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The influence of wildfire, logging and residual tree density on bird communities in the northern Rocky Mountains

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Abstract

By emulating natural disturbances like wildfire, managers hope to maintain biodiversity in managed forests. Leaving residual live trees in harvested areas is an important component of this strategy. However, the influence of this approach on songbird communities is largely unknown. We surveyed songbirds in 166 stands in the Rocky Mountains in BC, Canada, that had been logged or burned by wildfire. Stands were located in mid or high elevation biogeoclimatic zones, and varied from 7 to 45 years since disturbance and in density of residual trees from 0 to 320 conifer overstory, 0 to 832 conifer understory, and 0 to 68 broadleaf trees/ha. Although differences in bird communities between burned and logged stands of similar ages were detected, these differences were not consistent between biogeoclimatic zones, nor did they explain a large amount of the variation in bird communities. Logged stands had a higher density of birds, but expected species richness did not differ between logged and burned stands. All but a few rare species were detected in both disturbance types. Of 26 species analysed in detail, densities of 14 were greater in logged stands, 6 were greater in burned stands, and 6 were not significantly different between disturbance types. The bird community, bird abundance and densities of individual species were influenced by residual tree density and type. As time since disturbance increased, bird communities in burned and logged stands in the Engelmann Spruce-Subalpine Fir zone became more similar, but those in the Montane Spruce zone became less so, likely due to differences in residual tree density. Results suggest differences in bird communities in logged and burned stands ≥ 7 years post-disturbance are mainly in abundance rather than community composition, but abundances of individual species can be significantly influenced by residual tree density and type. Managers can influence the abundance of some species in harvested areas by manipulating the type and density of residual trees.

Keywords: Forest management; Disturbance; Fire; Bird community; Rocky Mountains; Residual trees; Biological legacies

1. Introduction

The concept of using natural disturbance regimes as a guide for forest management is currently being explored throughout boreal and temperate forests in North America and Scandinavia (e.g., Swanson et al., 1993; Attiwill, 1994; Morgan et al., 1994; BC Ministry of Forests, 1995; Fule et al., 1997; Angelstam, 1998; Bergeron et al., 1999; Cissel et al., 1999; Bergeron et al., 2002; Harvey et al., 2002). The idea relies on two premises: that the spatial and temporal variability resulting from disturbance is a vital attribute of ecological systems, and that past conditions and processes provide context and guidance for management of contemporary ecological systems (Landres et al., 1999). Moreover, the application of this concept for conservation of biodiversity rests on the premise that native species have persisted through or adapted to the disturbance events of the Holocene (Hunter, 1993; Swanson et al., 1993; Bunnell, 1995). Thus, ecosystems that are managed to resemble those created through natural disturbance are hypothesized to have a high likelihood of conserving native species and maintaining ecological processes (Swanson et al., 1993).

Several characteristics of natural disturbance regimes could be emulated through timber harvest practices, including rate of return, size and spatial distribution, and severity of disturbance (Hunter, 1993; Swanson et al., 1993). Other studies have examined rate of return (Armstrong et al., 1999; Bergeron et al., 2001) and spatial pattern (Cissel et al., 1999). Here, we focus on severity of disturbance and the influence of wildfire and logging on bird communities.

Shortly following disturbance, burned and logged stands differ significantly in many ways, including numbers of

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standing dead trees (Lee, 2002) and disturbance of the forest floor (Westbrook and Devito, 2002). These initial differences can have significant implications for biotic communities, including plants (Carleton and MacLellan, 1994; Ehnes and Shay, 1995; Bradbury, 2002), birds (Schulte and Niemi, 1998; Hobson and Schieck, 1999; Imbeau et al., 1999), arthropods (Buddle et al., 2000) and small mammals (Simon et al., 2002). However, although some differences between burned and logged stands persist through time, the magnitude of differences generally diminish as snags in burned stands fall and as vegetation becomes dominated by the new cohort of trees. Despite this understanding, the influence of disturbance severity on differences between post-harvest and post-wildfire stands and their convergence through time has not been well-studied.

Wildfires vary considerably in severity, ranging from low-intensity ground fires that kill few mature trees, to massive conflagrations in which most trees are killed, such as those common in boreal (Weber and Flannigan, 1997) and northern Rocky Mountain (Van Wagner, 1995) forests. Similarly, the number of trees left within logged areas also varies, from clearcuts, in which all trees are removed, to partial cuts, in which many trees remain standing post-harvest. Thus, the number and type of residual trees remaining following disturbance is correlated with disturbance severity (Runkle, 1985; Swanson et al., 1993; Bergeron et al., 2002). Residual trees play an important role in the ecology of young forests, providing seed sources for natural reforestation (Eberhart and Woodard, 1987) and refugia for organisms, allowing some individuals to survive the disturbance and recolonization areas for others (Franklin et al., 1997). Residual trees also create structural complexity, associated with productivity and biodiversity (Hansen et al., 1991; Schieck and Hobson, 2000). Thus, the number of residual trees may be expected to have a large influence on ecological communities in post-harvest and post-wildfire stands.

In this paper, we compare post-wildfire and post-harvest stands of varying residual tree density in a montane forest ecosystem using the songbird community as a focal community. In the northern Rocky Mountains, logging has largely replaced wildfire as the dominant disturbance regime (Gallant et al., 2003). Yet, the implications of this shift for avian communities are largely unknown. Few studies have compared the influences of wildfire and timber harvesting on birds. Of those that have, most were conducted in the boreal forest (Hobson and Schieck, 1999; Imbeau et al., 1999; Schieck and Hobson, 2000; Stuart-Smith et al., 2002), with one occurring in the hardwood forests of Minnesota (Schulte and Niemi, 1998) and one in the mixed conifer forests of the northern Rockies (Hutto, 1995). Only one of these studies (Schieck and Hobson, 2000) examined the influence of disturbance severity, as assessed through patches of residual trees, in addition to disturbance type.

The objectives of our study are to compare avian communities in post-harvest and post-wildfire stands in relation to density and type of residual trees and time since disturbance. Specifically, we evaluated differences in bird communities between post-wildfire and post-harvest stands of similar ages, and assessed whether these communities become more similar to one another as time since disturbance increased. We hypothesized that bird community composition and the abundance of individual species would be a function of disturbance severity and the resulting structural characteristics of stands, rather than disturbance type, and that any differences between disturbance types would diminish through time. In addition, we evaluated whether density and type of residual trees influence bird community composition and abundance of individual species. As residual trees are closely tied to structural complexity, we hypothesized that they should strongly influence bird communities. Two classic studies have documented fundamental relationships between birds and habitat structure, showing species diversity to increase with the volume and vertical diversity of vegetation (MacArthur and MacArthur, 1961; Willson, 1974). Harvested areas containing patches of trees (Lindenmayer and Franklin, 1997; Merrill et al., 1998) or single scattered trees (Hansen et al., 1995; Schieck et al., 2000) and partial cuts (Crawford et al., 1981; Hagan et al., 1997; Tittler et al., 2001) generally have a greater diversity of bird species than do clearcuts. Thus, we hypothesized that stands with greater residual tree density would have greater avian species richness.

2. Methods

2.1. Study area

The study was conducted in the Rocky Mountains of southeastern BC, Canada, in the White, Lussier, (49°54′–50°24′N, 115°36′–115°06′W) and Vermilion (50°56′–51°13′N, 115°50′–116°05′W) watersheds (Fig. 1). The area includes forests managed for timber production and protected forests (national parks), and covers approximately 100,000 ha within the Montane Spruce dry cool (MSdk, hereafter MS) and the Engelmann Spruce-Subalpine Fir dry cool (ESSFdk, hereafter ESSF) biogeoclimatic zones (Braumandl and Curran, 1992). Biogeoclimatic zones are broad units within the ecological classification system used for forest management in British Columbia, and consist of groupings of subzones based on similar zonal plant associations and climate (Pojar et al., 1987).

The MS occurs from approximately 1200 to 1650 m in elevation on south aspects and 1100 to 1550 m on north aspects. The climax community in the MS is dominated by interior Douglas-fir (*Pseudotsuga menziesii* var. *glauca*), white spruce (*Picea glauca*), and western larch (*Larix occidentalis*). Extensive seral stands of lodgepole pine (*Pinus contorta* var. *latifolia*) are common due to widespread fires, and trembling aspen (*Populus tremuloides*) and paper birch (*Betula papyrifera*) are present, particularly at lower elevations. Understory vegetation is dominated by buffaloberry (*Sheperdia canadensis*), Utah honeysuckle (*Lonicera utahensis*), Sitka alder (*Alnus crispa sinuata*), common juniper (*Juniperus communis*), Oregon grape (*Mahonia aquifolium*), and pinegrass (*Calamagrostis rubescens*).

The ESSF ranges from approximately 1650 to 2100 m on south aspects and 1550 to 2050 m on north aspects. The climax community in the ESSF is dominated by Engelmann spruce