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Response of brown-headed cowbirds and three host species to thinning treatments in low-elevation ponderosa pine forests along the northern Colorado Front Range

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ABSTRACT

Thinning ponderosa pine (*Pinus ponderosa*) forests to achieve desired ecological conditions remains a priority in the North American west. In addition to reducing the risk of high-severity wildfires in unwanted areas, stand thinning may increase wildlife and plant diversity and provide increased opportunity for seedling recruitment. We initiated conservative (i.e. minimal removal of trees) ponderosa stand thinning treatments with the goals of reducing fire risk and improving habitat conditions for native wildlife and flora. We then compared site occupancy of brown-headed cowbirds (*Molothrus ater*), chipping sparrows (*Spizella passerina*), plumbeous vireos (*Vireo plumbeus*), and western wood-pewees (*Contopus sordidulus*) in thinned and unthinned (i.e., control) forest stands from 2007 to 2009. Survey stations located in thinned stands had 64% fewer trees/ha, 25% less canopy cover, and 23% less basal area than stations in control stands. Occupancy by all three host species was negatively associated with tree density, suggesting that these species respond favorably to forest thinning treatments in ponderosa pine forests. We also encountered plumbeous vireos more frequently in plots closer to an ecotonal (forest/grassland) edge, an association that may increase their susceptibility to edge-specialist, brood parasites like brown-headed cowbirds. Occupancy of brown-headed cowbirds was not related to forest metrics but was related to occupancy by plumbeous vireos and the other host species in aggregate, supporting previous reports on the affiliation between these species. Forest management practices that promote heterogeneity in forest stand structure may benefit songbird populations in our area, but these treatments may also confer costs associated with increased cowbird occupancy. Further research is required to understand more on the complex relationships between occupancy of cowbirds and host species, and between cowbird occupancy and realized rates of nest parasitism.

1. Introduction

Historically, low elevation ponderosa pine forests in northern Colorado were characterized by open stand conditions and low intensity fires having return intervals of less than 30 years (Veblen et al., 2000; Sheriff and Veblen, 2007). However, fire suppression activities during most of the 20th century set low elevation ponderosa forests on a growth trajectory that has resulted in unnaturally dense and fire–prone forests (Veblen et al., 2000). Densely stocked ponderosa forests now predominate along the wildland/urban interface of the northern Colorado Front Range, and the recent recurrence of stand replacing fires in this area is unprecedented in modern history. During the past century or longer, these forest types have also exhibited a decrease in understory vegetation (Kolb et al., 1994; Brown et al., 2001), a shift in wildlife species composition (Saab and Powell, 2005; Gaines et al., 2007) and declines in use and reproductive success by several wildlife species (Germaine and Germaine, 2002, 2003; Cunningham et al., 2005).

Interest in large-scale fuels reduction treatments grew dramatically along the Front Range following the 2002 fire season (FRFTP, 2006), and potential exists for the goals of fire risk reduction and ecological restoration to be mutually served because overlap exists in the structural characteristics associated with both (Sheriff and Veblen, 2007). However, whether treatments are motivated by fuel reduction or ecological restoration concerns, potential exists for adverse effects on biological diversity (Noss et al., 2006), and more empirical information on the effects of fuels and restoration

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treatments on wildlife are needed. Forest restoration treatments increase available habitat for some wildlife species, including many forest birds (Woolf, 2003; Cunningham et al., 2005; Whitman and Germaine, 2006; Gaines et al., 2007), but can have negative, unintended consequences on others, including increased nestling parasite loads (Germaine and Germaine, 2002) and decreased visual concealment at mule deer bed sites (Germaine et al., 2004).

Little is known of the effects of ponderosa pine forest thinning on brown-headed cowbirds (*Molothrus ater*; hereafter "cowbirds"), although Gaines et al. (2010) found no influence of restoration treatments on cowbird abundance in mixed-conifer forests. Cowbirds are native, obligate brood parasites capable of severely depressing nest success of forest bird species in Colorado (Chace and Cruz, 1996; Chace et al., 2000) and elsewhere (Friedmann et al., 1977; Brittingham and Temple, 1983; Robinson et al., 1995). Prior to European settlement of North America, cowbirds occurred primarily in short-grass prairie habitats and were associated with nomadic bison (*Bison bison*) herds (Lowther, 1993), although they were occasionally observed in montane parks in association with bison (Chace and Cruz, 1998). As bison were replaced by domestic cattle, cowbirds associated with cattle, expanded their range (and probably, their abundance) and began parasitizing bird communities in forest habitats (Lowther, 1993). Cowbirds prefer open habitats (Brittingham and Temple, 1983; Thompson et al., 2000) that contain perches from which females search for host nests (Norman and Robertson, 1975). Therefore, activities that reduce tree density and canopy cover may result in increased occurrence of cowbirds as well as some forest nesting songbird species (Young and Hutto, 1999).

During 2007–2009, we surveyed cowbirds and three forest-breeding host species of conservation concern in the western US (Sauer et al., 2011), and measured the structural characteristics of stations located in thinned and unthinned ponderosa pine forest stands in Boulder County, Colorado, USA. We selected host species based on *a priori* knowledge of their abundance in our area, quantified response to forest thinning treatments elsewhere (Gaines et al., 2007), and reported level of susceptibility as cowbird hosts (Graham, 1988; Chace and Cruz, 1996; Scott and Lemon, 1996; Chace et al., 1997; Curson et al., 1998; Tewksbury et al., 1999; Chace et al., 2003; Swanson et al., 2004). We characterized thinned and unthinned forest stand structure, then used multi-model inference methods to identify the suite of forest stand attributes that optimally explained site occupancy rates of each of the four focal bird species. We did so to evaluate how the potential for nest parasitism changed over the gradient of structure types present in partially (i.e., heterogeneously) thinned ponderosa pine forests. We predicted that all 4 focal species would respond positively to attributes associated with thinned forest stands, but expected the level of response to vary among host species due to differences in preferred residual habitat structure.

2. Methods

2.1. Study area and thinning goals

Forest management goals in the treatment areas were to decrease the threat of high-severity wildfire by removing live trees in a manner that would also leave forest stands structurally more similar to pre-settlement conditions and enhance native plant and animal populations (Brown et al., 2001). Treatment prescriptions focused on removing small to medium diameter (15–23 cm) trees while retaining the largest and oldest trees. Operationally, treatments included mechanical (i.e., chainsaw) thinning and removal of boles and large limbs, after which residual woody material was either scattered or chipped and broadcast over the forest floor in a thin (<3 cm) layer. One stand received a light understory burn following chipping. Control stands did not receive any thinning treatments.

Survey stations were located at an elevation between 1756 and 2035 m in forested areas dominated by ponderosa pine in the Rocky Mountain foothills in Boulder County, Colorado, USA (Fig. 1). Using ArcGIS 9.3 (ESRI, Redlands, CA, USA), we selected only forested areas that were within average cowbird commuting distance (distance traveled between feeding and nest-searching areas: 3.2 km; Rothstein et al., 1984) from residential areas and cattle pastures to ensure cowbirds were not prohibited from any areas by excessive distance from feeding sites. Forest understory was dominated by grasses and forbs with <5% shrub cover on average. Dominant graminoid species included poverty oatgrass (*Danthonia spicata*), and sun sedge (*Carex pensylvanica* ssp.*heliophila*) while common forbs included foothill arnica (*Arnica fulgens*), blue-mist penstemon (*Penstemon virens*), and golden aster (*Heterotheca villosa*). Chokecherry (*Prunus virginia*), wax current (*Ribes cereum*), Oregon-grape (*Mahonia repens*), prickly-pear cactus (*Opuntia macrohiza*), and buckbrush (*Ceanothus fendleri*) comprised the understory shrub component.

2.2. Station establishment

We established 25 thinned and 22 control survey stations among 23 forest stands at an approximate density of one station per 6 ha (Fig. 1). Stations were non-arbitrarily located so as to maximize the number possible in each stand, but were separated by $\geqslant$225 m, and were $\geqslant$100 m from grassland or unthinned/thinned forest edges. Stations were marked with pinflags at plot center and flagging was placed 50 m distant in each cardinal direction to help estimate linear distance to bird detections and for use in plot-structure quantification.

2.3. Forest-stand measurements

At all survey stations, we established five forest vegetation sampling plots–one at station center and one in each cardinal direction at 50 m from station center. At each plot, we used a BAF 20 prism and a diameter tape to tally live sample trees and measure tree diameters. Trees for inclusion in measurements were identified by holding the prism at arm's-length directly over the 5 plot centers and rotated 360° to identify "in" trees. We used these data to calculate basal area and trees/ha (Beers et al., 2003). To record canopy cover, we walked 50-m transects in each cardinal direction from station center. Along each of these transects, we recorded a densitometer (Geographic Resource Solutions, Arcata, CA., USA) reading (i.e., ocular site tube held vertically and "hit or miss" recorded) at two meter increments, for a total of 100 readings (25/transect). Canopy cover was then calculated in terms of percent (James and Shugart, 1970).

2.4. Bird surveys

In addition to cowbirds (BHCO), focal species were chipping sparrows (*Spizella passerina*; CHSP), plumbeous vireos (*Vireo plumbeus*; PLVI), and western wood-pewees (*Contopus sordidulus*; WEWP). We surveyed each station four times in 2007, and three times each in 2008 and 2009. We conducted surveys between 1 May and 15 July to coincide with the breeding seasons of focal bird species in our area. Surveying began at sunrise and ended by 1030 h local time. We did not survey in winds exceeding level 5 on the Beaufort scale, in precipitation exceeding a light drizzle, or in background conditions exceeding 2 on the Massachusetts