Northwest Fire Science Consortium

A JFSP FIRE SCIENCE EXCHANGE NETWORK

WILDFIRE RISK IN WESTERN OREGON AND WASHINGTON

A brief review of recent scientific literature examining hazard west of the Cascades

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The wildfires that ignited September 7-9, 2020 (collectively named the "Labor Day Fires") on the west side of the Oregon Cascades (Westside) were a devastating reminder that these communities and forests are at risk from wildfires. The fires collectively burned more than 2.2 million acres, caused fatalities and billions of dollars in damage, placed more than 10% of the state's residents under evacuation advisories, and created hazardous air quality conditions across the northwestern US.

That the Labor Day Fires occurred at all, let alone the magnitude of the event, surprised many people in the region and raised questions about forecasting and preparing for future Westside wildfires. Many common wildfire risk assessment and communication methods were developed in dry forest settings and may not be well-suited for the Westside's unique socioecological context. The fires left researchers, practitioners, and local residents questioning how to better expect and prepare for similar events in the future. The three articles summarized in this brief focused on the challenges of understanding and communicating about wildfire surprises and risk in Westside systems, and how to better predict where similar events might happen in the future. A fourth article summarizes the key meteorological drivers behind the Labor Day fires.

KEY FINDINGS

Article	Research objective	Research approach	Main findings
1. Hulse et al. 2016	Identify how, where, and why future wildfire events might deviate from historical expectations in different scenarios in the Willamette Valley, Oregon.	Use geodesign techniques to create agent-based alternative futures simulation models that analyze whether, how, and why modeled patterns and likelihoods of future fires differ under climate change compared to historical fire activity.	The likelihood of surprising fires differed significantly between high and low climate change futures; in some areas well-intentioned actions contributed to surprisingly large fires under extreme fire weather. The divergence of surprise fire outcomes between different future scenarios resulted from complex interactions of biophysical events and sociocultural actions.
2. McEvoy et al. 2020	Explore the range of plausible mid-21st century changes in wildfire hazard and exposure in a municipal urban westside Oregon watershed.	Simulate wildfire occurrence and fire regime characteristics under contemporary and mid-21st century scenarios.	There was a wide range of plausible future fire frequency, extent and behavior, but most results indicate that wildfire will be more common and widespread as a result of climate change. Under the hottest and driest scenarios, novel fire regime characteristics suggest that permanent changes to forest structure, composition, and ecosystem services may occur.
3. McEvoy et al. 2021	Demonstrate the value of specific and intentional methods for characterizing community wildfire risk in low-frequency fire regimes.	Use wildfire simulations and building location data to identify plausible future wildfire disasters and evaluate Westside community wildfire exposure. Compare simulated disasters to historical events to determine whether simulations provide novel insight into community risk profiles.	Nearly half of Westside communities are vulnerable to a wildfire disaster, the magnitude of plausible disasters exceeds recent historical events, and ignitions on private land are most likely to result in very high community exposure to wildfire disasters.

The Northwest Fire Science Consortium is a regional fire science delivery system for disseminating knowledge and tools, and a venue for increasing researcher understanding of the needs of practitioners.

1. Hulse, D., A. Branscomb, C. Enright, B. Johnson, C. Evers, J. Bolte, and A. Ager. 2016. "Anticipating surprise: Using agent-based alternative futuressimulation modeling to identify and map surprising fires in theWillamette Valley, Oregon USA." ***Landscape and Urban Planning*** **156: 26–43. https://doi.org/10.1016/j.landurbplan.2016.05.012.**

The authors in this study draw on recent literature on the concept of surprise and how to avoid "expecting wrong" in environmental planning and design. Surprising fire behavior in this context is that which falls outside of expectations defined through an analysis of historic fire records. By modeling hundreds of spatially explicit alternative futures composed from different climate, residential development, and fuels hazard management scenarios across 50-years, the authors explore how, when, and where surprising fires in the Willamette Valley (Oregon) study area may occur.

RESULTS

Climate scenarios:

- Likelihood of surprising fire diverged dramatically under Low climate change and High climate change regimes, with climate change playing the dominant role in determining likelihood that a surprising fire would occur in the study area over the 50 years.
- In High climate future scenarios, surprising fires tended to start in areas with higher ignition probability but less hazardous fuels that did not result in ignitions under Low climate scenarios.

Fuels management and residential development scenarios:

- Surprising fires were both more frequent and larger under scenarios with Mixed fuels treatment approaches to managing fire hazard (increase landscape resiliency to fire by restoring fire-adapted oak ecosystems, reduce fire intensity and spread) compared to Conventional fuels management approaches (protect life and property by supporting rapid fire suppression, reduce fire spread and intensity). Despite well-intentioned land management actions in the Mixed approach, factors like slope, aspect, treatment areas, and vegetation heterogeneity, and fuels accumulation contributed to fires that burned with higher intensity and faster spread rates under extreme fire weather.
- Compact development increased the likelihood of a large fire marginally in comparison to Dispersed development.

Complex interactions among scenarios:

- In a smaller focal area of a wildland urban interface within the larger study landscape, the spatial pattern of surprising fires was similar for both Low and High climate futures, suggesting that landscape-scale events and actions similar to both climate scenarios influenced the likelihood of specific locations in the area experiencing a surprising fire.
- In this focal area, under Low climate models, when agents reacted to increased fire with a Mixed fuels approach (reducing risk in areas of high ignition probability by restoring oak savannahs and oak woodland grasslands), wildfires without historic precedent resulted. Essentially, under extreme fire weather in this scenario, fuels management actions created higher probability of rapid fire spread from treated to untreated areas where the fires then spread even more rapidly and with great intensity. This result highlights how surprising fires can result from the interplay between biophysical events and management actions under extreme conditions that become more likely due to climate change.
- The authors highlight that while the assumptions of each scenario influence overall fire likelihood and extent, "the observed spatial pattern of surprise fire likelihood is a property emerging from complex interactions among weather, vegetative succession, the character of human occupancy of the landscape, topography, human response to perceived fire risk, and other factors." (34)

MANAGEMENT IMPLICATIONS

In areas where models indicated that events and actions can combine under future climate scenarios to result in wildfire outcomes that are at odds with expectations, targeted programs of landowner education and fire hazard reduction strategies can help prepare for future novel fire scenarios. Because well-intentioned fuels reduction actions under some scenarios (focusing efforts in one type of high risk landscape) led to surprising fires, managers and policymakers may need to consider landscape-level effects that could inadvertently arise from site-scale restoration efforts such as landowners acting to protect their properties. Finally, in design and planning disciplines, anticipating surprise requires coping with increasing information and complexity, and a transition from deterministic, or precisely predictable, approaches to those that, like alternative futures modeling, "probabilistically explore trajectories."

2. McEvoy, A., M. Nielsen-Pincus, A. Holz, A.J. Catalano, & K.E. Gleason. 2020. "Projected Impact of Mid-21st Century Climate Change on Wildfire Hazard in a Major Urban Watershed outside Portland, Oregon USA." ***Fire*** **3(4): 70. https://doi.org/10.3390/fire3040070.**

Authors in this study used four climate scenarios for 2040-2069 to model potential climate change impacts on wildfire hazard in the Clackamas watershed, an important source of drinking water for the Portland metro area. They compared wildfire hazard projected under each scenario to the hazard projected under baseline (current) conditions, and speculated on how these changes might or might not lead to permanent shifts in forest structure and composition and the provision of ecosystem services.

RESULTS

In all mid-century climate scenarios, wildfire regime characteristics changed significantly. Specifically:

- Fire season: The length of the fire season expanded in three of the four scenarios. On average, scenarios projected a three-week increase in fire season length compared to baseline (current) conditions;
- Annual area burned increased anywhere from 50% to 540% compared to baseline conditions. The likelihood of years with no fires decreased in all mid-century scenarios.
- Large fire size and frequency: The size of large fires increased in each future climate scenario and extremely large fires (exceeding 99th percentile of baseline conditions) were up to eight times more frequent;
- Wildfire hazard (product of annual burn probability and wildfire intensity) increased under all scenarios and was the primarily driven by increased burn probability.
- Spatial distribution of hazard: The geographic distribution of wildfire hazard across the watershed followed the same spatial pattern in baseline and future scenarios, but under hotter and drier conditions wildfires could be more common in the lower watershed, directly affecting water infrastructure and communities.

Based on these results, the authors suggest that under hotter and drier mid-century climate conditions, the fire regime in the upper Clackamas Basin will be increasingly similar to that of contemporary high-frequency fire regimes in areas like central Oregon. Such a shift would represent a new disturbance regime that could plausibly lead to changes in dominant forest types and affect the provision of ecosystem services in the watershed.

MANAGEMENT IMPLICATIONS

Understanding the range of plausible future wildfire hazard helps planners and managers design climate adaptation and wildfire risk reduction strategies at appropriate scales. Given the differences of plausible future wildfire hazard between different climate change scenarios, the authors suggest that the most robust adaptation plans will be those that maintain essential ecosystem services across the broadest range of future hazard scenarios. Specifically, managers might use these results along with assessments of probable consequences to specific resources or assets "to develop climate adaptation strategies that balance forest management, fire suppression, and community preparedness to achieve a range of risk reduction objectives (70)."

3. McEvoy, A., B.K. Kerns, & J.B. Kim. 2021. "Hazards of Risk: Identifying Plausible Community Wildfire Disasters in Low-Frequency Fire Regimes." *Forests* 12(7): 934. https://doi.org/10.3390/f12070934.

Responding to risk assessments that commonly characterize westside communities as "low risk" compared to interior PNW communities, the authors assessed westside building exposure to simulated wildfires disasters as a way to characterize risk for low-probability, high-consequence wildfires.

RESULTS

Simulations showed that many westside communities are vulnerable to plausible wildfire disasters that do not resemble historic events. Specifically:

- Over 40% of westside communities are vulnerable to plausible disasters, including many communities with no historical wildfire exposure and communities in the most populated areas of the region.
- Simulations included wildfires that exposed more than 2,000 structures in major metro areas–nearly twice as many as were exposed in any of the 2020 Labor Day Fires.
- Contrary to historical fires, simulated wildfires that exposed the most buildings were not always the largest fires.
- Some communities are more vulnerable than others. Communities that experienced the most wildfire disasters or the greatest exposure were not always those with the highest annual burn probabilities.
- 86% of simulated wildfire disaster exposure resulted from ignitions that occurred within the community where exposure occurred; over 70% of simulated disasters ignited on privately owned land.

MANAGEMENT IMPLICATIONS

Results from this research give insight to westside planners and managers who need to know how to characterize wildfire risk that–owing to the low frequency of wildfire events in the region–is absent from traditional probability-based risk assessments. The methods offer a way to support investments in and communication with communities with plausible exposure to low probability, high consequence wildfires. Planners and managers can use results from this analysis, for instance that ignitions on private lands are most likely to result in very high community wildfire exposure, to guide communication, hazard assessment, and risk prevention strategies. They can also use the approach to evaluate exposure for other resources at risk (e.g., water resource) in efforts to further explore community vulnerability.

Climate and meteorological drivers of the Labor Day Fires

Article: Abatzoglou, J.T., D.E. Rupp, L.W. O'Neill, & M. Sadegh. 2021. "Compound extremes drive the Western Oregon wildfires of September 2020." *Geophysical Research Letters*, 48. https://doi.org/10.1029/2021GL092520.

Research objective: Understand the climate and meteorological factors drivers of the 2020 Labor Day fires in western Oregon.

Research approach: Compare conditions during the Labor Day Fires with those during other very large wildfires in western Oregon since 1900.

Results: The unprecedented concurrence of multiple extreme weather-related factors at the same time facilitated the spread of the Labor Day fires. **Specifically:**

- Conditions during the Labor Day fires were similar to those recorded during other historic very large western Oregon wildfires, but no individual weather of fuel condition was the most extreme on record. Rather, the concurrence of dry-windy weather, easterly wind direction, and dry fuels created unprecedented conditions.
- Similar to the Labor Day fires, the 13 very large fires in western Oregon since 1900 tended to occur during periods of below-average precipitation and above-average temperatures. The Labor Day Fires had neither the warmest nor the driest preceding months compared to the other very large fires. All 13 historic very large fires were also associated with a period of downslope easterly (offshore) wind during the event.
- At the same time fire danger indices in the area had increased with unusually warm temperatures by early September. When easterly winds picked up, they created a combination of extremely dry fuels and easterly wind that was unprecedented during the historical record examined.

Management implications: The analysis illustrates how individual conditions that create a level of hazard that managers may feel prepared for or experienced with can quickly lead to unprecedented conditions when they happen at the same time. Results support wildfire planning and preparation efforts in westside areas such as the development of fire early warning systems based on forecastable metrics. Additional research is needed to better understand the likelihood of concurrent extreme weather factors and how that likelihood may change in the future.

SUMMARY

Westside managers face unique socioecological considerations when planning for and responding to extreme Westside wildfire events, and the 2020 Labor Day Fires highlighted some of the challenges that managers face. Long fire return intervals in the region create a level of uncertainty that is further compounded by dynamic uncertainties surrounding climate change's possible effects on fire frequency, extent, and behavior. These fires highlighted the salience of wildfire research that focuses specifically on Westside socioecological settings.

The reviewed articles illustrate how wildfire simulations can provide critical insights and opportunities to communicate risk in low probability, high consequence settings. Each article points to critical knowledge gaps related to Westside wildfire. Collectively they make the case for more research aimed at understanding the drivers and consequences of Westside fire, as well as research aimed at developing robust climate adaptation strategies.

MORE INFORMATION

For more information on westside wildfire risk see:

West-Side Fire Research Initiative: https://www.fs.usda.gov/pnw/projects/fire-and-climate-adaptation-oregon-and-washington-west-side-forests

West-Side story map: https://storymaps.arcgis.com/stories/e6d0ee575e9948b5b956b6ed9237a374

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Photos from 2020 fire season and public domain courtesy of USDA Forest Service, Pacific Northwest Region 6.