König Hannes (Orcid ID: 0000-0002-4980-7388)
Ford Adam (Orcid ID: 0000-0003-2509-7980)

Human-wildlife coexistence in science and practice

Perspectives and Notes: Special issue "Methods for integrated assessment of human-wildlife interactions and coexistence in agricultural landscapes" in Conservation Science & Practice

Authors: König, H.J.*, Carter, N., Ceausu, S., Lamb, C., Ford, A.T., Kiffner, C.

*Corresponding author: hkoenig@zalf.de

Human-wildlife interactions shape human cultures, animal communities, and species evolution. They are ubiquitous, diverse in nature, leading to desirable and undesirable consequences (Nyhus 2016; Frank et al. 2019). 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 (Swinton et al. 2007; Ceauşu et al. 2019). 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; Lute et al. 2018, Lamb et al. 2020).

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Human-wildlife interactions are often framed as human-wildlife conflicts, yet this likely overly-simplifies a more complex and nuanced array of interactions (Redpath et al. 2015; Mason et al. 2018). 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 et al. 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, socio-ecological 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 fourteen contributions, including three perspective essays, and eleven research papers.

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 et al. (202*1*) propose a theory of change framework for promoting coexistence between dingoes and livestock, and highlight the importance of an evidence-based understanding of the barriers and opportunities to changing human behavior towards wildlife. König et al. (2021), present an integrated assessment framework that provides guidelines for systematically analyzing the multi-stage 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.

Social-ecological approaches towards 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. Young et al. (2021), emphasize the need to consider *stakesharers* when addressing a conservation crisis such as the rapid decline of Eurasian curlew in Ireland. Van Eeden et al. (2021) identified political ideology as critical in stakeholder conflicts while examining human-wolf conflicts in the U.S. Also examining human-wolf conflict in the U.S., Martin (2021) show 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 non-lethal 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 towards 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.

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 towards making better decisions while promoting human-wildlife coexistence.

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Table 1: Topical summary of the fourteen 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 et al. 2021	Developing a Theory of Change (ToC) to promote coexistence between livestock producers and dingoes in Australia.	Australia	Australian dingo (*Canis* spec.)	Australian public Aboriginal people Policy makers Livestock sector	Theory of Change (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, semi-quantitative, FoPIA-SEEDS-3i
Ostermann-Miyashita et al. 2021	Mobilizing the wide public to address human-wildlife conflict	Global review (US, 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 semi-quantitative interviews
Young et al. 2021	Transdisciplinary approach for joint conservation efforts of multiple stakeholders	Ireland (EU)	Eurasian curlew (*Numenius arquata*)	Stakeholders from government, conservation, forestry, NGOs, agriculture, energy production, and academia	Workshop with 80 participants of 12 stakeholder groups and targeted interviews with 10 stakeholders
van Eeden et al. 2021	Assessing attitudes toward wolves, ranching, wolf-livestock coexistence, and wolf management methods	Washington state (USA)	Gray wolf (*Canis lupus*)	Residents of Washington state	Online survey (N = 420)
Martin 2021	Adaptive governance of the Wood-River Wolf Project	Idaho (USA)	Gray wolf (*Canis lupus*)	Project partners and related stakeholders, including ranchers, government officials	40 semi-structured interviews, qualitative analysis
McInturff et al. 2021	Social-ecological approach to map risk of sheep predation by coyotes	California (USA)	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 (N=21)	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 et al. 2021	Effect of deterrence strategies on resource selection of cranes	Wisconsin (USA)	Greater sandhill crane (*Grus canadensis tabida*)	Crane foundation, seed corporation	Resource selection studies at multiple scales
Kiffner at 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 wildlife tolerance model for multiple species	Abruzzo (Italy)	Brown bear (*Ursus arctos*), Gray wolf (*Canis lupus*)	Rural residents who farmed for either commercial or non-commercial purposes	Interviews, Wildlife Tolerance Model (WTM) as the framework to define tolerance and identify correlates of tolerance
Kansky et al. 2021	Parameterizing a wildlife tolerance model 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, Wildlife Tolerance Model (WTM) as the framework to define tolerance and identify correlates of tolerance