Forest Ecology and Management 261 (2011) 10–18

Contents lists available at ScienceDirect

Forest Ecology and Management

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

Effects of fuel reduction on birds in pitch pine–scrub oak barrens of the United States

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ARTICLE INFO

Article history:
Received 28 May 2010
Received in revised form 19 August 2010
Accepted 20 August 2010

Keywords:
Avian
Fire
Forest
Risk
Shrub
Thinning

ABSTRACT

Fire-dependent ecosystems include some of the most threatened ecosystems in the world, and where fuels are allowed to accumulate, they can present significant threats to human life and property. Fuel reduction activities can be effective in reducing the risk of wildfire, but these practices need to be evaluated relative to their effect on biodiversity. We surveyed birds in an inland pitch pine–scrub oak barren, a fire-dependent plant community, in which fuel reduction had been carried out via thinning of canopy trees to reduce the risk of running crown fires. We hypothesized that thinning pitch pine forest would negatively affect the abundance of mature forest birds and positively affect the abundance of scrub–shrub birds. Our results confirmed these expectations: several mature forest bird species were less abundant in thinned pitch pine than unthinned pitch pine, although most of these species were also present in mixed deciduous forest, and therefore regionally well represented. In contrast, another group of bird species was scarce or absent from unthinned pitch pine and mixed deciduous forest, but present in thinned sites and scrub oak stands. These were scrub–shrub species that do not nest in mixed deciduous or pitch pine forest but depend on shrubland or savannah habitats that cover ~3% of the region. We conclude that fuel reduction by thinning canopy trees at this site provides habitat for high-priority scrub–shrub bird species at the cost of modest reductions in numbers of forest birds whose regional aggregate population is large.

Published by Elsevier B.V.

1. Introduction

Fire-dependent plant communities have unique structural and floristic characteristics that evolved in the presence of periodic fire, which encourages the regeneration of fire adapted species and discourages competition from fire-intolerant species (Nowacki and Abrams, 2008). Suppression of wildfires has decreased the representation of fire-dependent ecosystems worldwide, including in Mediterranean pine forests (Moreira et al., 2003), South African fynbos (Manders and Richardson, 1992), Australian eucalypt forest (Penman et al., 2007; Burrows, 2008) and temperate pine forests of North America (Kalies et al., 2010). In addition to its negative effects on ecosystems, fire exclusion, when not accompanied by mitigating fuel treatments, permits the accumulation of fuels to levels that increase the risk of catastrophic wildfire (USDA, 2000; Duveneck and Patterson, 2007; Penman et al., 2007; Burrows, 2008; Kalies et al., 2010).

Pitch pine–scrub oak (*Pinus rigida-Quercus ilicifolia*) barrens occur within the Atlantic Coastal Barrens ecoregion that covers nearly 9000 km^2 in the northeastern U.S. (Ricketts et al., 1999). Pitch pine–scrub oak barrens are considered to be of high conservation concern in the Northeast (Swain and Kearsley, 2001), and barrens systems in general are among the most threatened ecosystems in North America (Noss and Peters, 1995). Pitch pine–scrub oak barrens are dominated by flammable species with adaptations to survive and regenerate after wildfire (Motzkin et al., 1999), and which comprise some of the most dangerous fuels in the region (Duveneck and Patterson, 2007).

In the absence of an active fire-management program, fuels in fire prone systems accumulate to hazardous levels that support extreme fire behavior and pose significant risks to human health and property (Duveneck and Patterson, 2007; Moreira et al., 2003; Penman et al., 2007; Burrows, 2008). Pitch pine forests are susceptible to crown fires that can spread with such rapidity as to be uncontrollable until they run out of fuel (Clark and Patterson, 2003). One such fire in Massachusetts consumed nearly 6000 ha of forest in 24 h in 1957 (Clark and Patterson, 2003). Pitch pine–scrub oak barrens encompass substantial portions of some of the most densely populated regions on the continent (U.S. Census Bureau, 2009). As a result, residential developments in this region are often adjacent to or embedded within pyrogenic plant communities such as pitch pine–scrub oak barrens, which increases the risk of human-caused

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0378-1127/$ – see front matter. Published by Elsevier B.V.
doi:10.1016/j.foreco.2010.08.039

ignitions, as well as the potential consequences of uncontrollable wildfire.

Fuel reduction in pitch pine consists of reducing canopy coverage by thinning overstory trees to reduce the potential for running crown fires (Duveneck and Patterson, 2007). The alteration of habitat structure and floristic composition in the course of fuels management can be anticipated to affect birds (Moreira et al., 2003; Greenberg et al., 2007; Seavy et al., 2008), including high-priority disturbance-dependent species (Gifford et al., 2009). Managers and conservationists are obliged to consider the effects of management activities on native species, so an understanding of how management affects birds is essential. Here we characterize the avifauna of an inland pitch pine–scrub oak barren, describe the effects of fuels management on bird abundance and species composition, and discuss our findings relative to regional bird conservation. We hypothesized that thinning pitch pine forest would negatively affect the abundance of mature forest birds and positively affect the abundance of scrub–shrub birds.

2. Methods

2.1. Study area

The study took place on a 595 ha pitch pine–scrub oak barren within the Montague Plains Wildlife Management Area in western Massachusetts, U.S.A. This site is located on a sand delta formed more than 10,000 years ago when meltwater streams from retreating glaciers emptied into a large lake that has since drained. The site is characterized by well drained soils and dominant plant species that are highly flammable and adapted to regenerating after fire (Motzkin et al., 1999). Habitats included pitch pine forest (~178 ha) and scrub oak barrens (~36 ha) (Clark and Patterson, 2003). Mixed pitch pine and tree oaks cover most of the remaining area. Starting in 2004, the Massachusetts Division of Fisheries and Wildlife initiated a program to reduce fuel loads and fire risk to nearby towns. Fuel reduction consisted of mechanical thinning of dominant trees in pitch pine forest to a target canopy coverage of <50%, as well as thinning understory trees and saplings with either mechanical means or prescribed fire (Clark and Patterson, 2003). Overstory trees were removed from the site, and slash and understory trees were either chipped and left on site or stacked for later burning. By the conclusion of the study ~50% of the total area of pitch pine forest had been thinned.

2.2. Study design

Bird survey points were located at a subset of points originally established by Motzkin et al. (1999) to enable the linkage between our study and this extensive long-term database. We selected points located ≥250 m apart to allow statistical independence among samples (Ralph et al., 1995). Sample sizes represented the maximum number of points possible given the area of each habitat and the between-point distance constraint. Although thinned areas were chosen based on fire risk to neighboring communities and not randomly, thinned sites for which we had pre-treatment data were similar in tree density, canopy height and understory density to unthinned sites ($P > 0.11$), suggesting that thinned sites were generally representative of this habitat type.

Survey points were allocated among the following habitats, which represent the most common plant communities at the Montague Plains; pitch pine forest ($n = 40$), thinned pitch pine ($n = 11$), scrub oak barrens ($n = 16$), and mixed deciduous forest ($n = 13$). Unthinned pitch pine forest served as a reference by which to gauge the effects of thinning activities (Fig. 1a) and varied in composition from stands entirely dominated by pitch pine to stands with varying amounts of hardwoods such as tree oaks (*Quercus* spp.), red maple (*Acer rubrum*) and gray birch (*Betula populifolia*) as well as white pine (*Pinus strobus*). The shrub layer consisted of scrub oaks (*Q. ilicifolia* and *Q. prinoides*), pin cherry (*Prunus pensylvanica*), huckleberry (*Gaylussacia baccata*), blueberry (*Vaccinium* spp.), and oak and pine saplings.

Thinned pitch pine (Fig. 1b) consisted of pitch pine forest which had been thinned as described above. The remaining canopy consisted of mature pitch pines with scattered tree oaks. The understory consisted of scrub oaks, blueberry, and gray birch. Thinning occurred during the non-growing seasons of 2004, 2006 and 2007, so each of these years, several points were subtracted from the pitch pine sample and added to the treated pitch pine sample (3, 6 and 11 in 2004, 2006 and 2007, respectively). Three of these points had been treated prior to the bird surveys, but we had both pre- and post-treatment data for the remaining 8 points in thinned pitch pine.

In addition, we surveyed scrub oak barrens because shrublands represent a habitat of high conservation priority in eastern North America (Askins, 2000) and we wanted to use this habitat as a reference to evaluate the effectiveness of pitch pine treatments for accommodating the birds typical of this habitat type. Scrub oak barrens consisted of dense stands of scrub oaks generally <2 m tall with scattered pitch pine and tree oaks, as well as pin cherry, shadbush (*Amelanchier* spp.), huckleberry and blueberry (Fig. 1c).

Finally, we included mixed deciduous forest, because it represents the late-successional type which can develop on barrens in the absence of disturbance (Kerlinger and Doremus, 1981), and also to determine whether the bird communities of the various sandplain habitats were distinct from this widely distributed forest type. Mixed deciduous forest included both the deciduous and mixed deciduous types of Clark and Patterson (2003), and was dominated by tree oaks, red maple, and hickories (*Carya* spp.), as well as conifers including pitch pine, white pine and eastern hemlock (*Tsuga canadensis*) (Fig. 1d). The shrub layer was generally sparse, and consisted of regenerating trees of the canopy species as well as shadbush, black cherry (*Prunus serotina*), huckleberry, and mountain laurel (*Kalmia angustifolia*).

2.3. Vegetation measurements

At each bird survey location, we measured vegetation characteristics at 20 randomly selected points located within each 50-m point count radius. At each of the 20 sampling points we measured the presence and height of the overstory canopy, the height of the understory vegetation (i.e. vegetation ≤ 3 m tall), the plant species, or in the absence of vegetation, the type of ground cover (e.g. litter, slash, bare ground, etc.), and the number of contacts of vegetation with a 3-m pole held vertically divided into 1-m height intervals. We also counted all trees by species within a variable-circular plot using 10-factor metric cruising prism. These values were averaged for each sample point, and log-transformed to improve normality and equality of variances.

2.4. Bird surveys

We evaluated bird abundance during 2004–2008 with 10-min, 50-m radius point counts (Ralph et al., 1995). Each point was visited 3 times between 0530 and 1100 h between June 1 and July 15, and observers recorded the number of individuals of each species that were detected.

2.5. Statistical analyses

Because raw point counts may not provide a reliable index of bird abundance (Thompson, 2002) we estimated bird density