Minding the boundary: social–ecological contexts for fence ecology and management

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Fencing is a globally ubiquitous yet largely underestimated human infrastructure. To date, most fencing-related research and management has focused on its biophysical outcomes. However, fencing is often part of coupled human and natural systems, and inevitably affects social and ecological dynamics and the links between them. Drawing from three key case studies in the US, China, and South Africa, we delineate five social pathways through which fencing shapes social–ecological dynamics in a landscape. We show that the social functions and physical appearance of fencing conjointly form a positive feedback loop that stimulates the proliferation of fences across entire landscapes, rendering fencing a more impactful feature than expected from its ecological impacts alone. The emerging field of fence ecology and management must embrace the social–ecological complexities of fenced landscapes to minimize unanticipated social consequences.

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"The first man who, having fenced in a piece of land, said 'This is mine', and found people naive enough to believe him, that man was the true founder of civil society." – Jean-Jacques Rousseau, 1754

Fencing is a ubiquitous linear infrastructure (Panel 1; Hayward and Kerley 2009; Jakes *et al.* 2018). Encroaching on nearly all cultural and natural landscapes globally, fences likely have greater impact than roads (Figure 1; Løvschal *et al.* 2017; McInturff *et al.* 2020; Sun *et al.* 2020). Recent recognition that fencing can reorganize entire ecosystems has prompted efforts to formalize fence ecology, a discipline that examines "the interactions between fences, organisms, ecosystems, and societal needs" (McInturff *et al.* 2020). Yet most syntheses of fence research have so far focused primarily on biophysical aspects. A comprehensive framework that situates fencing within coupled human and natural systems, or social–ecological systems (SESs), is needed to solidify the interdisciplinary foundation of this burgeoning field.

In a nutshell:

- Fences occur in coupled human–nature systems across the world
- Fences can affect human mobility, land practices, economic relationships, social relationships, and human–nature relationships in a given system
- The social dynamics of fencing can affect ecological dynamics at various scales
- Fencing's physical form and social–ecological impacts mean it can spread rapidly across a landscape, pushing the system to a tipping point after which major transformation of social and ecological dynamics may occur
- Researchers and managers must consider the social–ecological complexities of fenced landscapes to avoid unexpected social and ecological consequences

In SESs, humans, animals, and land interact with each other in profound ways. Dividing one from another with fences alters social and ecological dynamics, as well as the connections between them (Hayward and Kerley 2009; Hoole and Berkes 2010). However, fences are often proposed to solve a purportedly "straightforward biological problem", such as forage competition with livestock and human–wildlife conflict, without considering that these problems are complex issues driven by mixed ecological, social, economic, and political forces (Li and Huntsinger 2011; Evans and Adams 2016). The rhetoric of the "technological fix" obscures potentially critical social impacts and their ecological feedbacks, leading to unanticipated negative outcomes for society and ecosystem (cf Ferguson 1990). Clearly, examination and management of fencing requires researchers and managers to embrace the social–ecological contexts of fenced landscapes.

Here, we review the impacts and characteristics of large-scale fencing as part of SESs. Drawing from three key case studies in the western US, western China, and southeastern South Africa (WebPanel 1), we delineate five interdependent pathways through which fencing's social impacts can be imprinted on ecosystems (Table 1; Figure 2, a and b). We further demonstrate that the combination of fencing's physical characteristics and social impacts can create a positive feedback loop that stimulates the proliferation of large-scale fencing across the landscape (Figure 2c), rendering it a powerful intervention that can drive major transformations in SESs.

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Panel 1. What is a fence?

Many linear structures can function like a fence to enclose resources and to bar unwanted entrance from other humans or organisms, including walls, sonic "fences", hedgerows, and even trenches (Figure 1d). Yet a classic fence can be described as a physical linear feature with vertical load-bearing components (such as poles) and with connecting non-continuous structures (such as boards, wires, rails, and netting) spanning these components. Such a structure has a unique history and social–ecological functions as compared with other fence-like structures. More detailed discussion about what constitutes a "fence" can be found in McInturff *et al.* (2020). Here, we focus on large-scale fencing: namely, fences with a certain morphological uniformity across a sizable geographic region. These fences are often associated with regional or national land-management needs, and are the most relevant to ecological research.

Social pathways through which fencing shapes ecosystems

"Our human landscape is our unwitting autobiography, reflecting our tastes, our values, our aspirations, and even our fears, in tangible, visible form." – Pierce Lewis, 1979

Building fences is a practice of demarcating space, rendering resources into objects of ownership and governance (Netz 2004). As early as the Neolithic Age, humans used fencing to claim territory or protect property (Kotchemidova 2008). Fencing's utility has grown considerably in more recent times, encompassing diverse purposes across social and cultural geographies, such as ameliorating wildlife–vehicle collisions along roads, deterring invasive species, reducing livestock depredation by predators, managing livestock breeding, and preventing disease transmission (McInturff *et al.* 2020). Notably, the diverse functions of fencing are rarely blatantly beneficial or harmful but instead vary widely by context (McInturff *et al.* 2020).

Drawing from three key case studies on three continents (WebPanel 1) and supplemented by other literature identified using a snowball approach, we examined the nuanced effects of fencing in SESs. The discussions presented here focus primarily on pasture and conservation fencing because it is the predominant research foci of fence ecology literature. We extended the McInturff *et al.* (2020) fence ecology framework to include the impacts of fencing on five social factors: human mobility, land practices and land use, economic relationships, social relationships, and human–nature relationships (Figure 2). We identified these themes by extracting, examining, and categorizing the relevant contents from the scholarly literature. Below, we describe each of these factors and how they essentially define an ecosystem (summarized in Table 1).

Human mobility

Perhaps the most conspicuous fencing social impact is on human movement. The advent of barbed-wire fencing in the late 19th century in the western US ended long cattle drives from the Great Plains to markets in the north (Webb 1959). More recently, fencing obstructs the daily commute of farmworkers in South Africa (Snijders 2012), and western China's pastoralists have had to reduce or change their large-scale annual migrations when extensive fencing became part of the landscape as a result of land allocation policy (Næss 2013). Whereas herders in Qinghai, China, formerly utilized several grazing areas seasonally each year, government fencing has created separate household land allotments, reducing most herd movements to only once per year. In response, certain families have stopped moving herds entirely and have elected to become sedentary instead (Cao *et al.* 2011).

At the same time, fencing can enforce human movement. In South Africa, fencing – together with land privatization and the establishment of protected areas – has led to the sometimes violent displacement of Black residents (Spierenburg and Wels 2006; Brandt and Spierenburg 2014). Remarkably, mobility has been used as a direct protest against the existence of fencing, as residents have continued crossing fences for generations despite increasing attempts to restrict their movement (Brandt and Spierenburg 2014).

The movement of humans, like the movement of animals, can shape ecosystems at

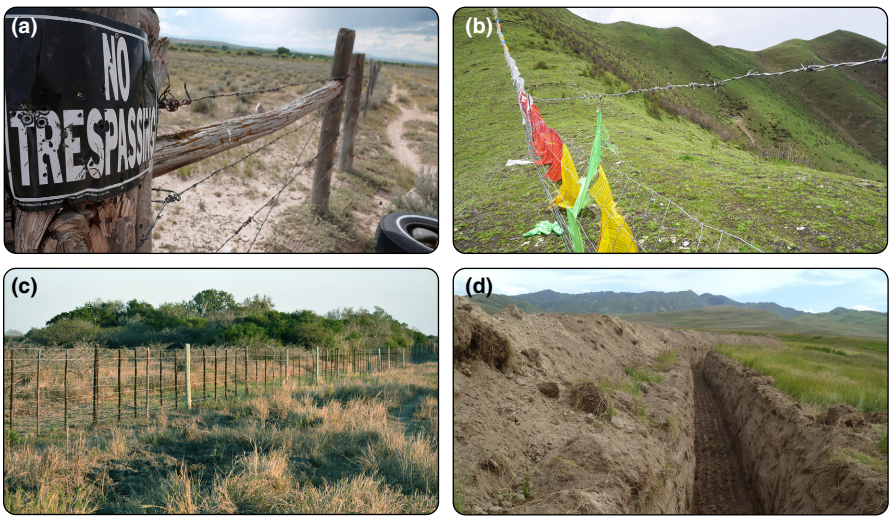

Figure 1. Fences in various social–ecological systems. (a) Fencing demarcating private and public lands in the western US; (b) livestock fences on the Qinghai-Tibet Plateau, decorated with prayer flags; (c) electrified fences around a wildlife conservancy in South Africa (image credit: L Gigliotti); (d) trenches that serve the purpose of fences on the Qinghai-Tibet Plateau, where fence materials are in short supply.

Table 1. Social pathways through which fencing shapes ecosystems

Social pathways		Example feedbacks on ecosystems
Human mobility	Affect movement patterns; sedenterization; displacement	Soil loss and quality decline; affect primary productivity; shift community composition; alter animal behavior and distribution; affect ecosystem processes and resilience
Land practices and land use	Alter reciprocal land practices; production mode diversification; land-use change or intensification	Species partitioning or regional concentration; alter disease dynamics; habitat fragmentation; shift primary productivity; cause biodiversity loss
Economic relationships	Financially expensive; economic stratification	Reduce fence efficiency; affect animal physiology and behaviors; exacerbate landscape fragmentation
Social relationships	Weaken social interaction; incentivize conflicts; social stratification	Modulate fencing's physical permeability; influence resource management efficacy; exacerbate landscape fragmentation; reduce system resilience
Human–nature relationships	Dissociation and alienation; alter human perception of nature	Inappropriate science and management provisions; links back to most of the ecological impacts mentioned above through feedbacks on other social impacts

multiple levels. At the local scale, restricting previously mobile humans can cause intensified resource use, leading to soil loss, species decline, and composition shifts. At the landscape scale, altered large-scale pastoralist movements essentially redistribute the human footprint, which can have cascading effects on primary productivity, fire dynamics, and system resilience (McNaughton 1985; Western *et al.* 2009). Such impacts are especially prominent in areas where human movement and distribution patterns are shaped by strictly defined impermeable fences that can rapidly create sharp habitat edges.

Land practices and land use

Fencing has restructured livestock-based land practices across the planet. For example, shortly after barbed-wire fencing was first invented in the early 20th century, fences quickly spread throughout US rangelands, leading to the reorganization of livestock production into bounded areas (WebPanel 1). A cowhand's main duties shifted from tending cattle to mending fences (Liu 2009). Today, grazing management in the US West continues to evolve under the influence of fencing. For example, the US Department of Agriculture Natural Resources Conservation Service (NRCS) subsidizes the division of large pastures into smaller ones as ranchers shift from continuous grazing or long rotations to higher frequency rotational grazing, as may be required by the NRCS to meet planning requirements (Knight *et al.* 2011).

Changes in land practices in pastoral societies induced by fencing are equally profound, if not more so. In China, previously collaborative tasks, such as communal herding and pasture care, become unfeasible with fragmentation into fenced pastures (Cao *et al.* 2011; Li and Huntsinger 2011). Pastoralists must often herd on and beside major roads to maneuver around the fences that enclose formerly common pastures, frequently necessitating longer travel distances and increased safety risks for both animals and herders (Li and Huntsinger 2011). Reduced access to seasonal forage forces herders to purchase supplementary feed more often (Miao *et al.* 2018). As fencing increases costs and reduces the benefits of pastoral practices in Asia and Africa, herders may switch to other modes of production, such as commercial ranching, cultivation, and tourism (Lamprey and Reid 2004; Wu and Du 2008; Weldemichel and Lein 2019), or lease or sell their land and become wage laborers (Williams 2002; Li and Huntsinger 2011).

Diversification of production modes can result in rapid land-use change. In parts of eastern and southern Africa, outside investors rapidly acquired most of the newly divided pastoral lands and converted them to commercial agriculture or private game reserves (Brandt and Spierenburg 2014). Overall, the previous mixed-use of land shared by people, livestock, and wildlife gradually shifted to specialized and intensified uses.

The effects of land-use change on biodiversity and ecosystem functions are well studied. Sedentarized pastoralism or

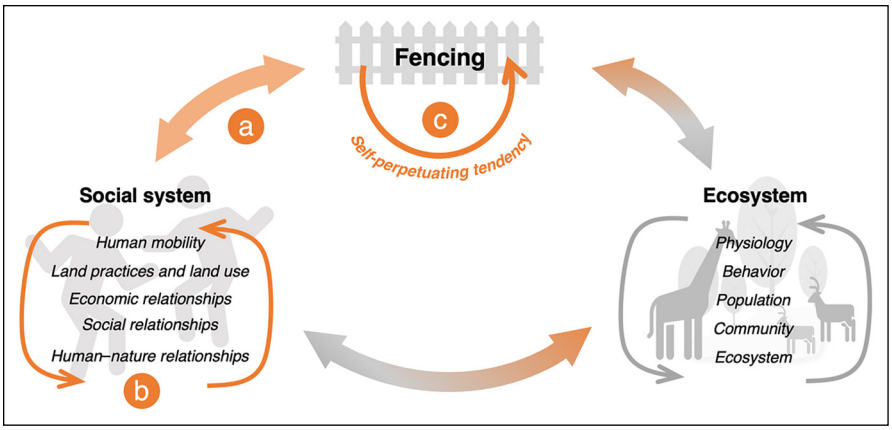

Figure 2. Social–ecological dynamics of a fenced landscape. In a social–ecological system (SES), fencing can influence social and ecological subsystems at multiple levels. Specifically, fencing's effects on the social system can be passed on to the ecosystem along five social–ecological pathways (a). Social impacts of fencing interact with one another (b), thereby amplifying fencing's influences on both the social and ecological subsystems. In addition, the physical and social impacts stimulate self-perpetuation and proliferation of fencing across space and time (c). Altogether, large-scale fencing can drive major transformations of SESs. The topics represented by the gray arrows are beyond the scope of this article and were discussed in McInturff *et al.* (2020).

intensified commercial livestock husbandry leads to regional concentrations of herbivory, likely enhancing disease transmission and habitat fragmentation (Næss 2013). In many grassland systems, even moderate increases in land-use intensity can lead to biotic homogenization, biodiversity loss, and shifts in ecosystem function (Allan *et al.* 2015). In southern Kenya, for example, wildlife populations and grass productivity fell sharply on privatized ranches following land subdivision and fencing, while wildlife populations increased steadily on adjacent land under mobile pastoralism (Western *et al.* 2009).

Economic relationships

Fences can effectively reduce financial loss by excluding crop-raiding animals, livestock predators, and wildlife poachers, but are expensive to build and maintain (Table 2). Because fencing can deteriorate rapidly, frequent maintenance is required. Agencies and individuals have often been forced to stop repairing fences due to long-term financial costs (eg Weldemichel and Lein 2019). However, few studies have tracked large fencing projects over time periods long enough to allow accurate determination of economic outcomes.

The high costs of fencing imply that few people can afford and benefit from the investment, which can entrench economic stratification. With notable exceptions (eg Lesorogol 2005), land division and distribution is often neither random nor just (Williams 2002; Weldemichel and Lein 2019). In South Africa, the division of a once-shared community commons into private parcels – which are affordable only to individuals, often non-locals, who have adequate financial resources – has led to the creation of a landless, impoverished class (Snijders 2012; Brandt and Spierenburg 2014). In China, although all households are eligible for a piece of land from the community's grazing lands, wealthier households are the first able to build fences. Any remaining unfenced land is then used as open-access grasslands accessible by everyone, including the holders of the fenced parcels, as community management institutions are dismantled with land allocation. Enclosure of parcels by wealthier households pushes poorer community members to marginalized land that becomes overused and on which livelihoods are difficult to sustain (Li *et al.* 2007). Globally, women, who in many areas are barred from owning land, may be left landless following land division (Weldemichel and Lein 2019). Such stratifications gradually marginalize traditional livelihoods that rely on mobility or access to large areas, fueling change in land practices and ecological conditions. At times, the economically disadvantaged are then pushed to employ illegal means to achieve a measure of food and income, such as poaching and night grazing in forbidden areas (Figure 2b; Mbaiwa *et al.* 2008).

The economic burdens of fencing can translate to ecological burdens. For one, lack of maintenance due to financial difficulties can compromise or even nullify the benefits of having fencing in the first place (McInturff *et al.* 2020). Unmaintained fences can lose tension and become more dangerous to wildlife because animals are more easily entangled. Some landholders in Australia cannot afford to maintain their sections of the "dingo fence", contributing to the reason why in 200 years this structure – the longest fence in the world – has done little to resolve human–dingo (*Canis familiaris dingo*) conflicts (Smith and Appleby 2018). For another, economic inequalities induced by fencing can exacerbate landscape fragmentation. In Inner Mongolia, certain herders who built fences early intentionally keep their livestock outside their own land as much as possible, exploiting the shared resources of other herders who cannot afford fences (Williams 1996a). Consequently, fencing becomes a means of co-opting common resources both within and outside the enclosure. In northern Tibet, overgrazing increased from 27.41% to 83.02% of the total grazing land area after the introduction of grazing exclusion fencing, resulting in overall ecological loss (Sun *et al.* 2020).

Social relationships

The famous adage "good fences make good neighbors" implies that physical boundaries can promote peaceful coexistence. For the Merak and Sakteng pastoralists in Bhutan, fencing

Table 2. Examples of the construction cost of fencing

Location	Year(s) built	Main purpose	Cost/km*	Structure	Source
Tibetan Autonomous Region (China)	2000s	Keep livestock	$1000	1.2–1.5 m high	Richard *et al.* (2006)
Southwest US	1930s	Keep livestock	$2245	1.3-m high four-strand barbed wire	Sayre (2015)
Montana (US)	2011	Keep livestock	$5151	Four-strand barbed wire	Knight *et al.* (2011)
Australia	2000s	Exclude invasive species (feral domestic cat [*Felis catus*], fox [*Vulpes vulpes*], rabbit)	$6700	1.15-m high	Moseby and Read (2006)
Australia	2000s	Exclude invasive species (feral domestic cat, fox, rabbit)	$9500	1.8-m high wire netting fence with two electric wires and a foot apron	Moseby and Read (2006)
Kruger National Park (South Africa)	1960s	Protected area boundary	$31,250	1.8–2.4-m high, sections are lower today	Hayward and Kerley (2009)
US–Mexico border	Suspended	Political border security, exclude people	$3.9–16 million	12-m high	Deeds and Whiteford (2016)

Notes: *cost estimates in current US$.

has become a part of cultural identity and serves to maintain social harmony (Wangdi and Norbu 2018). However, fencing sometimes alienates community members from one another. In western China, social gatherings, including group singing, dancing, and horseracing events, declined following land division and fencing (Williams 1996a; Cao *et al.* 2011), along with other reciprocal bonds of friendship, solidarity, trust, and shared memory (Li and Huntsinger 2011). Moreover, sudden increases in fencing can lead to violent territorial conflicts (Wu and Du 2008; Cao *et al.* 2011). In the 19th-century "fence-cutting war" in Texas, landless cattlemen formed armed bands to destroy fences that prevented livestock access to grass and water, causing over the equivalent of US$20 million worth of damage (estimated in current dollars) in 1883 alone (Netz 2004). Although direct conflicts may end, altered social relationships can persist for generations.

Fencing may also cause or enforce social stratification. In southern Africa, social relationships became depersonalized in fenced landscapes as the community is increasingly defined by "owners versus non-owners" and "us versus them" polarization (Brandt and Spierenburg 2014). Furthermore, the presence of fencing can legitimize accusations toward and punishment of those labeled as "others"; local community members who were caught venturing into a fenced game reserve were regarded as "poachers" (Spierenburg and Wels 2006). Social stratification tied to resources often occurs in tandem with economic stratification and altered land practices (Figure 2b).

On the other hand, strong social relationships can condition the physical permeability of fencing. Similar to what Ostrom (1990) described as the peer relations that enable community management of common pool resources, fences can be treated as social agreements. In Montana, a ranching community reinforced a highly held value for individual property rights and controlled livestock movement through fencing. At the same time, fences were generally held to be porous for local hunters that followed community protocols (Yung and Belsky 2007). Notably, where ownership, property, and territories are based on long-term development of social relations, such as in many Indigenous societies, fences are used sparingly if at all. The lack of fences as a physical signal of ownership – a common Western notion – has been argued to have made it easier for European colonists to justify seizing Indigenous lands because the native inhabitants were simply "living off nature" and fenceless land was therefore "free for the taking" (Cronon 1983).

Divisions in social relationships can become ecologically meaningful. In Namaqualand, South Africa, during the 1950s, fenced "white" and "colored" farms under apartheid policies diverged into landscapes that supported different vegetation communities noticeable even today (Rohde and Hoffman 2008), a pattern repeated at the Norway–Finland, US–Mexico, and China–Mongolia borders, to name a few (Beck *et al.* 1990; Williams 2002; Normand *et al.* 2017). In addition, weakened reciprocal social relationships can compromise optimal resource management and overall SES resilience (Conte and Tilt 2014). Traditional unfenced pastoral boundaries tend to be "fuzzy" and flexible (Fernandez-Gimenez 2002). Herders frequently exchange information and share resources, allowing for variation in herding locations in response to weather, disease, and other forces. However, with flexible boundaries hardened by fences and social relationships dissipated, capacity to tolerate disturbances weakens, resulting in rangeland deterioration and system resilience decline (Li and Huntsinger 2011). This feeds into the ecological consequences of altered mobility, land practices, and economic status (Figure 2b).

Human–nature relationships

The social impacts discussed above redefine human–nature relationships. In southern and eastern Africa, fencing dis-associates local communities from nature both physically by limiting human mobility and symbolically by altering cultural practices and core values (Hoole and Berkes 2010; Løvschal *et al.* 2017). Fencing can also alienate people from land by facilitating government agency administration (WebPanel 1), and by enabling neoliberal notions that commodify nature, promoting markets and transactions (Sayre 2008). For example, in South Africa, parts of Europe, and Texas, among other regions, fencing can lead to wildlife being designated as a legally defined commodity; as a result, wildlife ownership has become a profitable business (Snijders 2012; Huntsinger *et al.* 2014), a phenomenon that Hayward and Kerley (2009) described as "a start on domesticating wildlife".

Fences can distort human perceptions of land and result in inappropriate science and management. When land is divided, people have generally assumed that differences between adjacent divided parcels are solely a result of ecological or physical drivers without always considering social and economic histories that may be responsible for the observed ecological phenomenon (Benjaminsen *et al.* 2006; Hongslo 2015). In southern Africa, for example, such notions have led to a common narrative about rangeland degradation on communal land, which feeds into land-use policies that promote fragmentation and private land ownership (Rohde and Hoffman 2008; Hongslo 2015). Western range science for most of the 20th century took for granted the desirability of dividing rangelands into bounded areas, each with a determinable number of livestock belonging to a single owner (Sayre 2017). Arguably, the imposition of such approaches on pastoral areas in the past century has led to nearly universal failures of development projects around the world (Ferguson 1990; Sayre 2017).

The looming social–ecological tragedy

"We shape our dwelling and afterwards our dwellings shape us." – Winston Churchill, 1943

The physical form of fencing means it can easily self-generate. When fencing encloses a plot, it provides a

physical boundary for the neighboring plot; erecting fencing around the neighboring plot then requires less material and intellectual input, encouraging (or even forcing) neighbors to also install fences (Wu and Du 2008). This partially contributes to the fact that major road and protected area fences often attract subsidiary fences around them (Said *et al.* 2016; Weldemichel and Lein 2019). As established boundaries reduce remaining open space and drive increases in land parcel values, more people are incentivized to claim resources and properties with fencing (Said *et al.* 2016). Thus, fencing creates a positive feedback loop leading to its proliferation and rapid spread over extensive areas (Figure 2c; Løvschal 2020).

Furthermore, the perpetuation of fencing is often a unidirectional process, as a fenced landscape is rarely ever returned to being fenceless (Løvschal 2020). Although divided private land has occasionally been reconsolidated, such as by the Malpai Borderlands Group in the US and in Dalrymple Shire, Australia (Reid *et al.* 2014), more often the repeated financial and labor investments in fence construction and maintenance, as well as the ecological changes induced by fencing, mean that the cost to return to an unfenced landscape and to restore ecological processes accumulates over time. Although fencing may initially trigger discontent, people become accustomed to this organization of land and labor and increasingly accept, or even support, more fencing (WebPanel 1; Williams 1996b; Bauer 2005), eventually losing social relationships that enabled unfenced land use and stewardship. With an altered perception of tenure and community, removing one fence in a fully fenced landscape does little to incentivize others to do the same. In addition, in many US cases, fencing is underwritten by government agencies that require landowners to contain their livestock and make them liable for damage caused by loose stock (Centner 2000). Moreover, traditional knowledge and collective memory associated with open landscapes become superfluous in the new fenced landscape organization (Williams 1996b; Hoole and Berkes 2010). Lost knowledge and memory seldom recover, rendering the fencing process nearly irreversible.

Altogether, as more fences are constructed, opportunities to pursue fundamentally different land management strategies become increasingly rare (Lamprey and Reid 2004; Snijders 2012). The proliferation of fencing may eventually reach a tipping point after which the process of land enclosure becomes unstoppable (Løvschal *et al.* 2017). Considering fencing's multi-scale social and ecological impacts, complete SES transformation or even collapse can occur without deliberate policy and management interventions. For example, in southwestern Kenya, researchers predict that the unprecedented expansion of fencing may eventually lead to the end of pastoralism, as well as a complete cessation of megafaunal migrations (Said *et al.* 2016; Løvschal *et al.* 2017). By then, social–ecological processes, functions, and relationships in the system would be redefined.

Advancing fence ecology research and management

"There where it is we do not need the wall / He is all pine and I am apple orchard / My apple trees will never get across / And eat the cones under his pines, I tell him / He only says, 'Good fences make good neighbors'." – Robert Frost, 1914

Historically, many societies, through reciprocal social relationships, usufructuary property rights, community management of common pool resources, and other social infrastructure, have not required fencing to achieve long-term sustainability. Today, however, fencing has become a ubiquitous and essential part of various SESs. Many of these systems could be approaching a tipping point, leading to SES transformation. In order to predict whether and when a tipping point might occur, and to anticipate social changes that may have undesirable consequences, researchers should focus on how to measure factors influencing the long-term costs and benefits of fencing from the perspectives of stakeholders. We also encourage researchers to study fences other than those for conservation or livestock, which may reveal novel insights about the functions of fencing beyond those in this article.

The complex social–ecological connections in fenced landscapes render interdisciplinary dialogues essential in fence research. Our comprehensive view situating fencing in SESs provides a guiding framework for social and natural scientists to find common ground for collaboration (Figure 2). For example, combining human movement and animal movement research in fenced landscapes can assist in quantitatively examining interactions between social and ecological responses to fencing. In addition, the framework allows scholars to analyze aspects of fenced systems while contributing to systematic understandings of social–ecological systems and the emerging field of fence ecology.

Despite continued expansion worldwide, large-scale fence construction, maintenance, impact mediation, and removal still lack management guidelines (McInturff *et al.* 2020). In 2015, 45 scientists authored a directive calling for the development of multilateral fencing policies (Durant *et al.* 2015), but such policies have not yet been formulated or implemented. In continuously pushing for policy establishment at local, regional, national, and international levels, we caution that no single solution fits all and that decisions must be based on research with a social–ecological foundation. The interconnection between social and ecological systems and fencing's tendency to proliferate determines that the impacts of fencing, even if they appear to be solely ecological, are likely to include social and political ramifications that cannot be mitigated merely by physically restricting or removing fences. Because social connectivity can be as important as physical connectivity, restoring fenced landscapes likely requires adaptive co-management and resilience building that recouples social and ecological dynamics (Hoole and Berkes 2010). In some cases, understanding and promoting customary social rules may improve transboundary

connectivity even when physical fencing remains in place (Yung and Belsky 2007). One prominent example is Europe's "right to roam", which codifies the general public's right to access certain privately owned land. Overall, the future of fence ecology and management must embrace a macro view through space, time, and disciplinary boundaries.

Conclusion

By enumerating some of the social–ecological impacts of fencing, we complement the emerging field of fence ecology with critical interdisciplinary insights. We show that many ecological consequences of fencing are socially rooted, and that the social–ecological impacts of fencing are not dichotomously beneficial or harmful but are indeed highly context-dependent. Notably, by situating fencing in SESs, we encountered an otherwise hidden feedback loop in fenced landscapes that can amplify fencing's social and ecological impacts, which in turn can lead to SES transformations. As connectivity becomes increasingly important in global conservation schemes, insights gained from the emerging field of fence ecology may illuminate broader discussions concerning how fragmented landscapes can be reconnected for the benefit of both humans and wildlife. Essentially, when putting "good fences make good neighbors" back into its proper context, we may realize that "there where it is we do not need the wall".

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Data Availability Statement

No data were collected for this study.

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