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Perspective

A fence runs through it: A call for greater attention to the influence of fences on wildlife and ecosystems

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ABSTRACT

Fencing is a nearly ubiquitous infrastructure that influences landscapes across space and time, and the impact of fences on wildlife and ecosystems is of global concern. Yet the prevalence and commonness of fences has contributed to their "invisibility" and a lack of attention in research and conservation, resulting in a scarcity of empirical data regarding their effects. Stakeholders, including scientists, conservationists, resource managers, and private landholders, have limited understanding of how fences affect individual animals, populations, or ecosystem processes. Because fences are largely unmapped and undocumented, we do not know their full spatial extent, nor do we fully comprehend the interactions of fences with wild species, whether positive or negative. To better understand and manage fence effects on wildlife and ecosystems, we advocate for an expanded effort to examine all aspects of *fence ecology*: the empirical investigation of the interactions between fences, wildlife, ecosystems, and societal needs. We first illustrate the global prevalence of fencing, and outline fence function and common designs. Second, we review the pros and cons of fencing relative to wildlife conservation. Lastly, we identify knowledge gaps and suggest research needs in fence ecology. We hope to inspire fellow scientists and conservationists to "see" and study fences as a broad-scale infrastructure that has widespread influence. Once we better understand the influences and cumulative effects of fences, we can develop and implement practical solutions for sustaining wildlife and ecosystems in balance with social needs.

1. Introduction

Globally, wildlife contend with shrinking natural habitats in landscapes dominated by an expanding human footprint and the accumulating influence of infrastructure (Sanderson et al., 2002; Johnson et al., 2005; Leu et al., 2008). Linear transport and energy infrastructures (e.g., roads, pipelines, power lines, canals) often have negative impacts on native wildlife and ecological processes through direct mortality, creating barriers and hazards, or altering behavior (Bevanger, 1998; Lemly et al., 2000; Trombulak and Frissell, 2000; Taylor and Knight, 2003; Benítez-López et al., 2010). The resulting habitat fragmentation, population declines, and disrupted ecosystem processes (e.g., seasonal migrations (Berger, 2004)), have broad-scale effects on wildlife and natural ecosystems and have prompted substantial investment in research and mitigation.

Fencing is nearly ubiquitous yet has received far less research attention than roads, powerlines, and other types of linear infrastructure. Worldwide, lands are laced with countless kilometers of fences erected by diverse stakeholders at different scales for widely varying purposes. Collectively, fences form extensive and irregular networks stretching across landscapes, and their influence on wildlife and ecosystems is likely far-reaching. Yet fencing is largely overlooked and is essentially "invisible" in terms of systematic research and evaluation.

We see parallels with road ecology in the widespread influence of fences. In recent decades, substantial investment into the study of road ecology has driven its advancement as a science, leading to improved public safety and wildlife conservation. Yet in many landscapes fences are more prevalent than roadways. Unlike roads, fences have vertical

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Fig. 1. Fence densities vary widely in difference landscapes. (a) Roadside boundary/livestock fence in rural landscape; (b) pasture fence in exurban landscape; (c) yard fence in suburban landscape.

structure that imposes unique hazards and barriers for wildlife, are typically unregulated, are constructed and maintained largely by private landholders, but we may be able to mitigate some of their ecological effects in a cost-effective manner.

To date, most empirical research on wildlife-fence interactions and fence systems has been limited in scope, often focused on single species at local spatial scales. Existing studies have largely addressed fence impacts on ungulates or at-risk species, often motivated by mortalities and barriers to known movements (e.g., Mbaiwa and Mbaiwa, 2006; Harrington and Conover, 2006). Large gaps exist in the empirical science on wildlife-fence interactions and we need more information to support wildlife conservation and resource management. We lack knowledge on the broad-scale and cumulative effects of fence infrastructure on a multitude of species, population demographics, and ecosystem processes. We do not know the longer-term or ecosystem-level consequences of fences, even of those fences erected for specific conservation objectives.

There is a fledgling but growing movement in North America and elsewhere to install wildlife friendlier fence designs (Paige, 2012, 2015), now advocated by many conservation groups and government agencies. Yet most of the practical experience with fences—their design, utility, installation, and modifications—resides among private landholders and government resource managers, whose knowledge is built on field trials and circulated via peers. Private landholders, including livestock growers, construct and maintain most fences, are familiar with their location and structure, and need them to be functional. Working with these stakeholders represents an excellent opportunity to develop effective fence solutions that maintain local economies, reduce impacts to wildlife, and sustain dynamic ecosystems. Without a systematic understanding of fences—their purpose, design, extent, and ecological effects—we cannot communicate or collaborate effectively for conservation goals, nor create more sustainable landscapes where people and wildlife can co-exist.

Therefore, we advocate for a greater focus on *fence ecology*: the empirical investigation of the interactions between fences, wildlife, ecosystems, and societal needs. In nearly every fenced landscape, there are opportunities to study and better understand the influence of fences on wildlife populations and ecological processes at multiple scales. In