USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Northern Rockies Fire Science Network | Rocky Mountain Research Station

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How Effective Are Landscape Scale Fuel Treatments?

Appropriately designed fuel treatments reduce negative outcomes of wildfire and in some cases promote beneficial wildfire outcomes. Wildfires are a landscape scale phenomenon; therefore, fuel treatments should be evaluated at a landscape level to maximize effectiveness. This requires shifting perspective to think of a landscape mosaic, rather than an individual site. Given the inability to treat all forests at risk from wildfire, understanding where and how fuel treatments can be most influential at the landscape scale is crucial. Scientists at the USDA Forest Service, Rocky Mountain Research Station (RMRS) recently examined what we currently know about the effectiveness of landscape scale fuel treatments from literature reviews of empirical evidence, simulation studies, and case studies.

Documented benefits and challenges of landscape-scale fuel treatment

Benefits

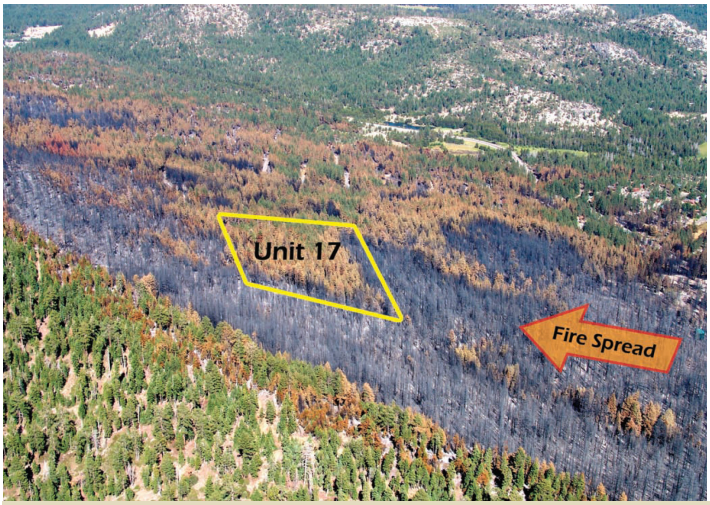
- Fire behavior becomes less extreme
- Reduces the rate of spread, progression, extent, or severity of wildfires both within and outside of treatment areas
- Facilitates suppression efforts such as burnout operations and fireline construction
- Increases perceptions of safety among firefighters

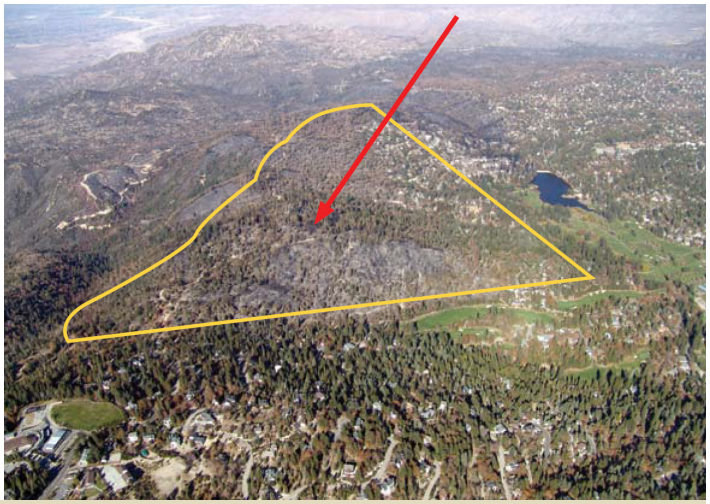
Challenges

- Fuel treatments must be maintained to remain effective
- Conflicting objectives (e.g., fuels, timber, wildlife, restoration) can complicate implementation
- Perceived success of treatments is often dependent on fire suppression efforts

Simulation studies and case studies: Extent, size, placement, timing, and prescription

- Extent: A larger treated area that reduces fuel loads across multiple vegetation layers is more effective, but there can be diminishing returns after reaching a treatment threshold of 20–30 percent of a landscape.
- Size: Depends on variables such as fire duration, fuel heterogeneity, and fuel load. Size is not as important as treatment design or extent and placement.
- Placement: Location optimization tools increase effectiveness but may depend on management objectives. For example, prioritizing treatments in stands with the greatest fire threat generally leads to a greater reduction of wildfire at the landscape scale compared to prioritizing stands near the wildland-urban interface (WUI), but the latter is generally more effective for protecting the WUI.





Examples of fuel treatments affecting landscape-scale fire behavior. Fuel treatment areas are outlined in yellow; arrows indicate prevailing direction of wildfire spread. Left: Angora Fire, Tahoe Basin, California (Murphy et al. 2007). Right: Grass Valley Fire, San Bernadino National Forest, California (Rogers et al. 2008).

- Timing: Recent treatments mitigate fire behavior more effectively than older treatments, although the length of time needed before retreatment depends on many factors.
- Prescription: Treating multiple strata (crown, ladder, and surface fuels) across large portions of the landscape reduces fire spread and severity. Treatment designs should integrate fuels, topography, prevailing winds, fire, or treatment history and available infrastructure.
- Treatment effectiveness was limited during periods of extreme fire weather, underscoring the need for treatment designs to incorporate the increasing occurrence of extreme burning conditions.

Fuel treatment effectiveness framework

The fuel treatment effectiveness framework is presented by RMRS scientist Sharon Hood and colleagues as a simple way to quantify current fuel hazard and fuel treatment effectiveness over time. Treating a landscape as a large spatial mosaic of landforms and ecosystems, this framework offers an informative approach to determining multiple fuel treatment outcomes over greater spatial and temporal scales compared to current reporting statistics but is less complex than fire simulation modeling.

- Phase One: Evaluating hazard, looking at both stand level and landscape level attributes.
- Phase Two: Evaluating treatment effectiveness, looking at environmental and ecological indicators as well as social values.

This process allows individual fuel treatments to be placed in the context of a fuel management regime and evaluated based on desired conditions to meet management objectives. Taking an iterative approach, with continued learning and adaptation, this framework can focus regional and national fuel management planning efforts on creating fuel management regimes that increase social and ecological resilience to wildfire.

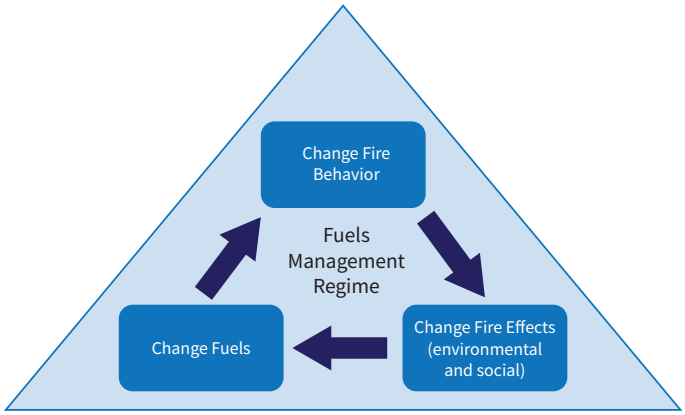
Challenges and research gaps

The current measurements for landscape scales are course, such as acres treated by activity type, area in high wildfire potential, number of fires, and acres burned. But reporting those numbers does not convey the type of fires and distribution of fire size, so a shift is required to move from reporting acres burned to reporting how the fires burned. Additionally, both limited resources and competing objectives can be a barrier to landscape scale fuel treatment implementation. More research is needed on effectiveness in non-forested ecosystems and on topics such as cost-benefit analysis and fuel treatment longevity. Future research should seek new ways to interpret the role of fuel treatments on a landscape level in order to provide insight on strategic designs and approaches to maximize treatment effectiveness.

Learn more

Webinar: Landscape Fuel Treatment Effectiveness Webinar

Science You Can Use: Can Fuel Treatments Change How a Wildfire Burns Across a Landscape?



Fuel management regime triangle consists of changing fuels to achieve desired fire behavior that will result in desired ecological and social fire effects, whether at stand or landscape scales (Hood et al. 2022).

FURTHER READING

Hood, S.M.; Varner, J.M.; Jain, T.B.; Kane, J.M. 2022. A framework for quantifying forest wildfire hazard and fuel treatment effectiveness from stands to landscapes. Fire Ecology. 18:33.

Jain T.B.; Abrahamson, I.; Anderson, N.; Hood, S.; Hanberry, B.; Kilkenny, F.; McKinney, S.; Ott, J.; Urza, A.; Chambers, J.; Battaglia, M.; Varner, J.M.; O'Brien, J.J. 2022. Effectiveness of fuel treatments at the landscape scale: State of understanding and key research gaps. Final Report for Joint Fire Science Project, 19-S-01-2. 71p.

McKinney, S.; Shawn, T.; Abrahamson, I.L.; Jain, T.B.; Anderson, N.; Nathaniel, M. 2022. A systematic review of empirical evidence for landscape-level fuel treatment effectiveness. Fire Ecology. 18:21.

Murphy, K.; Rich, T; Sexton, T. 2007. An assessment of fuel treatment effects on fire behavior, suppression effectiveness, and structure ignition on the Angora Fire. USDA Forest Service, R5-TP-025.

Ott, J.E.; Kilkenny, F.F.; Jain, T.B. 2023. Fuel treatment effectiveness at the landscape scale: A systematic review of simulation studies comparing treatment scenarios in North America. Fire Ecology. 19:10.

Rogers, G.; Hann, W.; Martin, C.; Nicolet, T.; Pence, M. 2008. Fuel treatment effects on fire behavior, suppression effectiveness, and structure ignition on the Grass Valley Fire. USDA Forest Service, R5-TP-026a.

Urza, A.; Alexandra, K.; Hanberry, B.; Jain, T.B. 2023. Landscape-scale fuel treatment effectiveness: Lessons learned from wildland fire case studies in forests of the western United States and Great Lakes region. Fire Ecology. 19:1.

Rocky Mountain Research Station researchers work at the forefront of science to improve the health and use of our Nation's forests and grasslands. More information about Forest Service research in the Rocky Mountain Region can be found here.

The Northern Rockies Fire Science Network (NRFSN) serves as a go-to resource for managers and scientists involved in fire and fuels management in the Northern Rockies. The NRFSN facilitates knowledge exchange by bringing people together to strengthen collaborations, synthesize science, and enhance science application around critical management issues.