Forest Ecology and Management 375 (2016) 84–95

Contents lists available at ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

Tamm Review: Are fuel treatments effective at achieving ecological and social objectives? A systematic review

Elizabeth L. Kalies [a,*], Larissa L. Yocom Kent [b]

[a] Ecological Restoration Institute, Northern Arizona University, PO Box 15017, Flagstaff, AZ 86011-5017, United States
[b] School of Forestry, Northern Arizona University, PO Box 15017, Flagstaff, AZ 86011-5017, United States

ARTICLE INFO

Article history:
Received 9 March 2016
Received in revised form 12 May 2016
Accepted 14 May 2016

Keywords:
Forest restoration
Fuel management
Prescribed fire
Treatment effectiveness
Western dry forests
Wildfire

ABSTRACT

The prevailing paradigm in the western U.S. is that the increase in stand-replacing wildfires in historically frequent-fire dry forests is due to unnatural fuel loads that have resulted from management activities including fire suppression, logging, and grazing, combined with more severe drought conditions and increasing temperatures. To counteract unnaturally high fuel loads, fuel reduction treatments which are designed to reduce fire hazard and improve overall ecosystem functioning have been increasing over the last decade. However, until recently much of what we knew about treatment effectiveness was based on modeling and predictive studies. Now, there are many examples of wildfires burning through both treated and untreated areas, and the effectiveness of treatments versus no action can be evaluated empirically. We carried out a systematic review to address the question: Are fuel treatments effective at achieving ecological and social (saving human lives and property) objectives? We found 56 studies addressing fuel treatment effectiveness in 8 states in the western US. There was general agreement that thin + burn treatments had positive effects in terms of reducing fire severity, tree mortality, and crown scorch. In contrast, burning or thinning alone had either less of an effect or none at all, compared to untreated sites. Most studies focused on carbon storage agreed that treatments do not necessarily store more carbon after wildfire, but result in less post-wildfire emissions and less carbon loss in a wildfire due to tree mortality. Understory responses are mixed across all treatments, and the response of other ecological attributes (e.g., soil, wildlife, water, insects) to treatment post-wildfire represents an important data gap; we provide a detailed agenda for future research. Overall, evidence is strong that thin + burn treatments meet the goal of reducing fire severity, and more research is needed to augment the few studies that indicate treatments protect human lives and property.

© 2016 Elsevier B.V. All rights reserved.

Contents

* Corresponding author.
E-mail addresses: liz.kalies@nau.edu (E.L. Kalies), larissa.yocom@gmail.com (L.L. Yocom Kent).

http://dx.doi.org/10.1016/j.foreco.2016.05.021
0378-1127/© 2016 Elsevier B.V. All rights reserved.

1. Introduction

Across dry forests of the western United States, stand-replacing forest fires are increasing in frequency and extent (Westerling et al., 2006; Miller et al., 2009). This change is occurring in historically frequent-fire forests due to unnaturally high fuel loads that have resulted from a century of fire suppression, logging, and grazing, combined with more severe drought conditions and rising temperatures (Covington, 2000; Fry and Stephens, 2006). Climate change is likely to exacerbate the situation, most likely resulting in increases in tree mortality due to competition, drought, insects and pathogens, and increases in wildfire size and severity (Garfin et al., 2013). These changes may already be occurring; several states in the western US, including Washington, New Mexico, Arizona, Utah, and California have experienced their largest wildfire in recorded history since 2000. An increase in fire severity has been documented in some regions as well (Miller et al., 2009; Poling, 2016).

Research over several decades has demonstrated heavier fuel loads present in today's forests compared to historical conditions (e.g., Covington and Moore, 1994; Taylor, 2004; Fry and Stephens, 2006). Fuel reduction treatments, including prescribed fire, mechanical thinning, and pile burning, are designed to create a more open forest structure and reduce fire hazard by removing surface fuels, increasing the height of the canopy and reducing canopy fuels, and retaining large, fire-resistant trees (Agee and Skinner, 2005; L.L. Stephens et al., 2012). These treatments also may improve overall ecosystem function, by increasing rates of decomposition and nutrient cycling, water availability, carbon storage, plant biodiversity, and populations of native wildlife species (Converse et al., 2006; Finkral and Evans, 2008; Boerner et al., 2009). Because of the potential benefits for reducing fire hazard and increasing ecosystem function, U.S. Department of the Interior land management agencies and the U.S. Forest Service spent an average of $522 million annually between 2002 and 2012 on fuel reduction treatments, and treated an average of 1.1 million hectares between 2002 and 2006 (Gorte, 2011, 2013), in the hopes of preventing catastrophic wildfires.

Despite the strong belief that fuel treatments should be effective in reducing fire risk, and their increased implementation on the landscape, firefighting costs have tripled over the last 25 years (Gorte, 2013). Thus, either treatments are not working as predicted, or they are not being implemented widely enough. Meanwhile, millions of hectares of forest containing uncharacteristically heavy and continuous fuel loads persist on the landscape (Covington, 2000), and fuel treatments are the subject of significant public and policy debate about risks, particularly in regards to prescribed fire, versus rewards (Kline, 2004; Ryan et al., 2013). It is timely to assess the current state of knowledge about fuel treatment effectiveness.

Research on fuel treatment effectiveness has been increasing in many fire-prone regions of the world. For example, prescribed fire has been implemented in Australia since the mid-1950s, and a review on the subject concluded that prescribed fires are effective in reducing fire severity, particularly <5 years post-treatment (Fernandes and Botelho, 2003). In Europe, treatments have been implemented more recently (circa 1990s) and mostly in the form of fuelbreaks; fuel reduction treatments have been limited due to high costs, minimal area where they can be implemented, and legal barriers (Xanthopoulos et al., 2006). In North America, fuel reduction treatments are widely implemented in dry forests and are thought to be a valuable land management tool (L.L. Stephens et al., 2012), but there has been no review of treatment effectiveness based on actual responses after wildfire, and modeling studies only provide predictions of fire behavior based on given forest and weather conditions, and could be misleading (Cruz and Alexander, 2010). After two decades of wide-spread treatment implementation in the U.S. and Canada, there are now many examples of wildfires burning through both treated and untreated areas, and the effectiveness of implemented treatments can be evaluated empirically. We chose to focus on western North America due to the need for synthesis and the particular forest history of the place: fire regime interruption resulting from westward expansion and settlement, and subsequent intensive livestock grazing, all temporally correlated (Fulé et al., 1997). There has also been a fairly consistent forest management response via the U.S. Forest Service (Dellasala et al., 2004). Thus, our review is directly relevant to the importance that fuel treatment effectiveness has for natural resource policy in the western U.S.

Evidence-based reviews, including systematic reviews, are being used in ecology as an objective and rigorous means of accessing and synthesizing the literature (Peppin et al., 2010; Fulé et al., 2012). The goal of a systematic review is to exhaustively search and obtain data in all relevant, peer-reviewed journal publications as well as unpublished, often not peer-reviewed, gray literature using clearly defined and replicable procedures. The final review uses criteria to rank the quality of each source of evidence, quantitatively or qualitatively summarizes the findings (using the quality of evidence as a weighting scheme), highlights areas where additional research is needed, and provides management recommendations that incorporate the quality of individual science findings (Pullin and Stewart, 2006). Systematic reviews are excellent tools for identifying the extent of research on a topic, including research gaps (Lortie, 2014). In this review, we identified studies that examined treated and untreated sites, both post-wildfire, to evaluate the current state of knowledge about whether treatments are more effective than no action, and whether certain treatments are more effective than others. Our objective was to address the question: What evidence is there that fuel treatments are effective at achieving ecological (restoring ecosystem structure, composition, and function) and social (saving human lives and property) objectives?

2. Methods

We searched Web of Science and Google Scholar databases for papers published prior to January 2016. We used the keywords "WILDFIRE and EFFECTS and TREATMENT," and selected studies that met these 4 criteria:

1. Subject: western U.S. and Canada coniferous forests dominated by (1) ponderosa pine (*Pinus ponderosa*), Jeffrey pine (*Pinus jeffreyi*), (2) pines mixed with oak (*Quercus* spp.), or (3) dry mixed conifer forests dominated by one of these pine species but also could contain true firs (*Abies* spp.), Douglas-fir (*Pseudotsuga menziesii*), other pine species (e.g., *Pinus lambertiana*, *Pinus coulteri*) and/or quaking aspen (*Populus tremuloides*).
2. Intervention: fuel treatments including thin, burn, or thin + burn; in all cases, later burned by wildfire.
3. Comparator: untreated forest stands or sites; in all cases, later burned by wildfire.

Download English Version:

https://daneshyari.com/en/article/6542154

Download Persian Version:

https://daneshyari.com/article/6542154

Daneshyari.com