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Historical and current forest conditions in the range of the Northern Spotted Owl in south central Oregon, USA

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ABSTRACT

Restoration to increase resilience to current and projected drought and fire in historically open-canopy forests in fire-prone environments may be constrained by concern for species that favor dense forest conditions. To assist the recovery of a threatened species, the Northern Spotted Owl (NSO), in dry forest environments, the US Fish & Wildlife Service (USFWS) recommends embedding NSO conservation and recovery in restoration efforts that enable ecosystem recovery from past management actions and increase resilience to changing climate. In this study, we assessed changes between historical and current (1) forest structure and composition and (2) extent of NSO nesting and roosting (NR) or foraging (F) forest cover on 39,000 ha at the eastern edge of the current designation of the range of the NSO. Historical records depict a predominantly open-canopy landscape dominated by large ponderosa pine. Current conditions include more than a 600% increase in trees 15–53 cm dbh, substantial decline in trees ⩾81 cm dbh, loss of the widespread distribution of trees ⩾53 cm dbh, and loss of the dominance of ponderosa pine on mixed conifer sites. NSO habitat assessment involves a suite of attributes including: landscape context; species composition; canopy cover; basal area; average tree diameter; diameter diversity; and abundance of large trees, snags, canopy layers, coarse woody debris, and mistletoe. We tested for the presence of forest that met USFWS threshold values for two of these variables, canopy cover and basal area. Historically none of the area met the 60% canopy cover threshold for NR or F forest cover and almost none meets it currently. However, several NSO nesting pairs and individual birds have been observed in the study area over the last 20 years, and studies in other frequent-fire forests show that canopy cover as low as 50% may be functional for NSO. To assess the implications of lower threshold values, we tested for NR or F forest cover presence at half the recommended thresholds, considerably below published estimates. Only five percent of the area exceeded 30% canopy cover historically; much of the current forest exceeds it today. Increase in canopy cover comes at the expense of increasing vulnerability to fire and drought and loss of historical functions and processes. Conflicting objectives of forest restoration and maintenance of spotted owl habitat on this site – isolated habitat in the dry margin of the range of the NSO – raises questions about how to achieve forest restoration in altered landscapes where existing, novel conditions favor at-risk species.

1. Introduction

Recent reviews of key concepts for enhancing resistance and resilience to current and projected wildfire and other drought-related stressors in fire-prone forests in the Pacific Northwest provide recommendations for integrating the recovery of characteristic patterns and processes with current management objectives given altered social and geophysical environments (Franklin and Johnson, 2012; Franklin et al., 2013; Stine et al., 2014; Hessburg et al., 2015, 2016; Lehmkuhl et al., 2015). Restoration is defined in the 2012 Planning Rule to implement the National Forest Management Act as "*The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Ecological restoration focuses on reestablishing the composition, structure, pattern, and ecological processes necessary to facilitate terrestrial and aquatic ecosystems sustainability, resilience, and health under current and future conditions.*" (USDA, 2012, 219.19). Predominantly open-canopy forests dominated by fire- and drought-tolerant trees have demonstrated resilience and resistance to fire and drought (Stephens and Gill, 2005; Stephens and Fulé, 2005; Collins and Stephens, 2010). Historical records and reconstructions provide additional

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reference conditions to inform restoration of landscapes substantially altered by management actions; for example, incorporation of the range of variation in historical spatial patterns as metrics to guide restoration efforts (Larson and Churchill, 2012; Churchill et al., 2013). Comprehensive planning at the spatial scale of the processes and functions to be restored or maintained is recommended prior to implementation. Other key recommendations include: retain and release old trees; shift composition toward fire- and drought-tolerant species; restore fine- and meso-scale variation in tree, shrub, and herbaceous cover; reduce live tree density and increase mean tree diameter; protect and restore understory plant communities; and treat activity fuels. However, restoration of conditions resilient and resistant to fire and other drought-related stressors may reduce dense forest cover that has expanded under a century of fire exclusion and suppression and that may currently be utilized by northern spotted owl (NSO, *Strix occidentalis caurina*). Populations of this threatened subspecies are in decline across their range due increasingly to competition with barred owls and habitat loss from fires (Dugger et al., 2015; Davis et al., 2016). Management actions cannot jeopardize survival or impede recovery of the listed species (Endangered Species Act of 1973 (16 USC 1531 *et seq*.)).

Recommendations in the NSO recovery plan (USFWS, 2011) support active, adaptive management, such as dry forest restoration, to embed conservation of occupied sites (currently and historically) and high value NSO habitat within broader efforts to restore ecosystem resiliency. Given the importance of dispersal processes, dispersal habitat may also be a priority for conservation. Restoration of ecosystem resilience as described in the recovery plan includes reducing the risk of continued loss of valued ecological structures (*e.g.,* large, fire-tolerant trees) and reversing the ongoing decoupling of vegetation patterns from characteristic disturbance processes. One important question, then, would be whether the dense forest conditions that NSO prefer to use for NR were present in the historical landscape. If so, maintenance of that cover type would be a goal of restoration and would help guide it. However, if it was not present in the historical landscape, then its maintenance could potentially conflict with forest restoration.

Unfortunately few studies of the historical availability of NSO habitat in the slopes and foothills of the eastern Cascade Range exist, and those that do differ in their conclusions. A study of 85 nest trees in Washington found that almost all (92%) were Douglas-fir, 26% were older than 200 years, 50% were older than 137 years, and trees on south-facing slopes were substantially older than trees on north facing slopes (Buchanan et al., 1993). Potential nest trees existed historically; however, dendrochronological reconstruction of fire history and historical forest conditions at a randomly selected subset of the same nest sites found little overlap between historical and current conditions around those nest trees (Everett et al., 1997). Kennedy and Wimberly (2009) simulated historical forest conditions for the Deschutes National Forest (NF) in central Oregon and estimated that closed canopy, older forest conditions potentially suitable as NSO NR cover may have existed on 9% of the area. In contrast to the relatively low estimates of potential NSO forest cover in the previous studies, an estimate based on a reconstruction of historical forest density from GLO survey data suggests that NSO forest cover was not rare in the eastern Cascade Range of Oregon; potential nest stands existed on 22–39% of the study area, and potential foraging and roosting cover existed on a minimum of 11% and maximum of 68% of the study area (Baker, 2015b). Thus, results of these studies, all of which are based on reconstructed or modeled conditions, conflict in their conclusions about the historical presence of NSO forest cover.

To further investigate the historical occurrence of potential NR cover in fire-prone portions of the current range of the NSO, we used a data-rich, historical record of trees ⩾15 cm dbh collected as a 10–20% sample of more than 39,000 ha in the study area. This 1914–1924 timber inventory provides a more substantial record of historical forest conditions than was available to previous studies of the historical extent of NSO forest cover. Using these historical records and 2014 United States Forest Service (USFS) stand exam data, we explored changes in forest conditions and availability of dense forest cover commonly used by NSO for NR. The dataset describing current forest conditions enables spatially explicit comparisons of change between historical and current conditions at a scale not previously available (Hagmann et al., 2013). Additionally, we explore changes in the very large (⩾81 cm dbh), old tree population and distribution. Results from this study provide information about whether restoration is justified on this landscape and also contribute to the dialogue on the tradeoffs between management focused on conservation of an at-risk species and restoration of a broader array of ecosystem functions and processes occurring in fire-prone environments across western North America.

2. Methods

2.1. Study area

The 39,466-hectare study area occupies the southwest corner of the former Klamath Reservation, now the Fremont-Winema NF, in the foothills of the Cascade Range in south central Oregon (Fig. 1), where the USFS is currently developing a restoration project. The Klamath Tribes are the senior partner in a stewardship agreement that covers most of the Fremont-Winema NF (USDA Forest Service, 2011) and is focused on implementing the Klamath Tribes' forest restoration strategy (Hatcher et al., 2016). Historically, forests in this area had predominantly low live tree densities dominated by large, fire- and drought-tolerant trees (Hagmann et al., 2013). Most of the study area lies within the Northwest Forest Plan (NWFP) boundary (Fig. 1) which reflects scientists' understanding of the range of the NSO when the NWFP was written (1993) and implemented (1994). Under the NWFP, most of the forest in the study area is classified as "matrix", the land-use allocation in which regularly scheduled timber harvests were expected to occur. Outside the NWFP and designated cultural resource areas, most of the area is classified as "timber production" under the Fremont-Winema Forest Plan (fs.usda.gov/main/fremont-winema/landmanagement/planning), although that classification is now tempered with commitments to conserve old forests and the species within them. NSO surveys have detected several nesting pairs and individual birds over the last 20 years. The area was not designated critical habitat (USFWS, 2012).

Much of the study area falls within the Pumice Plateau Forest subsection of the Eastern Cascades section (Cleland et al., 2007). At lower elevations, the forest grades from ponderosa pine (*Pinus ponderosa*) to mixed conifer forests consisting primarily of ponderosa pine, white fir (*Abies concolor*), Douglas-fir (*Pseudotsuga menziesii*), sugar pine (*Pinus lambertiana*), and incense cedar (*Calocedrus decurrens*). At the highest elevations in the study area, the forest is dominated by white fir and lodgepole pine (*Pinus contorta*). Annual precipitation ranges from 41–135 cm; mean monthly temperatures range from -42 °C in January to 29 °C in July (PRISM, 2012). Elevation ranges from 1269 to 2215 m. Soils in the mixed conifer area are predominantly well-drained volcanic ash over very gravelly and loamy material, ashy-skeletal typic cryandepts in the taxonomic order inceptisols.

2.2. Plant association groups (PAGs)

Potential natural vegetation is used to easily communicate a concise and validated description of the capability of an area to support vegetative ecosystems (Winthers et al., 2005). We used plant associations mapped in the USFS Terrestrial Ecological Unit Inventory