Received: 24 February 2021 | Accepted: 25 February 2021

DOI: 10.1111/csp2.401

EDITORIAL

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

Human–wildlife coexistence in science and practice

Human–wildlife interactions shape human cultures, animal communities, and species evolution. They are ubiquitous, diverse in nature, leading to desirable and undesirable consequences (Frank, Glikman, & Marchini, 2019; Nyhus, 2016). The human–wildlife interface is dynamic; emerging where humans expand into natural habitats or where wildlife populations expand into human-dominated areas. For example, human–wildlife interactions increased through better habitat protection, climate change induced range shifts, and where agricultural lands provide food and shelter to wildlife (König et al., 2020). Agricultural landscapes, because of the amplification of food production and relatively low-density human population, are a major arena for human–wildlife interactions. From an anthropocentric perspective, wildlife provides both benefits and costs. Benefits include ecosystem services such as pollination, seed dispersal, pathogen control, recreational value and income through tourism (Power, 2010). Disservices include damage to livestock, crops, pathogen transmission, or loss of human life (Ceauşu, Graves, Killion, Svenning, & Carter, 2019; Swinton, Lupi, Robertson, & Hamilton, 2007). Effectively and equitably governing these ecosystem service tradeoffs remains a key challenge to sustainably sharing landscapes with wildlife in agricultural landscapes (Redpath et al., 2013).

Coexistence science is challenging because it is fundamentally multidimensional and comprises complex interactions and feedbacks. In the last decades, research on human–wildlife coexistence has rapidly increased (König et al., 2020). Consolidating insights from those studies to achieve sustainable coexistence on the ground remains a formidable challenge (Carter & Linnell, 2016; Lamb et al., 2020; Lute, Carter, López-Bao, & Linnell, 2018).

Human–wildlife interactions are often framed as human–wildlife conflicts, yet this likely overly-simplifies a more complex and nuanced array of interactions (Mason et al., 2018; Redpath, Gutiérrez, Wood, & Young, 2015). Evidence-based conservation typically addresses such problems by systematically reviewing the scientific knowledge base and synthesizing the findings (Sutherland et al., 2020). While systematic assessments have addressed specific issues of human–wildlife interactions (Eklund, López-Bao, Tourani, Chapron, & Frank, 2017), they also suggest that generalizations and predictions of conservation outcomes are often elusive. Achieving coexistence in practice is difficult, being influenced by a plethora of forces, including local histories, political dynamics, and uncertainty. Integrating place-based knowledge with applied conservation science can generate new insights that may help achieve human–wildlife coexistence in a changing world.

This special issue "*Methods for integrated assessment of human–wildlife interactions and coexistence in agricultural landscapes*" features a collection of articles proposing, implementing and reviewing a variety of interdisciplinary, socioecological tools for addressing human–wildlife conflicts (Table 1). The case studies and tools proposed here support conservation practice in the context of agricultural landscapes, where benefits and costs of wildlife are experienced within the same area but distributed unevenly among different groups of people. The articles in this special issue introduce suitable and interdisciplinary toolsets that support the assessment of human–wildlife interactions and promote human–wildlife coexistence. In addition, the case studies highlight the inherent complexity of human–wildlife interactions. In total, this issue features 13 contributions, including three perspective essays, and 10 research papers.

1 | NEW PERSPECTIVES ON HUMAN–WILDLIFE COEXISTENCE

How we study human–wildlife coexistence evolves alongside our strategies for reducing conflict and amplifying benefits. Three papers in this issue touch on this evolving scholarship. van Eeden, Dickman, et al. (2021) propose a theory of change framework for promoting coexistence between dingoes and livestock,

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., Ceauşu, S., Kiffner, C., Lamb, C., Ford, A. T.

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TABLE 1 Topical summary of the 13 articles featured in the special issue "*Methods for integrated assessment of human–wildlife interactions and coexistence in agricultural landscapes*"

Reference	Topic	Geographic region	Wildlife species	Stakeholder involvement	Method
van Eeden, Dickman, Crowther, and Newsome (2021)	Developing a ToC to promote coexistence between livestock producers and dingoes in Australia	Australia	Australian dingo (*Canis* spec.)	Australian public; Aboriginal people Policy makers Livestock sector	ToC to promote coexistence between livestock producers and dingoes in Australia
König et al. (2021)	Developing a framework for integrated assessments of human–wildlife conflicts	Brandenburg state (Germany)	European bison (*Bos bonasus*), common crane (*Grus grus*), wild boar (*Sus scrofa*), gray wolf (*Canis lupus*)	Land users	Participatory methods, semiquantitative, FoPIA-SEEDS-3i
Osterman-Miyashita, Pernat, and König (2021)	Mobilizing the wide public to address human–wildlife conflict	Global review (United States, EU, Africa, Australia)	Gray wolf (Canis lupus), coyote (*Canis latrans*), African elephant (*Loxodonta africana*) and others	General public	Citizen science, review
Jin et al. (2021)	Identifying key stakeholders for the conservation of crane species	Civilian Control Zone (Republic of Korea)	White-naped crane (*Antigone vipio*), red-crowned crane (*Grus japonensis*)	Farmers and farming enterprises, local and national governance agencies in agencies in agriculture and environment, national and international NGOs supporting wildlife conservation, research institutions, tourism industry	Net-map, social network analysis of semiquantitative interviews
van Eeden, Rabotyagov, et al. (2021)	Assessing attitudes toward wolves, ranching, wolf-livestock coexistence, and wolf management methods	Washington state (United States)	Gray wolf (*Canis lupus*)	Residents of Washington state	Online survey ($N = 420$)
Martin (2021)	Adaptive governance of the Wood-River wolf project	Idaho (United States)	Gray wolf (*Canis lupus*)	Project partners and related stakeholders, including ranchers, government officials	40 semistructured interviews, qualitative analysis

TABLE 1 (Continued)

Reference	Topic	Geographic region	Wildlife species	Stakeholder involvement	Method
McInturff, Miller, Gaynor, and Brashares (2021)	Social–ecological approach to map risk of sheep predation by coyotes	California (United States)	Coyote (*Canis latrans*)	Current and former livestock producers from the study area	Combining social and ecological information to model predation risk
Delclaux and Fleury (2021)	Media coverage of the biodiversity-agricultural interface	France (EU)	Bee (*Apis mellifera*), gray wolf (*Canis lupus*), brown bear (*Ursus arctos*) and 26 others	Multiple	Content analysis of newspaper and descriptive statistics
Plaschke et al. (2021)	Ecological effectiveness of green bridges	Brandenburg state (Germany)	Gray wolf (*Canis lupus*), red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*)	Federal forest department	Camera traps, quantitative analysis
Barzen, Gossens, Lacy, and Yandell (2021)	Effect of deterrence strategies on resource selection of cranes	Wisconsin (United States)	Greater sandhill crane (*Grus canadensis tabida*)	Crane foundation, seed corporation	Resource selection studies at multiple scales
Kiffner et al. (2021)	Integrated assessment of methods to mitigate crop raiding by African elephants	Karatu district bordering Ngorongoro Conservation Area (Tanzania)	African elephants (*Loxodonta africana*)	Subsistence farmers and rural residents	Combining social and ecological information to assess the effectiveness and adoption potential of methods to reduce crop raiding
Marino et al. (2021)	Parameterizing a WTM for multiple species	Abruzzo (Italy)	Brown bear (*Ursus arctos*), gray wolf (*Canis lupus*)	Rural residents who farmed for either commercial or noncommercial purposes	Interviews, WTM as the framework to define tolerance and identify correlates of tolerance
Kansky, Kidd, and Fischer (2021)	Parameterizing a WTM for multiple species	Transboundary conservation complex in Namibia and Zambia	African lion (*Panthera leo*), African elephant (*Loxodonta africana*), spotted hyena (*Crocuta crocuta*), greater kudu (*Tragelaphus strepsiceros*), chacma baboon (*Papio ursinus*)	Rural residents in Namibia and Zambia	Interviews, WTM as the framework to define tolerance and identify correlates of tolerance

Abbreviations: ToC, theory of change; WTM, wildlife tolerance model.

and highlight the importance of an evidence-based understanding of the barriers and opportunities to changing human behavior toward wildlife. König et al. (2021), present an integrated assessment framework that provides guidelines for systematically analyzing the multistage process of stakeholder participation, enabling a holistic approach for addressing the complex challenge of human–wildlife conflicts. Finally, Osterman-Miyashita et al. (2021) emphasize opportunities that Citizen Science offers in the field of monitoring and managing human–wildlife interactions.

2 | SOCIAL–ECOLOGICAL APPROACHES TOWARD COEXISTENCE

For conservation science to provide actionable scholarship in support of human–wildlife coexistence will require social–ecological approaches to theory, multidisciplinary assessments and case studies.

Understanding stakeholder concerns and action is one primary vector of interest. Jin et al. (2021) mapped stakeholder networks, and revealed that trust between stakeholders and fair benefit sharing are key for coexistence between humans and two threatened crane species in Korea. van Eeden, Rabotyagov, et al. (2021) identified political ideology as critical in stakeholder conflicts while examining human-wolf conflicts in the United States. Also examining human-wolf conflict in the United States, Martin (2021) shows that openly addressing struggles in project implementation can provide important lessons for practitioners in landscapes recolonized by wolves. McInturff et al. (2021) combine ecological information and stakeholder perception to map predation risk and show that integrated social–ecological approaches improve the management opportunities for reducing livestock depredation by carnivores. Delclaux and Fleury (2021) describe dynamic changes in media coverage of the biodiversity-agriculture theme and how these changes are related to environmental issues and political events.

We also need to enhance our understanding of interventions on human–wildlife interactions. Plaschke et al. (2021) show that strategically planned overpasses can effectively enable connectivity and recolonization of wolves and their prey in human-dominated landscapes in Germany. Barzen et al. (2021) analyze nonlethal mitigation methods for reducing yield loss by Greater Sandhill cranes. Kiffner et al. (2021) tested the effectiveness of chili and beehive fences in reducing crop raiding by African elephants and found that chili fences had higher acceptability of implementation and reduced crop damage. Marino et al. (2021) investigated human tolerance for potentially problem-causing species such as brown bears and wolves in Italy. Kansky et al. (2021) assessed tolerance toward multiple wildlife species in the Kavango-Zambezi Transfrontier Conservation Area. Both studies found that human tolerance for wildlife was both species and area specific. While many factors may be associated with tolerance for a given species, increasing tangible and intangible benefits and reducing tangible and intangible costs are key for increasing tolerance.

3 | CONCLUSIONS

By highlighting advances in assessing, evaluating, and managing human–wildlife interactions, this special issue emphasizes the advantages of system thinking and employing holistic and transdisciplinary approaches. While such integrated approaches are unlikely to fully resolve the complex and unique nature of most human–wildlife interactions, they will contribute toward making better decisions while promoting human–wildlife coexistence.

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REFERENCES

Barzen, J. A., Gossens, A. P., Lacy, A. E., & Yandell, B. S. (2021). Applying hierarchical resource selection concepts to solving crop damage caused by birds. *Conservation Science and Practice*, e207.

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

Ceaușu, 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.

Delclaux, J., & Fleury, P. (2021). Medium-term evolution in French national newspaper coverage of the interrelations between biodiversity and agriculture. *Conservation Science and Practice*, e140.

Eklund, A., López-Bao, J. V., Tourani, M., Chapron, G., & Frank, J. (2017). Limited evidence on the effectiveness of interventions to reduce livestock predation by large carnivores. *Scientific Reports*, *7*, 2097.

Frank, B., Glikman, J. A., & Marchini, S. (2019). *Human-wildlife interactions: Turning conflict into coexistence*. Cambridge: Cambridge University Press.

Jin, H., Hemminger, K., Fong, J., Sattler, C., SueKyoung, L., Bieling, C., & König, H. J. (2021). Revealing stakeholders' motivation and influence in crane conservation in the Republic of Korea: Net-map as a tool. *Conservation Science and Practice*, e384.

Kansky, R., Kidd, M., & Fischer, J. (2021). Does money "buy" tolerance toward damage-causing wildlife ? *Conservation Science and Practice*, e262.

Kiffner, C., Schaal, I., Cass, L., Peirce, K., Sussman, O., Grueser, A., … Kioko, J. (2021). Perceptions and realities of elephant crop raiding and mitigation methods. *Conservation Science and Practice*, e372.

König, H. J., Kiffner, C., Kramer-Schadt, S., Fürst, C., Keuling, O., & Ford, A. T. (2020). Human–wildlife coexistence in a changing world. *Conservation Biology*, *34*, 786–794.

König, H. J., Ceaușu, S., Reed, M., Kendall, H., Hemminger, K., Reinke, H., … Ford, A. T. (2021). Integrated framework for stakeholder participation in identifying and addressing human-wildlife conflicts. *Conservation Science and Practice*.

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 of the United States of America*, *117*, 17876–17883.

Lute, M. L., Carter, N. H., López-Bao, J. V., & Linnell, J. D. C. (2018). Conservation professionals agree on challenges to coexisting with large carnivores but not on solutions. *Biological Conservation*, *218*, 223–232.

Marino, F., Kansky, R., Shivji, I., di Croce, A., Ciucci, P., & Knight, A. T. (2021). Understanding drivers of human tolerance to gray wolves and brown bears as a strategy to improve landholder–carnivore coexistence. *Conservation Science and Practice*, e265.

Martin, J. V. (2021). Peace in the valley? Qualitative insights on collaborative coexistence from the Wood River Wolf Project. *Conservation Science and Practice*, e197.

Mason, T. H. E., Pollard, C. R. J., Chimalakonda, D., Guerrero, A. M., Kerr-Smith, C., Milheiras, S. A. G., … Bunnefeld, N. (2018). Wicked conflict: Using wicked problem thinking for holistic management of conservation conflict. *Conservation Letters*, *11*, 1–9.

McInturff, A., Miller, J. R. B., Gaynor, K. M., & Brashares, J. S. (2021). Patterns of coyote predation on sheep in California: A socio-ecological approach to mapping risk of livestock-predator conflict. *Conservation Science and Practice*, e175.

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

Osterman-Miyashita, E. F., Pernat, N., & König, H. J. (2021). Citizen science as a bottom-up solution to human-wildlife conflicts: From theories and methods to practical implications. *Conservation Science and Practice*, e385.

Plaschke, M., Bhardwaj, M., König, H. J., Wenz, E., Dobias, K., & Ford, A. T. (2021). Green bridges in a re-colonizing landscape: Wolves (*Canis lupus*) in Brandenburg, Germany. *Conservation Science and Practice*, e364.

Power, A. G. (2010). Ecosystem services and agriculture: Tradeoffs and synergies. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*, 2959–2971.

Redpath, S. M., Gutiérrez, R. J., Wood, K. A., & Young, J. C. (2015). *Conflicts in conservation: Navigating towards solutions*. Cambridge: Cambridge University Press.

Redpath, S. M., Young, J., Evely, A., Adams, W. M., Sutherland, W. J., Whitehouse, A., … Gutiérrez, R. J. (2013). Understanding and managing conservation conflicts. *Trends in Ecology and Evolution*, *28*, 100–109.

Sutherland, W. J., Alvarez-Castañeda, S. T., Amano, T., Ambrosini, R., Atkinson, P., Baxter, J. M., … Wordley, C. (2020). Ensuring tests of conservation interventions build on existing literature. *Conservation Biology*, *34*, 781–783.

Swinton, S. M., Lupi, F., Robertson, G. P., & Hamilton, S. K. (2007). Ecosystem services and agriculture: Cultivating agricultural ecosystems for diverse benefits. *Ecological Economics*, *64*, 245–252.

van Eeden, L., Dickman, C., Crowther, M., & Newsome, N. (2021). A theory of change for promoting coexistence between dingoes and livestock production. *Conservation Science and Practice*, e304.

van Eeden, L., Rabotyagov, S., Kather, M., Bogezi, C., Wirsing, A., & Marzluff, J. (2021). Political affiliation predicts public attitudes toward gray wolf (*Canis lupus*) conservation and management. *Conservation Science and Practice*, e137.