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Short-term effects of fuel treatments on fisher habitat in the Sierra Nevada, California

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ABSTRACT

The characteristics of western forests have changed as a result of fire suppression and fuel reduction treatments have become a public land management priority. The effects of these treatments on wildlife habitat, however, have received limited attention. The fisher (*Martes pennanti*) is a species of concern in California and is vulnerable to fuels treatments due to its association with dense forests and use of large and old trees as resting sites. We evaluated the effect of fuels treatments by estimating predicted resting and foraging habitat at two sites in the Sierra Nevada that are part of the national Fire and Fire Surrogate Study. One site included three treatments (mechanical harvest, prescribed fire, and mechanical harvest plus prescribed fire) and the other included early and late-season prescribed fire; both sites included control treatments. We sampled vegetation before and after treatment application to estimate variables that were included in resource selection probability functions. Predicted resting habitat was significantly lower for mechanical plus fire treatments, but the control did not differ from the fire only or the mechanical only treatment. Late, but not early, season burns had significant impact on predicted resting habitat. Reductions in canopy cover affected predicted resting habitat directly. Fisher foraging habitat, unlike resting habitat was unaffected by treatments at either site. Within a stand, a number of management actions can mitigate the potentially negative short-term effects of fuels treatments on fisher habitat. Evaluating the effects of fuels management at the resting site, home range and landscape scales will be necessary to administer a treatment program that can address fuel accumulation while also restoring and maintaining fisher habitat.

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1. Introduction

The policy of suppressing fires in western North America has led to an unnatural accumulation of woody debris, an increase in the density of trees, and a shift in species composition (Skinner and Chang, 1996; Brown et al., 2003; Scholl and Taylor, 2010; Collins et al., 2011). These changes have increased the risk of uncharacteristically severe fires, which threatens the human communities in or near these forests and the wildlife that depend on them. Land managers are interested in reducing forest fuels, propelled by federal legislation designed to accelerate treatment activities, but the zeal to reduce fuels has not always been accompanied by consideration of the effects of fuels treatments on the habitat of species associated with dense forest conditions. When the effects of treatments on wildlife have been evaluated, they have typically involved either small mammals or birds (Stephens et al., 2012), rarely on other taxa such as carnivorous mammals.

The fisher (*Martes pennanti*) is a carnivorous mustelid associated with dense stands of mature conifer and mixed conifer-hardwood forests in the Sierra Nevada (Zielinski et al., 2004; Purcell et al., 2009; Spencer et al., 2011). Fishers select daily resting locations that are often in cavities of large trees and, of particular relevance, fishers select trees for resting that are most often in dense stands with abundant small-to-medium sized trees (Zielinski et al., 2004). These trees, often referred as 'ladder fuels' because they can provide vertical continuity of fuels from the forest floor to the overstory, are often the target for fuels reduction treatments (Menning and Stephens, 2007). Further exacerbating the risk to fisher habitat, from both uncharacteristically high severity fire and from fuels treatments, is the fact that fishers occur primarily in the mid-elevation forests in the Sierra (Zielinski et al., 2005) where the risk of fire is exceptionally high (McKelvey and Busse, 1996). The consequences of loss and alteration of fisher habitat is magnified further by the fact that fishers occupy a limited portion of their historical range in the Sierra (Zielinski et al.,

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1995, 2005), one of the reasons why fishers in the Pacific States have been found to be "warranted but precluded" for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 2004).

A conflict arises because it is unknown whether the potential risk of fuels treatments to fisher habitat (especially cumulative spatial and temporal effects) is offset by a commensurate reduction in risk of wildfire to habitat. Scheller et al. (2011) simulated the trade-off between treating stands to reduce their risk of fire and the direct effects of the treatments on fisher habitat and found that the indirect effects of treatments led to an increase, over time, in fisher habitat compared to the untreated condition. However, this work was based on simulations focused on the landscape scale; we still have much to learn about the effects of fuels treatments at the various scales of habitat selection important to fishers.

The fuels management strategies for public forests in the Sierra Nevada are outlined in bioregional forest management plans (Sierra Nevada Forest Plan Amendment [SNFPA]; USDA, 2001, 2004) and in similar, forthcoming forest management plans. These treatments involve mechanical thinning and the application of prescribed fire and are generally similar to those being experimentally investigated by the National Fire and Fire Surrogate Study (FFS) (Schwilk et al., 2009). The FFS program is a cooperative program among federal agencies, universities and private organizations to investigate the relative effects of fire and fire surrogate (mechanical) treatments on forest ecology and fire risk (Schwilk et al., 2009). The FFS provided an opportunity to understand better the potential impacts of vegetation treatments on habitat quality for fishers by taking advantage of planned experimental treatments to be applied as part of the FFS study.

The FFS study included two sites in California's Sierra Nevada: Blodgett Forest Research Station (BFRS) and its satellite study site in Sequoia-Kings Canyon National Park (SEKI). The BFRS study site was one of 12 main study sites contributing toward long-term research on the effectiveness of various fuel management treatments to restoring fire as an ecosystem process and reducing the risk of catastrophic fires. The four treatments at BFRS included no treatment (control), mechanical harvest, mechanical harvest followed by area burn, and fire only treatments (area burn) (Stephens and Moghaddas, 2005). The SEKI research was focused on different burning strategies and included early and late season burns as well as control units (Knapp et al., 2005). By collecting the same suite of habitat variables that have been used to assess fisher resource selection models for fisher (e.g., Zielinski et al., 2004, and models presented herein) before and after treatment implementation, a quantitative assessment of the short-term impacts of FFS treatments on fisher habitat quality can be made. Additionally, given the general similarities between treatments described in the SNFPA and the FFS treatments, the opportunity will exist to develop a qualitative understanding of potential impacts on fisher habitat resulting from implementation of SNFPA treatments.

Thus, the primary objective of this research was to compare changes in habitat conditions important to fisher at the BFRS and SEKI FFS sites resulting from treatment implementation. Importantly, we did not examine the effects of treatments on fishers themselves (in fact, fishers do not occur on or near the BFRS site; Zielinski et al., 2005); instead we evaluated the effects of treatments on *predicted habitat value*. We assessed change in predicted probability of resource use (as a surrogate for habitat quality) for fishers and we tracked changes in select variables presumed to be important to fishers and other species associated with old-forest conditions. This information will help us understand how we can improve vegetation management to reduce risks of severe wildfire while maintaining habitat value for fishers.

2. Materials and methods

2.1. Fire and Fire Surrogate Study areas

BFRS is a 1780 ha experimental forest owned and managed by the University of California, Berkeley. BFRS is located in the central Sierra Nevada, El Dorado County, California. Common tree species at BRFS are typical of those found in mid-elevation forests of the Sierra Nevada: Douglas-fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), ponderosa pine (*Pinus ponderosa*), sugar pine (*P. lambertiana*), incense cedar (*Calocedrus decurrens*), California black oak (*Quercus kelloggii*) and tan oak (*Lithocarpus densiflora*). Mixed conifer habitats dominate BFRS, with some ponderosa pine dominated and montane hardwood-conifer also present. Old-growth stands are very limited. Topography is generally rolling with slope averaging <30%, and elevation ranges from ~1200 to 1500 m. Additional details about the BFRS study area can be found in Stephens and Moghaddas (2005). Fishers have been described as historically occurring in this part of the central Sierra Nevada (Grinnell et al., 1937), but currently appear to be extirpated from the region (Zielinski et al., 2005).

The Sequoia-Kings Canyon (SEKI) FFS site occurred in Tulare County within Sequoia National Park in the southern Sierra Nevada and is described in detail in Knapp et al. (2005). The SEKI site occurred at higher elevations than the BFRS site, ranging from 1900 to 2150 m and was dominated by old-growth mixed conifer. White fir was the dominant tree species in the study area, and others present included red fir, ponderosa pine, sugar pine, incense cedar, Pacific dogwood (*Cornus nutalli*) and California black oak. Topography is somewhat steeper at SEKI than BFRS, ranging from 20% to 50% slope. Fishers currently occupy the SEKI region (Zielinski et al., 2005).

Treatment units at each FFS site were identified by Fire and Fire Surrogate Study site managers (Knapp et al., 2005; Stephens and Moghaddas, 2005). BFRS was divided into management compartments ranging in size from ~15 to 30 ha. Twelve compartments (hereafter, treatment units) were randomly selected from all compartments at BFRS, and each was randomly assigned to one of the four treatments. Within each treatment unit, an array of existing permanent plots was complemented with an array of grid points established at 60 m intervals to create the FFS sampling locations, hereafter referred to as plots (Stephens and Moghaddas, 2005). At SEKI treatment units were established based on recent fire history, accessibility, and ease of applying prescribed fire treatments (Knapp et al., 2005). Treatment units ranged in size from 15 to 20 ha and plots were established at 50 m intervals within each treatment unit.

At BFRS, mechanical treatments occurred in two stages which included thinning from below during fall 2001 and mastication of approximately 90% of understory trees between 2 and 25 cm dbh (Stephens and Moghaddas, 2005). Mechanical plus fire units followed the same treatment schedule as mechanical only units but were followed with backing fires from 23 October 2002 to 6 November 2002 (Knapp et al., 2005). Fire only units were burned during the same period, but used strip head-fires. At SEKI, early season burns were conducted 20 and 27 June 2002 and late season burns occurred 28 September and 17 and 28 October 2001 (Knapp et al., 2005).

2.2. Fisher habitat use and availability data

From 1993 to 1997, Zielinski et al. (2004) conducted an extensive study of fisher ecology at two locations in California, including a study site in the Tule River watershed of Sequoia National Forest, approximately 50 and 350 km south of the Sequoia-Kings Canyon