Conservation Biology*, *34*, 854–867.

Woodroffe, R., Thirgood, S., & Rabinowitz, A. (2005). *People and wildlife, conflict or co-existence?*. Cambridge: Cambridge University Press.

How to cite this article: König HJ, Ceauşu S, Reed M, et al. Integrated framework for stakeholder participation: Methods and tools for identifying and addressing human–wildlife conflicts. *Conservation Science and Practice*. 2021; e399. https://doi.org/10.1111/csp2.399