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Frequent and Catastrophic Wildfires in Great Basin Rangelands: Time for a Proactive Management Approach ☆

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Frequent and catastrophic wildfires are an increasing threat to the ecological and economic stability of Great Basin rangelands, specifically sagebrush rangelands at risk of exotic annual grass invasion (Crist et al. *this issue*). Historically, fires were a periodic disturbance in these communities that shifted dominance from woody vegetation to herbaceous vegetation (Wright and Bailey 1982; Miller and Rose 1999) and likely promoted diversity (Davies and Bates 2020). Alterations in fuel characteristics with exotic plant invasions and increased anthropogenic ignitions have greatly elevated the likelihood of wildfires in many of these rangelands (Balch et al. 2013; Fusco et al. 2022). However, other rangelands are experiencing decreased fire frequency, largely caused by reduced fine fuels from anthropogenic-induced alterations to plant community composition or land use. Though longer fire return intervals can also be problematic because they cause undesirable plant community compositional shifts and decreased heterogeneity in some rangelands, this special issue is focused on the problem of more frequent and catastrophic wildfires as this is a more pressing concern in terms of the rate of undesirable ecosystem change and risk to property and life.

One of the primary drivers of more frequent fires in the Great Basin of the United States is exotic annual grasses (cheatgrass [*Bromus tectorum* L.], medusahead [Taeniatherum caput-medusae {L.} Nevski], and other species). Exotic annual grasses have altered the historic disturbance regimes by replacing perennial vegetation and providing more continuous and greater amounts of highly flammable fine fuel (Brooks et al. 2004; Bradley et al. 2018). Exotic annual grasses are favored by frequent fire, and they often interrupt natural postfire succession to perennial dominance, leading to an annual grass-fire cycle (D'Antonio and Vitousek 1992; Balch et al. 2013). Vast areas of former perennial-dominated rangelands have transitioned to exotic annual grasslands with low diversity and a high propensity to burn (Bradley et al. 2018), and this ecosystem transformation continues at an alarming pace (Smith et al. 2022). Coupled with and promoted by climate change and CO_2 enrichment, annual grass invasion has fueled more frequent and larger wildfires, with many fires originating in exotic annual grasslands and then spreading into adjacent uninvaded rangelands (Ziska et al. 2005; Bradley 2009; Bradley et al. 2018; Davies et al. 2021). This has in turn facilitated the continued expansion and dominance of exotic annual grasses into previously uninvaded areas, which subsequently further fuels larger and more frequent wildfires.

Though the current fire problem in sagebrush communities of the Great Basin is disproportionately driven by exotic annual grasses, comprehensive assessments of fire risk and fuel management plans will need to address perennial herbaceous fuel in conjunction with annual herbaceous fuel. Fine fuel production and, subsequently, fire risk are highly variable in relatively uninvaded plant communities, as well as exotic annual grasslands. Fire likelihood increases dramatically when weather is favorable for herbaceous vegetation growth, especially over several years (Smith et al. *this issue*). Annual and perennial herbaceous production are equally strong predictors of fire probability; thus, perennial herbaceous

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fuel also contributes substantially to large fire years (Pilliod et al. 2017; Smith et al. *this issue*). Consequently, effective fuel management will need to attend to perennial and annual herbaceous fuel.

Fine fuel management in rangelands, though critically needed to reduce the risk of frequent and catastrophic wildfires, has not received the attention it deserves. Instead, fire mitigation efforts in rangelands have largely been reactive (i.e., suppression focused). A disproportionate emphasis on fuel and fire management in forests is also evident. Without a doubt, fuel management is also needed in rangelands that are experiencing frequent and catastrophic wildfires. Though ignition prevention and improved suppression are needed as integral components of an integrated fire management strategy, fuel management must become a greater management priority in order to meaningfully reduce large, frequent wildfires in rangelands.

Fire probability is predictable in time and space, largely based on fine fuel characteristics (Smith et al. *this issue*). Thus, resources and fuel management can be allocated and applied strategically, and funding can potentially be responsive to identified needs (Maestas et al. *this issue*). Livestock grazing is likely the only feasible treatment to manage fine fuels at the scale needed to influence fire across expansive sagebrush rangelands, though in high production years there is unlikely to be enough livestock to meet fuel reduction goals in all locations. Livestock grazing as a fuel treatment has its limitations, and strategic application is necessary to effectively reduce fire potential. Grazing effects on fuels and wildfire probability vary by level of use (Orr et al. *this* issue) and plant community composition (Thomas and Davies *this issue*), suggesting the need for strategic application of grazing treatments. Though grazing treatments have great potential for fuel management, their application is constrained by logistical and financial challenges (Wollestein and Johnson *this issue*). A collaborative process among land managers, livestock producers, and other interested parties can overcome some of these obstacles (Arispe et al. *this issue*). However, such partnerships must proactively coordinate planning and implementation at relevant scales to meaningfully influence fire occurrence and outcomes (Wollstein and Johnson *this issue*). New technologies, such as virtual fencing, may make strategic fuel management goals easier to achieve with grazing (Boyd et al. *this issue*). Though implementation challenges exist for using livestock grazing to decrease fire probability, collaborative processes and new technologies increase the likelihood that it can be effectively applied as an integral component within an integrated fire management strategy.

The purpose of this collection of manuscripts is to help move management of wildfires toward a more proactive approach. Though the focal area of these manuscripts in this special issue is the Great Basin, these manuscripts may provide insight into other rangelands threatened by more frequent and catastrophic wildfires. This issue provides managers, scientists, and the interested public a current and comprehensive view of the frequent and catastrophic fire problem in Great Basin rangelands, as well as tools and strategies to address it. The objectives of this special issue are to 1) highlight the need for fine fuel management in rangelands, 2) provide managers with the information they need to successfully forecast and reduce the probability of frequent and catastrophic wildfires, and 3) suggest future research and management directions to increase the effectiveness of efforts to reduce wildfire frequency. The information provided in this special issue can be used to improve management of rangelands at risk of frequent and catastrophic wildfires. The time for a proactive approach to fire management in rangelands is now, and the manuscripts collected in this special issue represent a step toward this goal.

Declaration of Competing Interest

We do not have any conflict of interest to declare.

References

Arispe, S. A., Hulet, A., Wollstein, K., Jensen, K. S., Johnson, J. D., Schultz, B. W., and Sprinkle, J. E.*This issue*. Strategically partnering for landscape scale fine fuel management. *Rangeland Ecology & Management*

Balch, J.K., Bradley, B.A., D'Antonio, C.M., 2013. Introduced annual grass increases regional fire activity across the arid western USA (1980-2009). Global Change Biology 19, 173–183.

Boyd, C. S., O'Connor, R., Ranches, J., Bohnert, D. W., Bates, J. D., Davies, K. W., Parker, T., and Doherty, K. E. *This issue*. Using virtual fencing to create fuel breaks in the sagebrush steppe. *Rangeland Ecology & Management*

Bradley, B.A., 2009. Regional analysis of the impacts of climate change on cheatgrass invasion shows potential risk and opportunity. Global Change Biology 15, 196–208.

Bradley, B.A., Curtis, C.A., Fusco, E.J., Abatzoglou, J.T., Balch, J.K., Dadashi, S., Tuanmu, M., 2018. Cheatgrass *(Bromus tectorum)* distribution in the intermountain Western United States and its relationship to fire frequency, seasonality, and ignitions. Biological Invasion 20, 1493–1506.

Brooks, M.L., D'Antonio, C.M., Richardson, D.M., Grace, J.B., Keeley, J.E., DiTomaso, J.M., Hobbs, R.J., Pellant, M., Pyke, D, 2004. Effects of invasive alien plants on fire regimes. Bioscience 54, 677–688.

Crist, M. R., Belger, R., Davies, K. W., Davis, D. M., Meldrum, J. R., Shinneman, D. J., Remington, T. E., Welty, J., and Mayer, K. E.*This issue.* Trends, impacts, and cost of catastrophic and frequent wildfires in the sagebrush biome. *Rangeland Ecology & Management*

D'Antonio, C.M., Vitousek, P.M, 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. Annual Review of Ecology and Systematics 23, 63–87.

Davies, K.W., Bates, J.D., 2020. Re-introducing fire in sagebrush-steppe experiencing decreased fire frequency: does burning promote spatial and temporal heterogeneity? International Journal of Wildland Fire 29, 686–695.

Davies, K.W., Leger, E.A., Boyd, C.S., Hallett, L.M., 2021. Living with exotic annual grasses in the sagebrush ecosystem. Journal of Environmental Management 288, 112417.

Fusco, E.J., Balch, J.K., Mahood, A.L., Nagy, R.C., Syphard, A.D., Bradley, B.A., 2022. The human-grass-fire cycle: how people and invasives co-occur to drive fire regimes. Frontiers in Ecology and Environment 20, 117–126. doi:10.1002/fee.2432.

Maestas, J. D., Smith, J. T., Allred, B. W., Naugle, D. E., Jones, M. O., O'Connor, C., Boyd, C. S., and Davies, K. W. *This issue.* Using dynamic, fuels-based fire probability maps to reduce large wildfires in the Great Basin. *Rangeland Ecology & Management*

Miller, R.F., Rose, J.R., 1999. Fire history and western juniper encroachment in sagebrush steppe. Journal of Range Management 52, 550–559.

Orr, D., Bates, J. D., and Davies, K. W.*This issue.* Grazing intensity effects on fire ignition risk and spread in sagebrush steppe. *Rangeland Ecology & Management*

Pilliod, D.S., Welty, J.L., Arkle, R.S., 2017. Refining the cheatgrass-fire cycle in the Great Basin: precipitation timing and fine fuel composition predict wildfire trends. Ecology and Evolution 7, 8126–8151.

Smith, J. T., Allred, B. W., Boyd, C. S., Davies, K. W., Jones, M. O., Kleinhesselink, A. R., and Naugle, D. E.*This issue.* Where there's smoke, there's fuel: predicting Great Basin rangeland wildfire. *Rangeland Ecology & Management*

Smith, J.T., Allred, B.W., Boyd, C.S., Davies, K.W., Jones, M.O., Kleinhesselink, A.R., Maestas, J.D., Morford, S.L., Naugle, D.E., 2022. The elevational ascent and spread of exotic annual grass dominance in the Great Basin, USA. Diversity and Distributions 28, 83–96.

Thomas, T. W., and Davies, K. W.*This issue*. Grazing effects on fuels vary by community state in Wyoming big sagebrush steppe. *Rangeland Ecology & Management*

Wollestein, K. L., and Johnson, D. D. *This issue.* Integrating rangeland fire planning and management: the right scale, people, and processes. *Rangeland Ecology & Management*

Wright, H.A., Bailey, A.W., 1982. Fire ecology: United States and Southern Canada. John Wiley & Sons, Inc, New York, NY, USA 496 p..

Ziska, L.H., Reeves, J.B., Blank, B., 2005. The impact of increases in atmospheric CO_2 on biomass production and vegetation retention of cheatgrass *(Bromus tectorum):* implications for fire disturbance. Global Change Biology 11, 1325–1332.