HEALTH & MEDICINE

Spreading Like Wildfire

Economics and wildfire policy offer useful lessons for COVID-19 response.

BY DEAN LUECK AND JONATHAN YODER

The United States in 2020 has been scarred by an extreme wildfire season and a viral pandemic. Fires have ravaged the Southwest, the Rockies, the Pacific Northwest, and California since April. Over that period, 8.6 million acres have been scorched, nearly equivalent to New Jersey and Connecticut combined. California has been the hardest hit, with over 4 million acres burned, 9,200 buildings destroyed, and 31 people killed. Smoke filled the air over 10 states from late July to early September, blanketing cities such as Portland and Seattle and drifting to states in the Great Lakes and Mississippi Valley. Meantime, COVID-19 has been spreading across the country since March, infecting millions and killing hundreds of thousands of Americans, along with many others around the world.

Virus management is perplexing and tortuous. While markets are good at allocating resources to their highest-valued use under the right circumstances, economic activity and associated interpersonal activities in workplaces and shopping places have unintended and contagious consequences not always accounted for in our economic transactions or our regulatory decisions. The dominant response to COVID has been social distancing, sometimes enforced by governments with near draconian measures. Political decision-making and bureaucratic administration seem to dominate the pandemic response, and the consequences on labor and service markets dominated by in-person transactions have been extreme. The cost of social distancing is very high. The benefits may well be even higher, but at this point they are wildly uncertain.

ECONOMIC INSIGHTS

The basic benefit–cost calculation for COVID policy is simple:

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the benefits are the value of the reduction in mortality and morbidity and the costs mostly accrue from lost economic activity. For example, if 1 million lives are saved and each life is valued at $10 million (using the value of a statistical life approach) and the costs are $8 trillion in lost gross domestic product, then the policy generates $2 trillion in net gains. Of course, there is great controversy over the key variables in this calculation: the number of lives saved by these policies, the value of a saved life, and the economic costs of social distancing policies.

The economic basis for decisions becomes even murkier when we ask and try to answer the *how*, *how much*, and *which* questions that inevitably arise in policy design and response. How much testing should be done and who should be tested when there are capacity constraints on testing? Should COVID response for primary and secondary education be different than from higher education? Should guidelines for behavioral response be recommended or mandatory for certain activities? When vaccines are available, should they be subsidized, and if so, by how much?

Despite those questions, the calculus is still conceptually simple: try to implement COVID response so that the incremental benefits of our chosen actions are at least as large as the opportunity costs of pursuing them. The problem is that in an emergency where uncertainties abound, this simple calculus can at best be applied as a provisional stopgap until the next surprise arises. Further, while there are good reasons for government involvement in resource allocation, coordinating action, and designing and

DAVEALAN/GETTY IMAGES (WILDFIRE), LOOPS7/GETTY IMAGES (CORONAVIRUS)

enforcing rules even with the best intentions, there is a disconnect between the benefits and the costs of the decisions being made.

The fundamental economic idea—that important decisions are to be made so that incremental benefits and costs are equated—is seriously challenged during wildfires and pandemics because the incentives of those making decisions are not tightly linked to the full costs and benefits of their behavior. When thinking about the economics of wildfire and pandemics, where transaction costs are high and markets are limited or challenged, the insights of Nobel economics laureate Ronald Coase are fundamental. He recognized the reciprocal nature of harmful effects and drew upon the power of comparative institutional analysis for understanding the economics of organization. For fire and COVID, the reciprocal nature of the "problem," to use Coase's term, is vivid. Fires spread across neighboring properties if and only if each property has fuel to burn. Who should be liable for the damage from a fire, the owner of land from which the fire spread or the owner of neighboring land who kept it in a flammable state? Similarly, the virus spreads from person to person if and only if each person allows enough contact for the virus to transmit. For both fires and COVID, the simple Pigouvian tax approach is not workable because it is not clear what to tax, let alone how to enforce such a tax. Coase's broad consideration of alternative governance structures is a clear and valuable paradigm for understanding settings like fires and COVID. Various public policies, including forms of government regulation, come into consideration.

Insights from two other Nobel economics laureates who focused on governance and institutions—Elinor Ostrom and Oliver Williamson—are also valuable. Ostrom stressed the importance of private and local behavior in solving collective action problems, while Williamson expanded Coase's idea of transaction costs to examine how the costs of establishing, maintaining, and enforcing property rights and contracts shape alternative market and nonmarket systems of governance. Taken together, the insights from Coase, Ostrom, and Williamson provide an economic lens that illuminates more than the standard neoclassical model. They point to understanding a world with a complex mix of interdependent private and public responses across a mosaic of jurisdictions.

Economic punditry has proliferated during the pandemic. Comments tend to be either an elaboration of the high costs of social distancing, the appropriateness of government mask mandates, or a debate about the details of stimulus plans and recession dimensions. But the economic fundamentals of this pandemic are not unique. The metaphor of the virus spreading like wildfire may be cliché, but as wildfire historian Stephen Pyne recently noted, the similarities between infectious disease outbreaks and wildfire outbreaks suggest there are lessons to be learned from wildfire management about strategies to combat the coronavirus pandemic.

COLLECTIVE ACTION

A starting point is to think about purely private and local community responses to wildlife and COVID. The analogies are clear and offer insight into the institutions and organizations that govern fire and pandemics. For wildfire mitigation, private action can include building with fire resistant materials, maintaining defensible space around buildings in fire-prone areas, managing fuel on one's property, and keeping personal firefighting tools handy. For COVID mitigation, private actions can include staying at home, avoiding crowds, wearing masks, and using sanitary techniques as home. These private actions are routinely advised by both wildfire and public health agencies and can be very important. Indeed, a growing body of economic studies of COVID response suggests that private distancing in response to news about the pandemic may have been more important than public mandates, especially in the early months of the pandemic.

Local collective action has shown itself to be common and important for both wildfire and COVID. For wildfire, volunteer firefighting organizations and, more recently, prescribed fire associations for fuel management have emerged where the benefits of relatively small-scale coordinated effort are sufficiently high. As Coase, Ostrom, and Williamson suggest, these local collectives tend to be more important where the number of property owners is relatively small compared to the fire landscapes. For COVID, local collective action is a newer phenomenon compared to organizations for fire and fuel management, but such organization is emerging. For example, "COVID pods" are small groups of families that informally organize to interact with each other but socially distance from other groups in order to mitigate COVID spread and mitigate economic costs of isolation. Members of the pods share childcare and schooling duties as well as other social interactions.

As important as private action and local collective action can be, given the typically large geographic scale of wildfire and COVID spread, such actions are unlikely to fully internalize the costs and benefits of various policies. From this starting point, we consider the economics of wildfire and COVID governance.

Wildfires and COVID / How is the COVID pandemic like a wildfire season? First, both are biophysical phenomena with growth rates that are at first small but can grow quickly under the right conditions. Trees, brush, and grass are fuel for wildfires; people are the fuel for COVID. Through a process of contagion, fire and virus spread through their respective fuels by contact or proximity. The growth and effects of both can be altered by human intervention, and this intervention is most effective when applied during periods of slow growth, when they have not yet affected large numbers. And if not completely extinguished, they can return—"reburn"—to wreak havoc.

Second, both are ephemeral, unpredictable in specific time and space, yet knowable and predictable in broad terms. Knowledge of general patterns allows for preparation and response, but uncertainty and ephemerality make both preparation and response tricky.

Third, no one owns the fire and no one owns the virus. The scale at which the virus and fires emerge and live is vast; regional

for fire, worldwide for the virus. This means that both fire and the virus live on the property of thousands if not millions of private and public parties, and as implied above, a large-scale authority—government—is called forth to coordinate a response.

Fourth, the effectiveness of fire and virus "suppression" is inherently difficult to assess. It is difficult to know—especially in real time—how far the fire or virus would have traveled in the absence of action to control spread, at what intensity and rate, and how destructive it would have been. Indeed, for COVID, this debate itself has been raging since the beginning.

Fifth, the ultimate severities of viruses and fire seasons are highly variable and skewed. Most years, fires are scattered over space and time and exert little pressure on pre-committed resources. In exceptionally bad fire years, fires are large and simultaneous, heavy smoke fills the sky for weeks, and resources are stretched to their limits. The parallels between the COVID pandemic and severe wildfire outbreaks are striking in this regard.

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And sixth, the consequences of both fire and viruses vary substantially depending on how they affect the bio-economic medium through which they spread. Some vegetation is well-suited to withstand fire and even evolved with regular fire occurrence; other vegetation is more likely to succumb to fire. A virus outbreak likewise affects individuals differently, imposing mild symptoms in some cases and death in others. COVID is notable in this regard, having low infection fatality rates in young people but being highly lethal to the elderly.

FIGHTING FIRE

Humans have coexisted with fire and viruses for our entire existence as a species. When people found themselves in the path of a fire, they did what they could to protect themselves. People have been intentionally setting fires to alter habitats for tens or hundreds of thousands of years. Active, more sophisticated suppression techniques are more modern phenomena. Trained fire brigades first emerged in Rome under Caesar Augustus. Wildland fire management developed much later that urban firefighting—around the turn of the 20th century—first to protect valuable stands of private timber. Epidemiology is likewise a recent development; viruses were not even discovered by biologists until 1898 and viral infections were largely unchecked until the middle of the 20th century.

The Great Burn of 1910 was a turning point in wildfire management. It scorched over 3 million acres across Idaho and Montana, killing over 80 people in just a few hot, windy August days. This event was a catalyst that led to the development of the modern network of public agencies to manage wildfire. The rationale for public firefighting is like that for public health efforts to control a virus: the number and heterogeneity of private parties over such huge landscapes (landowners primarily) is just too great to coordinate ad hoc, and special organizational preparations are called for. In particular, the gains from specialization and coordination, combined with certain police powers for firefighters, yield benefits for private parties that the parties themselves—without the government involvement—would be unlikely to achieve. Moreover, because large regions have similar or the same fire seasons (much like virus seasons), they can require resources at the same time, creating bottlenecks in the supply chain for suppression.

Federalism / Wildfire management organization has evolved considerably since the 1910 Burn. The United States now has a network of specialized wildlife suppression crews, mostly employed by public agencies. These assets are organized in a military-style hierarchy of commanders and firefighters and are pre-positioned around the country in fire-prone regions, coordinated by the National Interagency Fire Center in Boise, ID. The network includes a vast array of detection assets, originally in the form of fire lookout towers but now in the form of aerial and satellite surveillance. In addition to trained wildland firefighters employed by the government, the wildfire network is comprised of private contractors who provide aviation assets and other supplies (e.g., food services, heavy equipment operations). These crews and resources are moved around the country based on competing requests of incident commanders.

Federal and state budgets fund these efforts, and the law has evolved to give firefighters near martial law authority and minimal liability when undertaking suppression actions. The annual federal budget for these suppression-related actions has been over $2 billion in recent years. There are considerable state expenditures as well, particularly in California and Texas. The evolution of the organization of firefighting in the United States is a lesson in federalism, with national, state, county, and municipal firefighting units playing their own role in a complex mosaic. These component parts must work together seamlessly for successful mission-critical emergency mobilization.

Virus response is different. Economic historians have found that it has been difficult to coordinate the activities of 50 states with independent authority for efficient infectious disease response. The complexities, tensions, and benefits of defining multi-tiered response vary across geography and jurisdiction. This variation has led to a wide variety of policies and outcomes, which

in turn provides an opportunity to learn from these differences. While health care response to geographically dispersed outbreaks is multi-tiered as well, a great deal of COVID news highlights a natural tendency and perceived need to identify appropriate roles for each level of government for effective response, and both tension and complexity in doing so. Despite the benefits of a federal system for pandemic response, there are downsides.

FROM THE "10 A.M. RULE" TO "LET BURN"

The policies and tactics of firefighting have also evolved. After the 1910 Burn, the federal government invested heavily in fire detection and suppression assets by establishing crews and lookout towers. In 1935 the Forest Service implemented the "10 a.m. Rule," which asserted the goal of extinguishing all wildfire by 10 a.m. the day after detection. This goal required large investments in pre-positioned initial attack crews and was a blanket rule. This one-size-fits-all approach succeeded in stopping most fires before they grew beyond tiny "spot fires." It also led to wasteful over-suppression in remote areas. In parts of the Rocky Mountains and Alaska, where the damage from letting fires burn was low and the cost of suppression was high, it would have been more efficient to economize on these efforts. Eventually, fire policy changed to allow fires to take their natural courses in remote areas or regions managed primarily for natural amenities. This "let burn" policy became famous in the 1988 Yellowstone Park fires. The blazes raged with limited intervention, while protection was focused on high-valued assets such as hotels and related man-made infrastructure.

The trend toward a let-burn policy has been accompanied by a trend toward more targeted "point protection" to reduce losses to high-value assets such as buildings. This is ostensibly a response to growth in the Wildland Urban Interface as development increasingly occurs in forested areas where people find higher amenity value and quality of life. Because firefighting resources tend to be limited, especially during the peak of fire season, firefighters often face a tradeoff between protecting specific buildings at the expense of containment—saving houses in a fire's path while allowing a fire perimeter to grow. Let-burn strategy has merit for several reasons. It focuses effort on saving high-valued assets at the expense of lower payoffs, and it may also reduce future wildfire activity by allowing more fuel to burn instead of accruing in fire-prone areas.

Wildfire policy has evolved as well. It now includes managing fuels by thinning forests and performing prescribed burns to reduce the severity of potential or eventual wildfires. Zoning rules and building codes in urban settings and the Wildland Urban Interface are intended to reduce economic losses when fires do occur. Fuel management is costly and—in the case of prescribed fire—risky, and although anecdotes suggest it can be useful, evidence for its effectiveness in reducing aggregate wildfire losses is scant. Building codes requiring fire-resistant materials and techniques, in contrast, have led to a spectacular decline in structure losses from fire over the last half century, especially in urban settings. As noted above, active surveillance systems have long been an integral part of wildfire preparedness and has evolved from fire lookouts and binoculars on mountaintops to aerial and satellite surveillance platforms. These practices and investments are made in expectation and preparation for fires and are designed to limit the spread and damage from potential fires when they do occur.

APPLYING WILDFIRE POLICY TO VIRUSES

The 10 a.m. Rule is analogous to a uniform pandemic lockdown mandate across a widely diverse society. A let-burn wildfire policy is akin to allowing a virus to run its course, allowing infection and recovery, while permitting private mitigation actions that potentially reduce public response and management costs. A let-burn policy also can inoculate a landscape to near-future re-exposure by allowing the fuel to burn, much like infection induces a body to develop antibodies that may protect individuals and limit contagion for a period of time. But like a let-burn policy, allowing a virus to run its course potentially leads to more immediate losses than an all-out suppression effort. Point protection during a wildfire is akin to targeting the most vulnerable individuals of a disease for protection or treatment. It became evident early in the COVID pandemic that the elderly are significantly more at risk of death from infection. As a result, elder-care facilities should be, and in many cases have been, the focal point of protection, as are the elderly in general.

The COVID analogues to wildfire management are summarized in Table 1. Fuel treatments and zoning are equivalent to social

TABLE 1
Wildlife and COVID-19 Policy Comparisons

	Wildfire Characteristic	COVID-19 Analogue
Prevention and Detection	Fuels management, zoning	Social distancing, masks
	Building codes	Vaccination
	Lookouts, aerial surveillance	Infection status testing
Suppression	Asset prepositioning	Stockpiling protective equipment, clearing houses
	10 a.m. Rule and rapid initial attack under emergency conditions	Lockdown: confinement to residences
	Point protection	Social distancing, mask requirements in public, schools open but elder care homes tightly protected. "Focused protection" of the Great Barrington Declaration.
	"Let burn"	Open economy—treat COVID like the flu
	Over-suppression: long-term fuel accumulation	Loss of immunity and excessive costs

distancing and masks, which reduce risk of contagion across each respective landscape of biological fuels. Vaccination acts as both building code and fuel treatment, reducing private damage and illness and reducing contribution to further contagion. Regional networks and stockpiles for protective equipment and vaccines are like asset pre-season equipment positioning and pre-season contracts and agreements. Targeting specific demographics for avoidance of COVID is like wildfire point protection, and lockdowns during COVID flare-ups are like all-out wildfire suppression.

Incentives/ Public policy is a response to coordination and incentive problems. The fundamental similarities between COVID and wildfire, and between public health response to COVID and wildfire response, come down to similarities in the incentives faced by individuals in a contagious environment of costly spillover. Either harm can spread like wildfire.

A laissez faire approach that relies on purely private, decentralized action could well lead to greater rates of infection and related fatalities than one protected by some element of collective action. Fuel treatments and social distancing may provide self-protection, and no doubt there is strong evidence that people invest in these activities for the protection of themselves, their property, and their loved ones. But these activities also provide public benefits through reducing risk of contagion to others. Masks, for example, provide some private benefit, but also limit spread from one mask-wearing potentially asymptomatic infected individual to others. Vaccinations, which are more invasive and involve some small risk of side effects to the individual being treated, are like building codes. They inoculate the community against damage and destruction by reducing contagion (flammability). While building codes are often mandated by law and mandatory vaccines have been found by the courts to be allowed by the Constitution, they are ostensibly a much heavier lift. Given that a relatively large swath of the population may choose not to be vaccinated, this difference in public control options may be consequential.

In highly mobile societies with networks of interaction that can span the globe, these public benefits from self-protection may be large. This suggests that even if individuals act on private incentives, they will tend to underinvest in these activities because the benefits are spread so widely while the costs are borne privately. Nonetheless, the nature of private response, either suggested or directed through public information campaigns, guidelines, or regulation, are nonetheless generally a crucial dimension of response effectiveness.

All-out suppression for wildfire has included heavy investments in pre-positioned assets and policies like the 10 a.m. Rule. For COVID, all-out suppression means the most extreme lockdowns, in which people are confined to their homes and all but the most essential businesses are prohibited from operating. Focused or "point protection" during a wildfire means suppression is directed to the most valued assets—usually homes and other buildings—while the fire front is generally left to burn through its course. The COVID analogue is an open economy with limited contact restrictions, but with an associated focus on those most susceptible to serious harm, such as the elderly and those having co-morbidities such as diabetes and lung diseases.

DETERMINING SUCCESS

What does economic success look like? For a century, wildfire and wildfire suppression outcomes have been measured and assessed in terms of the area that has burned. Large fire sizes and aggregate acres burned are deemed bad outcomes. This focus is unsatisfactory for two reasons. First, not every burned acre is equally damaging, and not every saved (unburned acre) is equally expensive to protect. Second, what matters is what *did not* burn because of the response and what it cost to protect what was ultimately saved. Firefighting effectiveness is difficult to assess, especially in real time during the emergency, because the necessary comparison is between something that happened and something that did not. Further, assessing the cost-effectiveness of deploying limited available resources across competing mitigation efforts requires information about the relative effectiveness of alternative actions *not* taken (and therefore unobserved). Understanding what was lost is simply not enough for effective policy assessment.

Information is always in short supply during an active emergency, but we can learn from past emergencies. The landscape of COVID response experiments that has arisen through relatively independent and variable approaches across countries and states will provide extremely valuable information for understanding what worked and what did not in the current pandemic, but potentially valuable information must be collected to be used. Although a massive amount of information is collected about wildfire outcomes, little is known about the effectiveness of wildfire preparedness and suppression because data on what lies outside the fire perimeter—and even what was saved inside the perimeter—are hard to come by and compile and have not been the focus of much research.

While there is an economic rationale for the public sector to be responsible for wildfire response, it comes with incentive problems inherent in public resource management. When examined closely, wildfire economics appear rife with inefficiency. Public agencies and their employees do not own the resources they are protecting. They are forced into a position of making value judgments on the resource owners' behalf, while simultaneously watching out for their own employment and safety. In doing so, they are spending public dollars that are not directly tied to the values of the resources they are protecting, most often in an emergency setting where making quick decisions with limited and rapidly changing information is the norm. The firefighting bureaucracy and rules that have developed in part to address these misaligned incentives can themselves lead to mismanagement and waste.

The COVID response in the United States and elsewhere has been subject to the same types of criticisms of mismanagement, waste, and poor coordination that firefighting has been accused of year after year. Consequently, we should not expect COVID

policy to perfectly align marginal costs and benefits along all dimensions of decisions. But it does make sense to focus on that goal and to aim for positive net benefits overall. The wisdom of Coase is clear on this point: Avoid the Nirvana Fallacy by focusing on actual available alternatives, and account for the inevitable and idiosyncratic weaknesses of each in designing a strategy.

CONCLUSION

What can we learn about virus management from wildfire management history?

First, the problem is complex because of the large scale of the challenge preparation and response. Wildfire management has evolved into a highly regimented, multi-tiered organizational structure, designed to balance emergency needs for regional resource deployment and reallocation with spatially and temporally variable conditions. While there is a strong emphasis on active and expensive fire suppression and while there is a growing understanding of the value of prevention and mitigation in the form of fuel management and active or passive controlled burning, there arguably are strong incentives to underinvest in prevention and overinvest in firefighting response. Careful institutional design that mitigates these failings can potentially provide large benefits.

Second, the system and policies will evolve as more is learned. Wildfire management has evolved from a blanket all-out suppression approach to one that varies highly by location, time, and environment.

Third, because of the dominant role of agencies, decisions will be cumbersome and not as fine-tuned as in the market for typical goods and services. Watching these developments and their implementation is and always will be painful. Bureaucratic decision-making cannot be avoided. Political rhetoric is inevitable because there will be public assets in play and politicians allocate them, constrained by laws and constitutions.

Fourth, as with wildfire policy, assessing the net benefits of virus policy is challenging. Thoughtfully designed data collection platforms provide value for the future.

Fifth, a better targeted focus on costs would have the potential to improve COVID governance. The media tend to obsess over total acres burned and total people infected. For wildfire, acres burned has been a focal metric for assessing wildfire outcomes, but it is nearly useless for assessing firefighting effectiveness. Similarly, raw statistics of the number of people infected can illustrate the magnitude of the problem but are only one of many metrics necessary to assess response effectiveness. Populations of infected people, like fire-prone landscapes, are heterogenous, which implies a more focused analysis on costs (e.g., deaths, hospitalization, reallocated health care assets) rather than blunt physical measures like acres and infections.

The high costs of the most extreme lockdowns are being felt and policy seems to be moving toward a more fine-tuned point protection approach in many parts of the world. For COVID, the answer to what would have been the outcome without lockdowns or subsequent partial openings is hotly debated. Early studies predicting widespread U.S. deaths without a lockdown seem far too pessimistic now, but there remains scant consensus among epidemiologists about the optimal path more than half a year into the COVID pandemic. The recent Great Barrington Declaration—a statement by a group of epidemiologists and public health scientists—has challenged the lockdown policy on purely public health grounds, not explicitly considering lockdown costs and benefits. This group advocates what they call "Focused Protection," basically the wildfire analogue to point protection. Intriguingly, several economic studies have shown that much—maybe most—of the social distancing occurred before lockdown policies were enacted in response at least in part to public messaging and information campaigns, suggesting a critical role for government but perhaps with a different emphasis.

We will always have to live with fire and viruses. The idea of eliminating either "at all cost" makes no economic or common sense. Eliminating a single fire, a single outbreak, or even a single virus may be possible, but the calculus and the best strategy for doing so is often nebulous at first and learned over time.

Time will tell how COVID response policies have fared. Did Sweden, with a more relaxed social distancing approach, make a better policy choice than neighboring Norway? In the early summer, Sweden was roundly criticized for its much higher infection and death rates, but this fall that criticism has waned as Swedish schools have remained open, with likely significant long-term benefits for its children, and its economy has rebounded more quickly. Was the South Korean approach of test, trace, and isolate better yet? What about the extreme lockdowns in China and New Zealand? Where does the varied 50-state approach of the United States fit? What we are observing—and research economists love this—is a vast natural experiment in pandemic suppression from which we can and should learn. *R*

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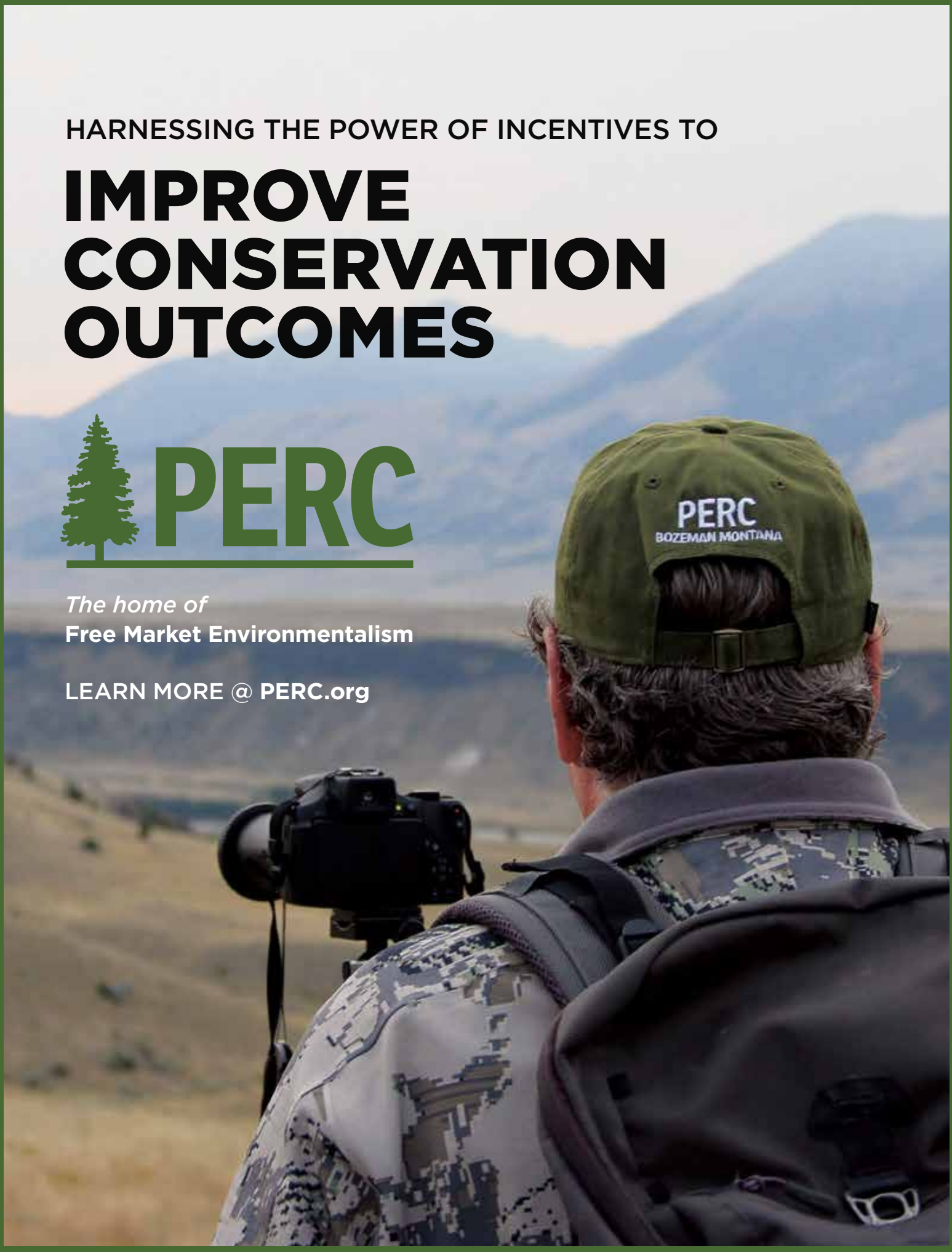

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