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Editorial: Disentangling the complexity of fence effects on wildlife and ecosystems

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Editorial on the Research Topic
Disentangling the complexity of fence effects on wildlife and ecosystems

Introduction

By some estimates, the length of fences on Earth could likely reach the sun, yet we know very little about the extent and scale of their social-ecological impacts. Fence ecology is a relatively new and rapidly growing discipline (Jakes et al., 2018; McInturff et al., 2020) that focuses on interactions between fences, organisms, ecosystems, and society. While fences were once an afterthought and "invisible" to scientists and practitioners, new research is shedding light on their widespread effects. Ecologically, fence impacts range in scale from individual fitness and physiology to continental ecosystem change (e.g., Connolly et al., 2009; Flesch et al., 2010; Letnic et al., 2011; Cozzi et al., 2013). Socially, fences have triggered changes in land practices, economic patterns, and the human-nature relationship (e.g., Evans and Adams, 2016; Linnell et al., 2016). As fences are ubiquitous and continue to multiply worldwide, the need to study, understand, and mitigate their effects on wildlife and ecosystems has never been greater.

Upon first notion, a typical inclination is to assume all fences are ecologically negative. However, a foundational princi ple of fence ecology is that nearly every fence has "winners and losers", with certain species, human and/or wildlife communities, ecological functions, and abiotic processes being affected differently by a given fence, depending on context. While a large proportion of studies have assessed livestock exclusion fence effects on large wild mammals (McInturff et al., 2020), there is an enormous array of fence types and purposes whose context-specific and scalable impacts remain enigmatic. The sheer variety of fence specifications and purposes gives rise to one of the primary challenges in advancing fence ecology: estimating fence locations, type, and density at broad scales using remotely sensed data or sociopolitical proxies (Jakes et al., 2018). Once we distinguish the 'where and what',

we can improve our questions and approaches to test social-ecological effects. In turn, determining conclusions about fences' winners and losers will help to advance conservation- and ethics-focused legislation and practices around fences as they continue to proliferate across the globe.

As fence ecology is an inherently interdisciplinary field, we cast a broad net for this Research Topic. While the term *fence ecology* implies a focus solely on ecology, fences of any purpose are fundamentally a sociopolitical construct rooted in complex human histories and needs (Xu and Huntsinger, 2022). Thus, the field of fence ecology, and any policies related to fences, will need to take into account the sociocultural and economic contexts underlying fence construction, maintenance, and removal. Therefore, we requested articles related to a range of topics, which included: positive or negative effects of fences on wildlife, ecosystem function, and processes; social and economic need for and histories of fences; methods to spatially map fences; approaches to mitigate the effects of fences; compounding effects of fences and other anthropogenic linear features; and reviews of policy and practice of fencing standards. Our goal was both to encourage dialogue from diverse perspectives and locales, and to spark discussion on critical directions forward in this burgeoning field.

Geographic representation in fence ecology research

The articles accepted for this Research Topic span field locations in four countries (Canada, Kenya, Namibia, and the USA), with authors representing eight countries on three continents (Africa, Europe, and North America). Research articles conducted in Asia or Australia, which are well-represented in the fence ecology literature (McInturff et al., 2020), are notably absent from this collection. This sparse geographic spread is likely because the field of fence ecology is relatively new. Some of the most established dedicated fence ecology research programs are located in Africa and North America, mostly centered around the impacts of fences (and mitigation thereof) on ungulate migration (see Jones et al., 2018; Løvschal et al., 2022). Additionally, there are as yet relatively few self-professed dedicated "fence ecologists" in the world, so the lack of diverse representation could be because 1) emerging fence ecology research programs are still gathering data, and 2) researchers may not be aware that their existing fence-related research programs can be grouped into this field. Lastly, many– if not most– fence ecologists are deeply embedded in impactful on-the-ground management, and may not identify as academics who seek scientific outlets for their work.

Topical diversity in fence ecology research

The articles in this Research Topic compensate for their relative lack of geographic spread with their interdisciplinarity and diversity in foci. Topics covered include increasing fence data and database utility, ungulate and carnivore behavior in relation to fences, social-ecology and economics of fences, and livelihoods and practitioner engagement. MacDonald et al. assess wildlife-friendlier fencing for mule deer and white-tailed deer, determining that wire height is the primary factor influencing deer navigation of fences, and providing insight into constructing wildlife-friendlier fences. They also explore how demographic differences within a species may impact the ability to cross fences, and implications thereof for population-level effects. Meanwhile, Hering et al. consider ungulate navigation of conservation fences for resource-tracking in arid environments, providing evidence for the necessity of incidental or intentionally managed fence gaps. This study is the first to demonstrate potential benefits of under-resourced fence maintenance, which is a major challenge for conservation fencing (Wilkinson et al., 2021). Foca and Boyce present one of the first studies outside of South Africa to assess large mammal behavior, ecology, and interactions inside of a fenced reserve - determining that interactions between two ungulate species remain similar within the fenced reserve (with different ecological and predation parameters) as without.

Fence ecology is inherently about relationships between people and the environment, interwoven with the priorities of decision makers. Towards this point, Hyde et al. demonstrate the value of co-producing knowledge on fence effectiveness, and provide a roadmap for collaboratively setting fence-related research and management priorities with practitioners who rely upon fences for their livelihoods. Meanwhile, Ford et al. explore fence effectiveness for reducing wildlife-vehicle collisions and provide an economic impact assessment for roadside fence implementation.

Lastly, some articles addressed the main impediment to the advancement of fence ecology studies: fence mapping. Buzzard et al. provide methods for estimating fence locations by comparing a created fence model to a fence mapping approach in Montana, indicating how roads, land ownership and land use type can estimate fences, while also comparing fence attributes to assess factors that may influence fence specifications. Demonstrating the utility of the open access *landDX* database, Tyrrell et al. dive both deeply and broadly into the complex sociocultural, economic, and political drivers of fence proliferation and impacts in southern Kenya. Using these social-ecologically-informed algorithms and remote sensing tools to explore fence drivers and effects across landscapes ultimately can lead to scalable understandings of fence "winners and losers" and promote impactful policies around fences.

Conclusion

Fence ecology is a relatively new field that has great potential for influencing policies and practices around conservation, livelihoods, and political boundaries. In fact, ecology publications with titles containing "fence" or "fencing" have more than doubled in the decade since the seminal *Fencing for Conservation* (Hayward and Somers, 2012) was published (decade prior: 93 publications; decade post: 195 publications). The interdisciplinarity of publications presented in this Research Topic demonstrates the inherent complexity of this field and the diversity of perspectives required to assess fence effects at scale. This Research Topic will introduce readers to the breadth of research and management foci that are encompassed within fence ecology, to hopefully encourage

discussion that addresses underrepresented topics and locales and fosters exciting future research.

Author contributions

CW, PJ, and AJ conceptualized the editorial. CW led the writing. All authors edited and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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