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Opportunities to Increase Wildfire Risk Mitigation Through Cattle Grazing in Western Canada

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Abstract
The fire season of 2023 was record-breaking in Canada given the number, severity, and intensity of wildfires. Factors contributing to the number of fires are likely to get worse in the future because of the interaction and complexity of many factors such as climate change and the legacy of decades of successful wildfire suppression. Further complicating wildfire management is the ever-continuing expansion of the wildland-urban interface and subsequent increases in values at risk. Fire management solutions including prevention and suppression will require novel approaches given rising costs and logistical complications. This paper examines the payment concept for ecosystem services whereby ranchers are paid to graze cattle in targeted high-priority areas in the wildland-urban interface. Grazing can be ecologically appropriate and has long been used in fire-prone ecosystems in Europe. With some key considerations, implementing PES (Payments for Ecosystem Services) could reduce fire risk, support agricultural producers, and enhance societal protection.

Keywords: ecosystem goods and services, wildfire risk, grazing, non-market values, sustainability, PES

Introduction

In August, only partway through the Canadian fire season, NASA (2023) reported that the number of hectares burned by wildfire was nearly twice the annual average. On 7 September, the Canadian Interagency Forest Fire Centre[2] indicated that 6,151 fires were recorded for the year to date and that 16.6M hectares had already burned (Fig. 1). Data also indicate that of all fires in Canada, approximately 67% occurred in the West, [3] which accounts for just over half of all the area burned (57%).

While wildland fire is a necessary ecological process, it can also be highly destructive causing damage to buildings, infrastructure, communities, and human life. In July, the Associated Press[4] reported that wildfires had already broken records for the number of evacuations as well as

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[2] See www.ciffc.ca for the situation report and fire statistics.
[3] For the purposes of this paper, the West includes British Columbia, Alberta, Saskatchewan and Manitoba, and the Yukon and Northwest Territories.
[4] Associated Press, 6 July 2023. Retrieved from: https://abcnews.go.com/International/wireStory/wildfires-canada-broken-records-area-burned-evacuations-cost-100806230

suppression costs. By mid-July, the estimated number was 155,856. In mid-August 20,000 people in Yellowknife, NT were evacuated,[5] followed by another 30,000 in the BC interior.[6]

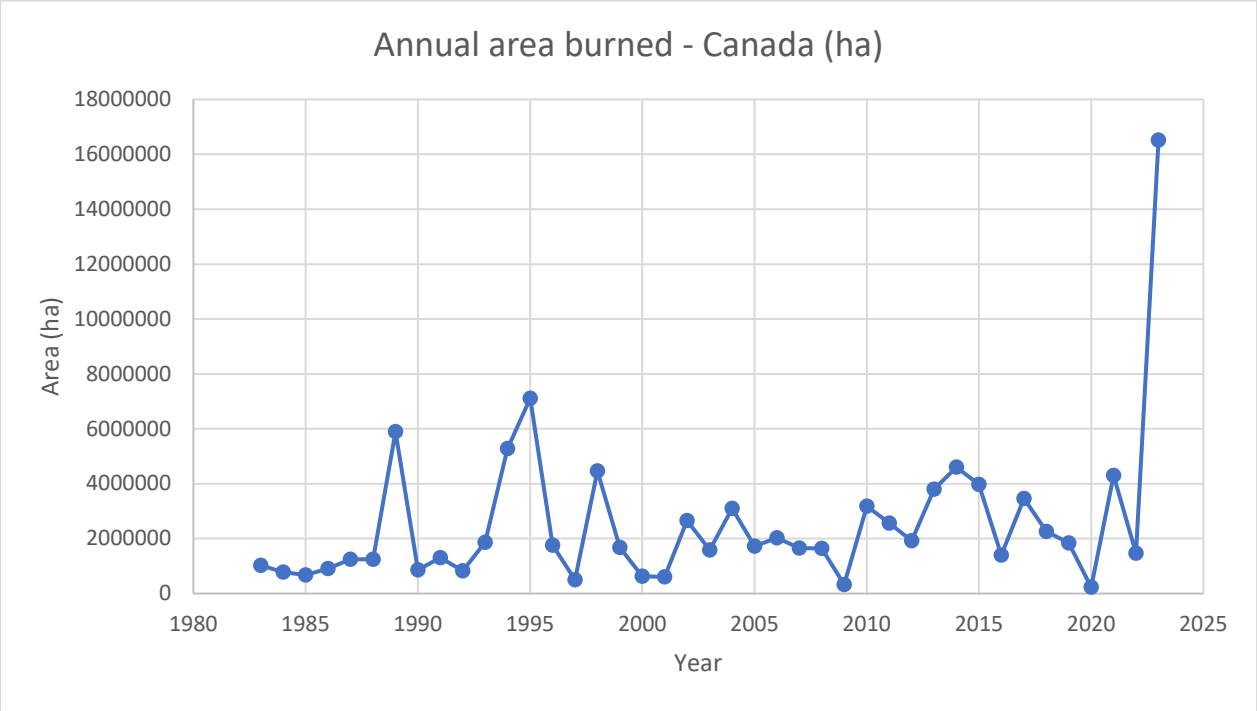

Figure 1: Annual area burned (ha) in Canada. Area burned for 2023 is the total number of hectares burned by 6 September 2023. Source: Canadian Interagency Forest Fire Institute. Data retrieved from CIFFC.net/statistics.

Wildland fire costs have been on the rise for decades, making news, particularly between 2016 and 2021. Expenditure data from Natural Resources Canada (2021) show increasing costs for both preparedness (fixed fire expenditures) and suppression (variable fire expenditures), the total surpassing $1.4B in 2015 and 2017 in nominal dollars (Figure 2).

Public Safety Canada reported that the 2016 Fort McMurray Fire in Alberta resulted in direct and indirect costs and damages approximating $7B.[7] A study after the fire estimated the value to be closer to $9.9B when the replacement of buildings and infrastructure, and losses from forgone royalties related to reductions in economic activity related to the oil sands and provincial forests were accounted for (Alam et al. 2017).

While expenditures for fire management are increasing, they represent only a small fraction of total costs. Not accounted for are the spikes in medical costs related to hospitalizations and complications associated with respiratory and circulatory illnesses as well as additional economic losses related to the labor force and interruptions in economic activity. For example, Borgschulte et al. (2022) estimated that the pollution from wildfire smoke in the United States reduced earnings by approximately $125B US per year between 2007 and 2019 (2018 base year).

[5] Reuters, 17 August 2023. https://www.reuters.com/world/americas/canada-wildfires-crews-battle-stop-blaze-yellowknife-evacuates-2023-08-17/

[6] BBC News. 20 August 2023. Retrieved from: https://www.bbc.com/news/world-us-canada-66562610

[7] Public Safety Canada, 2023. Backgrounder: Wildland Fires. Retrieved from: https://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/ntnl-rsk-prfl/bckgrndr-wldlnd-frs-en.aspx

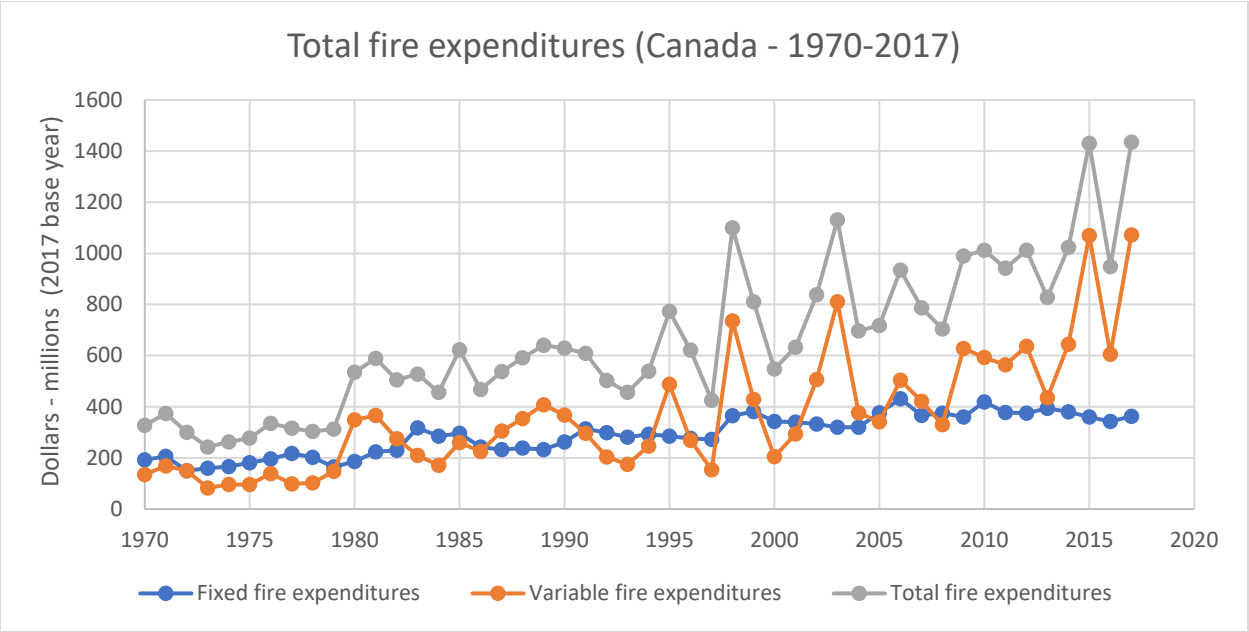

Figure 2: Total fire expenditures in Canada for wildfire management. Fixed fire expenditures represent presuppression and variable fire expenditures are for suppression. Data retrieved from Natural Resources Canada. Retrieved from: https://natural-resources.canada.ca/climate-change/impacts-adaptations/climate-change-impacts-forests/forest-change-indicators/cost-fire-protection/17783#why

Global wildfire risk is growing from an increase in seasonality, intensity, and frequency (Ellis et al. 2021) given the combination of ecological and climatic conditions, which are then exacerbated by changes in human factors (e.g., ignitions, expanding wildland-urban interface), and the results of historical suppression policy and the availability of continuous fuel. Pausas and Keeley (2021) point out that it is not one or two factors that have led to greater fire activity, rather they identify the main causes of wildfire activity to be a complex combination of drought, population growth in both rural and urban settings, changes in atmospheric carbon, increases in invasive grasses, heatwaves, and unnatural fuel loads.

Historically in North America, fire management began with the view that all wildfires were bad and should be extinguished. The suppression paradigm has since changed, recognizing wildfire as a necessary ecological process (Coogan et al. 2020). While budgets have increased for prevention using tools such as silvicultural practices (e.g., mechanical forest thinning), the reintroduction of fire (prescribed fire) and preparedness to reduce the risk of loss to communities (Firesmart in Canada/Firewise in the USA), most public funds are spent on suppression.

Evidently, from the fire activity this year in Canada and other fire-prone jurisdictions such as Australia, Spain, and Portugal, we need to learn to live with fire (Moritz et al. 2014). We need innovative solutions that reduce the risk of wildfire occurrence, and the ability to better manage wildfires once they begin. Traditional tools have included prescribed burning and mechanical thinning, or a combination of approaches depending on policy and jurisdiction, ecosystem needs, and public support and acceptance. It is also important to consider the sustainability of solutions, and how they can be implemented over time given the scope and scale of the area needing treatment, and the complexity of land ownership, jurisdiction, competing interests for land use, and socio-economic considerations.

Mediterranean countries prone to wildfire, particularly Spain and Portugal, fund agricultural producers using PES (payment for ecosystem services) to graze sheep, goats, and cattle in key

locations to reduce fine fuels. While there are some examples of grazing, particularly in grasslands to mitigate wildfire risk in North America, PES to ranchers has not been widely adopted in forested areas. Notwithstanding, growing evidence suggests that forest grazing by cattle is an effective strategy to mitigate wildfire risk. Furthermore, as a service, it might be more cost-effective when agricultural benefits are considered in conjunction with potential loss avoidance. This paper explores PES agreements for grazing cattle in strategic locations in the wildland-urban interface (WUI).

Ecosystem Goods and Services from Grazing

Ecosystem goods and services (EGSs) refer to the benefits that accrue to humans from ecosystem processes that sustain, maintain, and enhance the quality of ecosystem goods (Brown et al. 2007). While all EGSs are essential to human well-being, they have critical differences in their functioning, how they are provided, and how or whether they are valued. To help identify and explain what goods and services are and their connection to human sustainability, the Millennium Ecosystem Assessment (Reid et al. 2005) resulted in a taxonomy that included four general categories: supporting (e.g. nutrient cycling, soil formation, production), provisioning (e.g. food, water, fuel), regulating (e.g. climate, flood, water), and cultural (e.g. recreation, aesthetics, spiritual). Each category is associated with how it affects human security, and the provision of materials for life, health, and other social benefits.

With respect to forest and rangeland grazing in the US and Canada, there has been a tremendous amount of research conducted that examines the environmental, social, and economic relationships between grazing and the provisioning of EGSs. Much research focuses on methods to evaluate and improve agricultural effects on the production or mitigation of greenhouse gases, particularly methane (e.g., Alemu et al. 2021, Legesse et al. 2015), or how EGSs, provided by cattle production, offer social benefits and environmental outcomes that support society (e.g., Pogue et al. 2020, Maczko et al. 2011, Havstad et al. 2007). Many authors have also tried to estimate the value of goods and services provided by cattle ranching (e.g., Maher et al. 2021, Tanaka et al. 2011) or the direct and opportunity costs borne by producers to provide EGSs (Ritten et al. 2018).

Since 2005, many other EGS frameworks have been published, but as Depietrie and Orenstein (2019) point out, none but the Common International Classification of Ecosystem Services V5.1 (Haines-Young and Potschin 2018) include the regulating services of wildfire. In the most recent update, "fire protection" was added and accounts for situations whereby "a particular ecological structure, such as a grassland corridor or a wetland area, prevents or mitigates the risk of fire spreading between forest stands," (Haines-Young and Potschin, 2018, p 16.)

Depietrie and Orenstein (2019) suggest that this omission causes fire-regulating services to be overlooked when evaluating ecosystem-based approaches to land management, and certainly the benefits and value of such services. Their research looked at the literature on fire risk reduction to define actions and tools that characterize fire-regulating services and disservices. Among their findings are the positive effects of grazing, when properly implemented, to reduce fuel loads, increase patchiness in fire-prone ecosystems, and limit biomass accumulation. An additional benefit to society is the reduction in potential damage from wildfire and economic benefits to agricultural producers.

European fire managers have incorporated grazing into fire management plans and have reported success in achieving multiple sustainability goals including fire hazard reduction, greater levels of safety for communities from fuel breaks, and economic sustainability. Some of the lessons

learned in the Mediterranean countries could be applied to North America to more closely connect grazing with fire risk mitigation and to support both communities at risk and agricultural producers in ways that provide benefits for all parties.

Integrating Grazing into Fire Management

The Mediterranean ecosystem is one conducive to the occurrence of wildfires given the combination of climate and vegetation. Like North America, the increase in fire activity is not only because of changes to the environment, but socio-economic factors such as land use, growing populations, and the expanding wildland-urban interface (Plana et al. 2016). To manage wildfires, government agencies take the same approach using a range of prevention strategies and tools, and suppression once fires begin. However, fire management often relies on a collaborative approach involving multiple parties to achieve fire protection objectives.

Researchers have explored the positive effects of increasing agricultural production in combination with forest-related activities such as thinning and prescribed burning. Growing evidence indicates that grazing produces EGSs in terms of fire risk mitigation, that grazing is effective and efficient, and that public demand exists for such services (Bernués et al. 2022). One of the challenges is to reach critical mass in terms of the area treated. Ascoli et al. (2023) addressed this issue with a focus on sustainability and determined that modifying landscape flammability at an effective scale required strategic planning between multiple parties and that PES schemes were effective in accomplishing ecological and economic goals. Similarly, Brunson et al. (2016) emphasize the need for collaborative management with multiple stakeholders to achieve socio-economic objectives.

Research by Lecina-Diaz et al. (2023), evaluates the effects of different management scenarios in a simulation run over forty years to determine cost-effective strategies to reduce expected losses from wildfires in Spain and Portugal. Their results indicate that silviculture alone was not enough to provide ecosystem goods and services or to sufficiently reduce potential damages and suppression costs. Rather, the optimal strategy was to increase agricultural production (food and forage/grazing) in combination with standard forest practices. The overall strategy provided value to agricultural producers for increased ecosystem services including fire risk mitigation and expected reductions in suppression costs.

The Mediterranean experience also uses incentives to reward agricultural producers through PES, thus adding to the overall sustainability of the approach (Mena et al. 2016). Varela et al. (2018) evaluated the RAPCA program (*Red de Áreas Pasto-Cortafuegos de Andalucia)* which incorporates extensive livestock grazing into fire management. The program includes 220 shepherds (of largely small ruminants) who work to maintain fuels breaks based on a targeted measure of biomass consumed. Because the program can be monitored and the effects measured according to several key indicators, the arrangement has been considered efficient and sustainable economically, socially, and environmentally.

Emerging research pertaining to North America looks at how grazing can help to reduce wildfire threats. However, it is not generally contextualized as an ecosystem service, and payments for such services are often nil or relatively low in the case of reduced grazing fees. In both cases, payment is not reflective of costs saved or and/or damages avoided.

Notwithstanding, several papers demonstrate the effects cattle grazing can have on reducing fuels. Huntsinger and Barry (2021) reviewed grazing in California making note that ranchers are independent operators not governed by firefighting agencies. They note that agriculture has been an

effective, but neglected, approach to restoring fire-prone ecosystems and that it is efficient, particularly when compared to other fuel reduction alternatives. Barriers to increasing the use of livestock include a lack of awareness of grazing effectiveness and negative views of cattle (e.g., GHG emissions, poor use of public lands). Ratcliff et al. (2022) assessed the effects of cattle grazing on California rangelands. Using the statewide cattle inventory, they estimated that cattle removed 5.3 billion kg of non-woody plant material. Using fire behavior models, they concluded that resulting fires would have lower flame lengths, thus making fires more manageable.

Targeted cattle grazing was the focus of a USDA Climate Hub project designed to create wildfire fuel breaks on public lands. The project is in the Great Basin and relies on collaboration among USDA Agricultural Research Service, the BLM, and a collection of individual ranchers.[8] Because fires greater than 40,000ha (100,000ac) are becoming more frequent, traditional fuels management techniques are no longer cost effective. This project targeted specific areas with high values at risk in three states (Idaho, Oregon, and Nevada). Rather than paying for permits to graze, ranchers were offered payment in terms of waived fees to graze in specific locations and times. Locations were selected based on a combination of forage needs and strategic fire break locations. The outcome in the four years the project has been active is that one fuel break was effective in slowing fire growth and intensity during the pilot project, which was considered successful (Clark et al, 2023).

In British Columbia, in response to the active fire seasons in 2017 and 2018, the provincial government partnered with cattle producers, scientists and communities to reduce forest fuels in fire-prone areas (Schultz and Noulis 2022). Results were positive in that fine fuels were successfully removed using agricultural firebreaks adjacent to rural/urban interests. Additionally, ecological functioning was restored to create ecological patterns that more closely represented historical fire regimes. More research is planned to assess the effects of treatments on fuel connectivity and fuel types.

Research focused on the Great Basin also addresses issues raised in Mediterranean fire management – that of scale. Davies et al. (2022) also suggest that the only tool available to manage rangelands for fire at a meaningful scale is grazing. Wollstein and Johnson (2023) examine the issue more deeply to address challenges brought about by scale including different institutional objectives and capacity, and the difficulties in coordinating actions on the landscape. Their research supports European findings in that innovative solutions that deal with competing land uses and multiple stakeholders will be necessary to manage large wildfires.

Targeting Key Locations

An important area to target for treatment is the wildland-urban interface (WUI). This is the transition zone between wild areas (forests and rangelands) and human development. Johnston and Flannigan (2017) generated the first sets of WUI maps for Canada that included human-built structures such as houses, industrial structures, and infrastructure such as roads and railways. Calculations indicated that in 2017, the WUI made up 32.3 million ha or 3.8% of the total national land area. Furthermore, the industrial interface was 10.5 million ha (1.2%), and the infrastructure interface was 109.8 million ha (13%). They also presented their findings by province and territory. The following table shows their results for the western provinces and territories by percentage of land area (see page 8, Johnston

[8] USDA Climate Hub. No date. Targeted grazing for wildfire fuel breaks. Retrieved from: https://www.climatehubs.usda.gov/hubs/northwest/topic/targeted-grazing-wildfire-fuel-breaks

and Flannigan 2017) to better understand the potential impact to human life in areas prone to wildfire.

Table 1: Percentage of wildland urban interface, industrial interface and infrastructure interface for Canadian western provinces and territories. Source: Johnston and Flannigan 2017, page 8.

	Interface Area as % of Total Land Area		
	Wildland-Urban Interface	Industrial Interface	Infrastructure Interface
Alberta	5.1	5.5	29.0
British Columbia	6.4	2.1	20.5
Manitoba	4.4	0.7	13.5
Northwest Territories	0.2	0.1	3.3
Saskatchewan	3.3	0.6	13.1
Yukon Territory	0.7	0.5	7.0

However, it is important to look beyond the geographic extent. Erni et al. (2021) estimated the wildland-human interface (WHI) using spatial and demographic information. They estimated that the WHI is 17.3% of Canada's forested area and that 12.3% of the country's population live in the interface, which includes 32.1% of First Nations people who live on reserves.

While not all hectares designated as WUI or WHI are suitable for grazing cattle, the Beef Cattle Research Council (BCRC) promotes forest grazing across Canada noting the importance of timing, carrying capacity, and forage needs as well as cautions regarding water quality and erosion, for example (BCRC 2023). Using the WHI and WUI inclusive of infrastructure and industry overlays could help to identify critical areas to expand the use of forest grazing.

The Argument for PES in North America for Wildfire Risk Reduction

The Mediterranean example demonstrates that using local shepherds to reduce fine fuels to mitigate wildfire risk has been successful. Similarly, studies in North America show grazing to have a positive effect on fire risk mitigation through fuel breaks or by reducing fine fuel biomass resulting in lower expected flame lengths. The difference between the two approaches is that the use of agricultural producers to reduce wildfire risk in Europe has been institutionalized with longer term commitments and structured contacts. Why are PES tools not used more widely in North America, particularly for large ruminants in forested locations despite the increasing discourse around the need to account for ecosystem benefits and the benefits from operationalizing such schemes?

Kerr et al. (2021) suggests an "implementation gap" exists in Canada for ecosystem service payment schemes. While there is evidence of payment for services for sheep and goats, for example,[9] public agencies have not fully embraced agriculture as a means of wildfire risk mitigation. The reasons given were that the market instrument is still conceptual and that using PESs are not occurring because values are not used for specific policy analysis or decisions, and that there is no regulatory mandate for provincial land management or firefighting agencies. Similarly in the US,

[9] CommonwealthEditos, a Chicago power company borrowed goats to clear fine fuels. See: https://flaggerforce.com/blog/solar-power-wind-power-tidal-energy-and-nowgoat-power/

over a decade ago, Wu et al. (2011) argued strongly that policymakers in the US failed to account for the full range of costs and benefits associated with restoration after a wildfire. They suggested that EGSs should be valued and included in the decision-making process to ensure long-term forest health. Furthermore, they suggested that the costs associated with high-severity fires vastly outweigh the benefits of landscape projects that reduce the risk and likelihood of fire occurrence. Rogers et al. (2019) recommend that decisionmakers consider the costs and benefits of ecosystem goods and services, both tangible and intangible, and suggest using a benefit transfer approach to make investments in natural hazard reductions.

Final Thoughts

Payment for ecosystem services for wildfire risk mitigation looks promising and has the potential to create a broad range of benefits for society as well as reduce the costs of wildland fire management in the Western US and Canada in both forested areas and grasslands. Additionally, indirect benefits would arise through greater agricultural production. Best practices from the Mediterranean, also supported by research in North America, suggest that the approach on public lands needs to be supported over several years for profitability and should include multiple parties (e.g., government and fire agencies to transfer payments, ecologists, both smaller and larger agricultural producers, and the public), and to be implemented at a sufficient scale for effectiveness. Furthermore, the areas identified should be selected based on proximity to the wildland-urban interface and strategically located to reduce risk. Finally, payments should be linked to quantifiable measures in fine fuel reduction.

While the prospect of using PESs to increase cattle grazing in strategic areas is positive, there would be challenges. Public funders would need to commit to long-term agreements and ranchers would have to be flexible to changes resulting from drought, fuel loads, and forage availability. Specific projects would require consideration of water needs, logistics (e.g., fencing, movement, transportation), timing for risk reduction effectiveness from an ecological perspective, landscape effects, public support, and an efficient payment strategy, mechanism, and amount based on the value of risk reduction and loss avoidance. This paper is intended to spark a dialogue and further research to investigate new opportunities for wildfire risk mitigation.

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