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An assessment of fisher (*Pekania pennanti*) tolerance to forest management intensity on the landscape

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ABSTRACT

Forest restoration intended to reduce the overabundance of dense vegetation can be at odds with wildlife habitat conservation, particularly for species of wildlife that are strongly associated with structurally diverse forests with dense canopies. The fisher (*Pekania pennanti*), a mesopredator that occurs in mid-elevation forests of the southern Sierra Nevada, is such a species and managers are challenged to address fuel accumulations while at the same time maintaining sufficient habitat. We were interested in whether fishers tolerate the amount of management-related disturbance that fire ecologists predict will be sufficient to reduce the severity and spread rate of fires. To address this question we related an index of relative fisher abundance to data on the amount of each sample area that has been affected by one or more forms of disturbance. These are forms of forest management associated with either restoration activities (e.g., thinning, prescribed fire) or timber harvest (e.g., clear cutting, selection harvest). We used scat detection dogs to determine the relative abundance of scats in each of 15, 14 km^2 hexagonal sample areas that were sampled twice a year for 4 years. These data were used to classify each sample area as either low, moderate or high relative abundance of fishers. We also summarized for each of the sample areas the total number of hectares (including overlap) affected by management activities each year, and generated a 3-year running average. The areas exhibiting the highest use by fishers had an average of 36.7 hectares per year affected by ground-disturbing activities. Given that each sample area was 1400 hectares, this suggests that fishers consistently occupy – at the highest rate of use – places where an average of 2.6% of the area has been disturbed per year. This translates to an average of 7.4 ha of disturbance/year/km^2 (47.1 acres of disturbance/year/mi^2). This is more disturbance than was predicted to be necessary to treat forests to reduce fire spread rate and severity in the southern Sierra Nevada, but less than predicted to be necessary by fire models for other geographic locations. Our work suggests that it may be possible to implement restorative treatments at an extent and rate that achieves fire modeling goals and does not affect occupancy by fishers. Implementation of such an approach, however, should also consider protection of large trees (conifers and hardwoods) used as resting and denning sites and account for the maintenance of habitat connectivity.

1. Introduction

The fisher (*Pekania pennanti*, formerly *Martes pennanti* [see Sato et al., 2012]) is an intermediate-sized mammalian carnivore that is associated with late-successional, mixed hardwood-conifer forests in western North America (Lofroth et al., 2010). The population in the Pacific states has been considered warranted for federal listing under the Endangered Species Act (USFWS, 2004) and, as such, it is necessary to understand how sensitive the fisher is to the types of disturbances that characterize forest management. The fisher in the Sierra Nevada of California occurs in a forest environment that is characterized by a frequent fire regime (Van de Water and Safford, 2011) but the 20th century era of fire suppression has resulted in an altered ecosystem characterized by an accumulation of fuels that increase the risk of severe and widespread fires (Collins et al., 2011; Miller et al., 2009; Miller and Safford, 2012; Scholl and Taylor, 2010; van Wagtendonk and Fites-Kaufman, 2006). Uncharacteristically severe fires threaten human habitations as well as important wildlife habitats. Consequently the USDA Forest Service and other land managers seek options to reduce the surface and ladder fuels that can lead to large crown fires. Crown thinning and underburning, using prescribed fire, are the most frequently applied treatments for this purpose (Martinson and Omi, 2013). In addition, ecologists have increasingly recog-

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nized the important role of fire in the forest ecosystems of the Sierra Nevada, for its role in nutrient cycling, forest development and the generation of structural heterogeneity that fosters a diversity of wildlife habitats (Long et al., 2013; North et al., 2009, 2012). Thus, there is a great deal of motivation to reduce accumulated fuels to the point that forests can sustain regular low-intensity fires that will restore important ecological processes.

The goal of restoring forests to conditions that will sustain regular low-intensity fire is a difficult one to achieve, especially in the face of warm and dry conditions expected in future climates (Collins and Skinner, 2013). The prevailing philosophy, at least in the Sierra Nevada, suggests that a combination of mechanical thinning and prescribed fire – distributed in a strategic arrangement designed to retard fire spread rate (Finney et al., 2007) – will address the fuel accumulation problem and also make suppression easier in situations where it is necessary. This philosophy, however, has not often considered the effects of these changes in forest structure on wildlife, especially species like the fisher that are strongly associated with spatially connected dense forests that include a significant amount of dead and downed woody material (Aubry et al., 2013; Lofroth et al., 2010; Raley et al., 2012). These habitat conditions are precisely the conditions that fire managers seek to reduce, in their effort to decrease fuels and apply treatments in spatial configurations that slow fire spread rates.

Reconciling the need to protect vulnerable fisher habitat while reducing unnatural accumulations of forest fuels has been an issue that has stymied fuels reduction actions for well over a decade in the southern Sierra. Until recently, there has been little opportunity to gather empirical evidence regarding fisher reaction to management efforts. Instead, efforts to fill this information void have been largely limited to informed inference. Truex and Zielinski (2013) explored the effects of small scale treatments (mechanical and prescribed fire) on predicted fisher resting habitat value and reported that the combination of both treatments significantly reduced resting habitat compared to controls. Scheller et al. (2011) modeled the regional effects of fuels treatments on the distribution of fisher habitat. Although the benefits of fuel treatments varied by elevation and treatment location, and there was considerable uncertainty in their projections, they found that indirect benefits to fishers of forest thinning exceeded the negative effects of treatments on habitat quality. Neither of these studies, however, evaluated the direct effects of management disturbances on fisher use of habitats. Garner (2013) used radio-tracking data to analyze second-order and third-order (Johnson, 1980) fisher habitat selection relative to treatment areas. He reported that while fishers tend to avoid treated areas when resting or foraging, they will tolerate treatments within their home range but use primarily the untreated areas. What remains unclear is the extent of the tolerance that fishers have to disturbance that occurs within the areas they use. We estimate the amount of forest management (e.g., timber harvest, vegetation management, prescribed burning) that occurs in areas regularly used by fishers. We compare these estimates with predictions by fire ecologists as to the amount (area and rate) of fuel treatment predicted to be necessary to significantly reduce fire severity and spread rate. Our goal is to help managers understand how the extent and frequency of treatments necessary to reduce the negative effects of fire compares with the proportions of areas occupied by fishers that have been subjected to some form of vegetation management.

2. Materials and methods

We used scat detection dogs (MacKay et al., 2008; Thompson et al., 2012) to conduct surveys for fisher scats on 210 km^2 of suitable habitat on the High Sierra District of the Sierra National Forest (SNF) in the southern Sierra Nevada, California. The survey area was divided into 15, 14-km^2 hexagonal shaped sample areas each roughly the size of a female fisher's home range (Fig. 1). These sample areas occurred between 1000 and 2000 m elevation and within an area where an empirically based model (Davis et al., 2007) predicted uniformly high habitat suitability, with the exception of one sample area (Fig. 1). Scat detector dog teams, provided by the University of Washington's Center for Conservation Biology (UWCCB) and trained to locate fisher scat, surveyed the area twice a year, in June and October, for 4 years (2007–2010). During a month-long survey, each sample area was surveyed 3 times on different days by alternating dog teams in order to account for the variation associated with weather conditions and individual dog ability. Surveys began in the early morning hours and lasted 5–7 h, capitalizing on morning moisture and air movement. Teams carried GPS receivers that logged the team's location at 60-second intervals, generating a tracklog of the survey route. Tracklogs were consulted to aid in complete coverage of the sample area. Because of the diversity of mesocarnivore species in the area and the risk of misidentification, all scats were genetically verified as fisher by UWCCB or the USFS Wildlife Genetics Laboratory, Missoula, Montana.

Intensity of use by fishers was indexed by calculating the total number of fisher scats collected across all sampling periods, then calculating the percent of total scats collected that were found in each of the 15 sample areas. Each area was classified as high use (>10%, $n = 5$), moderate use (5–10%, $n = 3$) or low use (<5%, $n = 7$) based on the ranked average scat detection rates. Although this was a relatively arbitrary definition, we recognize that fishers do not use all parts of the landscape equally for reasons that can have nothing to do with management actions. Instead, we simply wanted to identify those areas of the landscape that were used more often than others. It was in these areas that we were most interested in assessing the amounts of previous disturbance by forest management activities.

We related the fisher use indices to the proportion of each sample area that had been subjected to any of a selected set of forest management activities that are reported in a USDA Forest Service database referred to as FACTS (Forest Service Activity Tracking System), and a smaller database of the locations of prescribed burns maintained by the SNF. Only those 22 activities in the FACTS database that were assumed to have significant effects on fisher habitat structure or were substantial ground-disturbing activities were included (Table 1). For example, we included forms of harvest (e.g., code 4152 *Group Selection Cut*) and vegetation management (e.g., code 4220 *Commercial Thinning*) that would have direct effects on the basis of their disturbance and their alteration of forest structure. We excluded activities that did not meet this criterion or which very rarely occurred (e.g., code 4290 *Administrative Changes*, code 4314 *Pretreatment Exam for Reforestation*; code 4552 *Area Fertilizing*, code 4980 *Other Tree Improvement*; code 1250 *Rearrangement of Activity Fuels*). The smaller, prescribed fire database from the SNF is an internal database maintained by the High Sierra Ranger District that documents the ignition dates and extent of prescribed fires ignited on the district since 1994. All entries in this, second, database were included in the set of activities we considered affecting fisher habitat.

The extent of management activity for each sample area was quantified using a 3-year running average (calculated from 2000 to 2011) of the area (hectares) of management activities. For example, the 2005 value was calculated as the sum of 2003, 2004 and 2005 divided by 3. The running averages were based on three years to represent the average amount of disturbance experienced during a fisher generation time and to smooth the effect of year-to-year variation in amount of area treated. The 12 years of data resulted in 10, 3-year running averages for each sample area. The fisher scat data were compared to the annual area of treatments